

**LEG DOMINANCE IN LANDING ERROR USING MODIFIED LESS
AMONG ELITE BADMINTON PLAYERS
AN OBSERVATIONAL STUDY**

By

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**In Partial Fulfilment
of the requirements for the degree of
MASTERS OF PHYSIOTHERAPY (M.P.T)
In
SPORTS**

**Under the Guidance of
DR. CHINMAYA KUMAR PATRA (PT)
Principal, ABSMARI.**



**ABHINAV BINDRA SPORTS MEDICINE & RESEARCH INSTITUTE
Bhubaneshwar, Odisha
2022-2024**

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled “**“Leg dominance in Modified Landing Error Scoring System (LESS) among Badminton players- An Observational Study”**” is a bonafide and genuine research work carried out by me under the guidance of **Dr. Chinmaya Kumar Patra, Principal, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar**

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LIST OF ABBREVIATIONS USED

LESS - Landing Error Scoring System

TABLE OF CONTENTS

Sr.no	Content	Page No
1	Abstract	1
2	Introduction	3
3	Need of the study	6
4	Review of literature	7
5	Aim & Objective of the study	10
6	Hypotheses	11
7	Material & Methodology	12
8	Procedure	17
9	Statistical analysis	18
10	Results	19
11	Discussion	24
12	Conclusion	28
13	Clinical Implication	29
14	Summary	31
15	Limitations	32
16	References	34
17	Annexures 1-Consent Form	37
18	Annexure 2-Proforma	38
19	Annexure 3-Ethical Clearance	39
20	Annexure 4-Masterchart	41

LIST OF TABLES

Sr. No	Table	Page No.
1	Normality of Age and LESS score	19
2	Normality of Gender	20
3	Within Group Comparison	21
4	Between Group Comparison	22

LIST OF FIGURES

Sr. No.	Graph	Page No.
1	Normality of Age and LESS score	19
2	Normality of Gender	20
3	Within Group Comparison	22
4	Between Group Comparison	23

ABSTRACT

Title:

Leg dominance in Modified Landing Error Scoring System (LESS) among Badminton players- An Observational Study”

Background and Objective:

This observational study aimed to investigate the presence of leg dominance in landing errors among recreational and elite badminton players using a modified Landing Error Scoring System (LESS). The study sought to identify whether significant differences exist between the dominant and non-dominant legs within each group and to compare the landing error scores between recreational and elite players.

Methods:

The study included 24 participants, with 12 recreational and 12 elite badminton players, comprising an equal number of males and females (6 males and 6 females in each group). Landing error scores for both the dominant and non-dominant legs were recorded using a modified LESS. Statistical analyses were conducted to compare the landing error scores between the dominant and non-dominant legs within each group, as well as between the recreational and elite groups.

Results:

The results indicated a statistically significant difference ($p < 0.05$) between the dominant and non-dominant leg scores in recreational badminton players, suggesting the presence of leg dominance in landing errors within this group. However, no statistically significant difference ($p > 0.05$) was observed between the dominant and non-dominant legs in elite badminton players, indicating more symmetrical landing mechanics. Furthermore, a statistically significant difference ($p <$

0.05) was found between the recreational and elite groups, with elite players showing fewer landing errors overall.

Conclusion:

The study concludes that recreational badminton players exhibit leg dominance in landing errors, which may be attributed to asymmetrical neuromuscular control and muscle strength. In contrast, elite players demonstrate more balanced landing mechanics, likely due to specialized training that enhances bilateral coordination.

The findings suggest the importance of incorporating bilateral training in recreational players to reduce asymmetries and potentially lower injury risk.

Keywords:

badminton, elite athletes, leg dominance, landing errors, modified LESS, recreational athletes,

INTRODUCTION

Badminton holds a significant position in India, thriving as both a competitive sport and a beloved recreational activity. Renowned for its fast-paced gameplay, it stands out as the quickest among racquet sports, predominantly featuring overhead shots [1]. The sport demands high intensity from its players, requiring them to execute a diverse array of movement patterns including jumps, lunges, and rapid changes in direction [2]. To excel in badminton, athletes must possess a blend of physical attributes such as aerobic stamina, agility, strength, speed, and precision. Moreover, the technical aspect of badminton necessitates strong motor coordination and the mastery of sophisticated racquet movements [1].

Characterized by unilateral strokes, badminton mandates varied landing strategies that correspond to the direction of each stroke, showcasing its inherent asymmetry [2] [3]. A pivotal technique in badminton matches is the jump smash, where players leap to execute a powerful overhead shot aimed at steepening the shuttlecock's trajectory upon contact. Interestingly, despite the stability provided by using both feet for jumping and landing, the majority of players opt for a single-foot technique during jump smashes. This approach allows for greater elevation and control over the shuttlecock's placement [4].

In addition to the jump smash, another notable maneuver in badminton is the lateral jump smash, frequently employed in doubles matches as an effective backcourt attack move. Players receive specialized training to perfect this technique, underscoring the strategic depth of the sport [2]. Recent studies have highlighted that approximately 21.07% of all badminton game events involve single-leg landings

following overhead strokes, with a significant proportion occurring on the backhand side of the court [5].

Jumping remains a prevalent tactic in badminton smashes, complementing the use of deceptive skills to outwit opponents and secure crucial points during matches [4].

The Landing Error Scoring System (LESS) serves as a crucial clinical tool developed to assess the biomechanics of jump landings using standard video cameras.

Research has validated the LESS, demonstrating good-to-excellent interrater and intrarater reliability, making it a reliable method for identifying movement patterns that may predispose athletes to injury [6].

Like other pre-participation screening tools, the primary objective of the LESS is to detect individuals demonstrating risky movement patterns relevant to their sport-specific activities [7]. The LESS holds potential as a valuable tool for large-scale screenings aimed at identifying individuals at risk for non-contact ACL injuries and other serious lower extremity injuries [6].

Despite its efficacy in evaluating bilateral jump-landing tasks, the LESS has limitations in predicting future ACL injuries due to the bilateral nature of the landing task. Research indicates that the majority of injuries occur during single-leg movements, which place greater stresses on the trunk and lower extremities [7]. To address this gap, there is a recognized need for the development of scoring systems akin to the LESS that can assess movement mechanics during single-leg tasks. Such advancements could significantly enhance knee injury risk screening protocols, particularly in sports like badminton [7].

Leg dominance, extensively studied in sports such as soccer, basketball, and volleyball, remains relatively underexplored within the context of badminton. Leg

dominance refers to an individual's inclination to favor one leg over the other for activities involving unilateral movements. This preference can influence movement patterns and potentially affect injury risks in athletes [8].

To contribute to this area of research, an observational study employing the Modified Landing Error Scoring System (LESS) aims to investigate leg dominance and its impact on landing errors among badminton players. This study seeks to provide valuable insights for coaches, trainers, and sports medicine professionals, ultimately aiming to enhance injury prevention strategies and optimize athletic performance.

In conclusion, badminton's popularity in India as both a recreational pursuit and a competitive sport underscores its dynamic nature and the physical demands it places on athletes. The strategic use of techniques like the jump smash and lateral jump smash highlights the sport's complexity and tactical depth. The development and application of assessment tools such as the LESS reflect ongoing efforts to understand and mitigate injury risks associated with badminton-specific movements. Future research into leg dominance and its implications for landing mechanics promises to enhance our understanding of athlete safety and performance optimization in badminton.

NEED FOR STUDY

The findings of this study will have important implications for injury prevention and performance optimization in elite Badminton Players. By understanding the influence of leg dominance on landing error, one can design tailored training program that addresses specific landing technique and its deficiencies in players. This observational study aims to provide valuable information regarding leg dominance and landing errors among elite badminton players, contributing to injury prevention, performance optimization and rehabilitation.

REVIEW OF LITERATURE

- ✓ Min Hao Hung.et.al (2022) conducted a study on **“The Applications of Landing Strategies in Badminton Footwork Training on a Backhand Side Lateral Jump Smash”** The aim of the study was to explore the applications of landing strategies while performing smashes, target striking, and shadow training in badminton. It was found that striking the target could affect the landing strategies used by players. The condition under which a player hits a shot to a target area can affect the landing. The results of this study suggest that target practice is more effective for improving the landing technique employed during actual shots than shadow practice.

- ✓ Ivana Hanzlíková¹.et.al (2022) conducted a study on **“Preliminary Scoring Template of a Modified Landing Error Scoring System”** The aim of this technical report was to present a preliminary scoring template of a modified LESS applied to a SLJLrot task that is likely to be more sport-specific.

- ✓ Maegan L. O'Connor (2015) conducted a study **“The Development of the Single-Leg Landing Error Scoring System (SL-LESS) for Lower Extremity Movement Screening”** The purpose of this study was to investigate the validity and reliability of the Single-Leg Landing Error Scoring System (SL-LESS) to identify individuals who may be at a greater risk of knee

injury. This study found that the SL-LESS demonstrated fair interrater reliability and good test-retest reliability.

- ✓ Darin A. Padua.et.al (2009) conducted a study on **“The LESS is a valid and reliable clinical assessment tool of jump landing biomechanics- The Jump ACL study”**. The purpose of this study was to investigate the concurrent validity and reliability of the LESS. Laboratory based 3-dimensional motion analysis was used as the gold standard against which we assessed the validity of the LESS. The study reported that subjects with poor (high) LESS scores demonstrated different lower extremity kinematics and kinetics across multiple biomechanical factors and in multiple planes of motion. The LESS demonstrated good-to-excellent interrater and intrarater reliability. On the basis of these findings the LESS is a valid and reliable assessment of overall jump-landing biomechanics that considers multiplanar movement patterns. Potentially, the LESS is a useful clinical assessment tool to use during large-scale screening to identify those at risk for noncontact ACL injury and other serious lower extremity injury.

- ✓ Timothy E. Hewett.et.al (2005)conducted a study on **“Reducing knee and anterior cruciate ligament injuries among female athletes- A systematic review of neuromuscular training interventions”** . The study emphasized that poor landing mechanics and asymmetrical loading are major contributors to injury risk, highlighting the need for targeted training interventions. This is

relevant to the current study as it focuses on landing errors and leg dominance in badminton players.

- ✓ Felipe P. Carpes .et.al (2010) conducted a study on **“On the bilateral asymmetry during running and cycling- A review considering leg preferences”** Author reviewed the prevalence of bilateral asymmetry during running and cycling, noting that leg preference and habitual activity patterns often lead to muscle imbalances, which are linked to a higher risk of injury
- ✓ Fousekis K .et.al conducted a study on **“Intrinsic risk factors of noncontact ankle sprains in soccer: a prospective study on 100 professional players”** Author explored the intrinsic risk factors of non-contact ankle sprains in professional soccer players, finding that higher skill levels and experience were associated with more symmetrical movement patterns and lower injury rates

AIM OF THE STUDY

To investigate and compare leg dominance in landing error among badminton players using Modified Landing Error Scoring System (LESS).

OBJECTIVE OF THE STUDY

- To assess landing errors in elite badminton players using modified Landing error scoring system (LESS)
- To determine the influence leg dominance in landing errors by comparing the dominant and non-dominant legs of the players.

HYPOTHESES

- **Null Hypotheses (H01):** - There will be no significant difference in landing errors between the dominant v/s non-dominant legs among elite badminton players when assessed using the modified Landing error scoring system (LESS)
- **Null Hypotheses (H02):** - There will be no significant difference in landing errors between the dominant v/s non-dominant legs among Recreational badminton players when assessed using the modified Landing error scoring system (LESS)
- **Alternative Hypotheses (Ha1):** -There will be significant difference in landing errors between the dominant v/s non-dominant legs among elite badminton players when assessed using the modified Landing error scoring system (LESS)
- **Alternative Hypothesis (Ha2):** -There will be significant difference in landing errors between the dominant v/s non-dominant legs among Recreational badminton players when assessed using the modified Landing error scoring system (LESS)

MATERIALS AND METHODODLOGY

- **STUDY DESIGN:** - Observational Study
- **STUDY POPULATION:** - Elite Badminton Players & Recreational badminton players
- **SAMPLE SIZE:** - 30
- **SAMPLING DESIGN:** - Purposive Sampling.
- **STUDY SETTING:** - Badminton Academy in Bhubaneswar (Proposed SAI Academy Bhubaneswar)
- **STUDY DURATION:** - 1year
 - Ethical clearance- 6 Months
 - Sample selection, data collection- 4 Months
 - Statistical analysis, result, discussion: - 2Months
- **MATERIALS REQUIRED:** - 1) 2 Video Cameras
 - 2) Measuring Tape
 - 3) 20 cm Box
 - 4) Marking Tapes
 - 5) Laptop

INCLUSION CRITERIA: - Age- 11 to 19years

: - Both genders

: - no significant restriction of movement or

muscle weakness

: - no lower extremity pain before the test

: -training at least four times a week.

: -badminton players with the right hand as the
dominant hand.

: -no history of surgery on the lower limbs or
musculoskeletal disorders in a span of 1 year

SINGLE LEG – LANDING ERROR SCORING SYSTEM

- Participants will be provided with standardized verbal instructions on the single leg drop vertical jump (SLDVJ).
- Participants then will complete 2-3 practice trials on each leg from the ground and then from the box. During this time the participant will choose the leg they felt most comfortable performing the task on during the data collection.
- The SLDVJ consisted of the participant standing on a 20 cm box on a single leg and then jumping out a distance of 25% of their height and landing with that same leg.
- Immediately following landing the participant progress into a single-leg maximal vertical jump with arms moving freely. An emphasis will be placed on the participants jumping as high as possible after landing from the box.

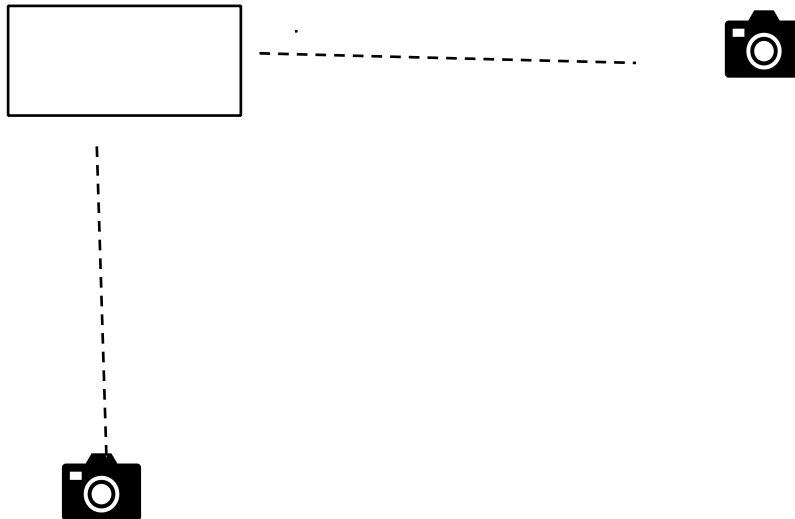
CAMERA PLACEMENT: -

Two standard video cameras on tripods will be placed 3.6 m anterior and 3.6 m lateral to the test limb at a height of 95 cm.

Five valid trials of the SLDVJ will be recorded and the first three valid trials will be used for analysis.

Jump Box of height 20cm

Frontal plane camera set
95cm from lens to floor



Sagittal plane camera set
95 cm from lens to floor

➤ **SCORING:** - Using Kinovia Software

1&2 = Good

3 = Moderate

≥ 4 = Poor

➤ **WARM UP PROTOCOL:** - a) 5 min jog on treadmill at self-selected

pace

b) 2 sets x 8 repetitions of Squats

c) 2 sets x 5 repetitions of Maximal vertical
jump.

➤ **EXCLUSION CRETERIA: -**

A trial will be considered invalid if the a) participant did not jump off one

foot

b) jumped vertically off the box

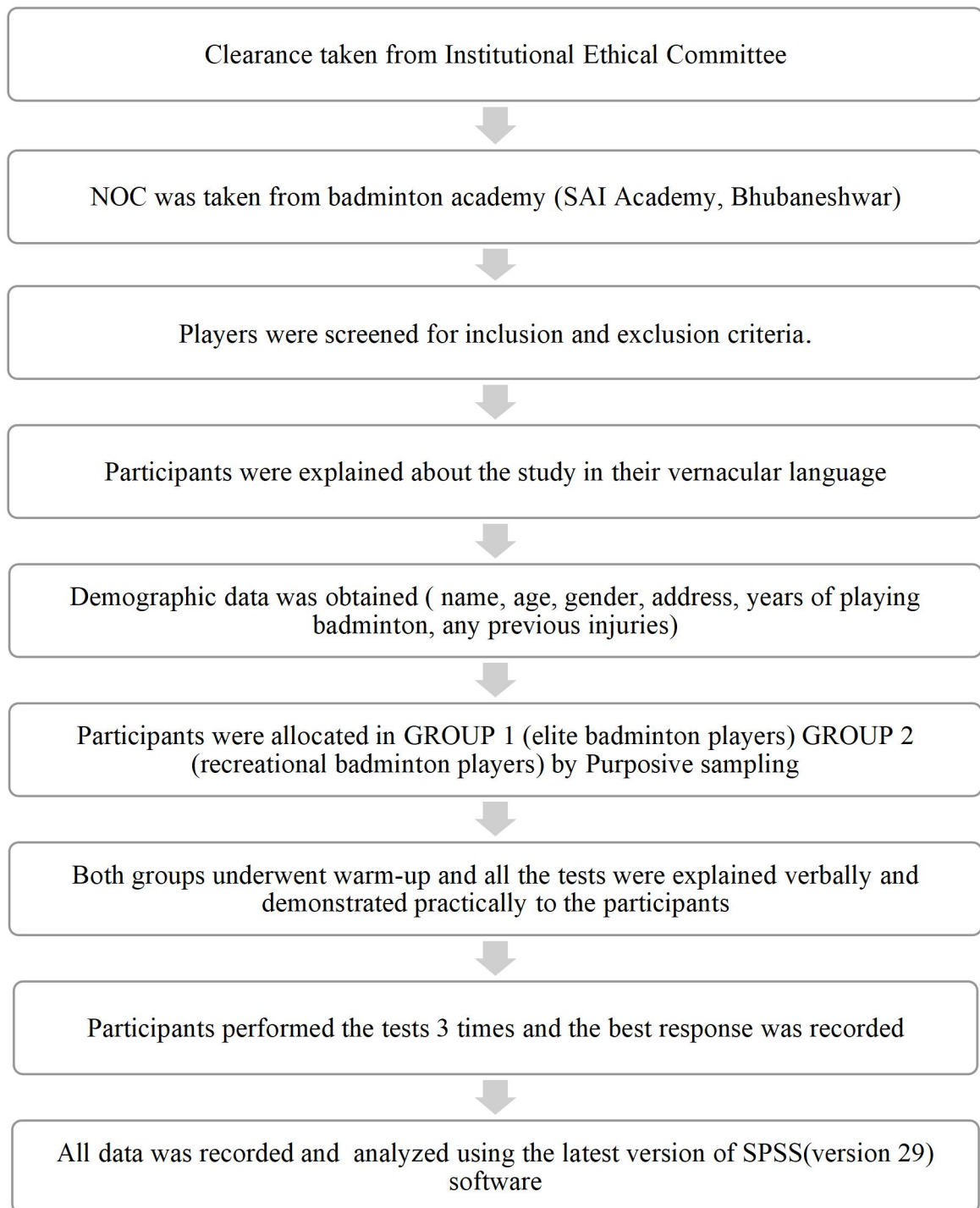
c) don't land with entire foot

d) touched the ground with the
non-supporting

e) lost balance/fell,

f) do not complete the task in a
fluid motion.

PROCEDURE



STATISTICAL ANALYSIS

Statistical Analysis was performed using SPSS statistical package of social sciences version 25. The normality of the data was found using Shapiro-Wilk Test. Descriptive analysis was done using median and interquartile range. The inferential statistics that is Wilcoxon Signed Ranked Test was used for within group comparison and Mann Whitney U test was used for between group comparison. The level of significance (p value) kept at ≤ 0.05 .

VARIABLES

- Independent Variable: - Leg dominance
- Dependent Variable: - SL-LESS

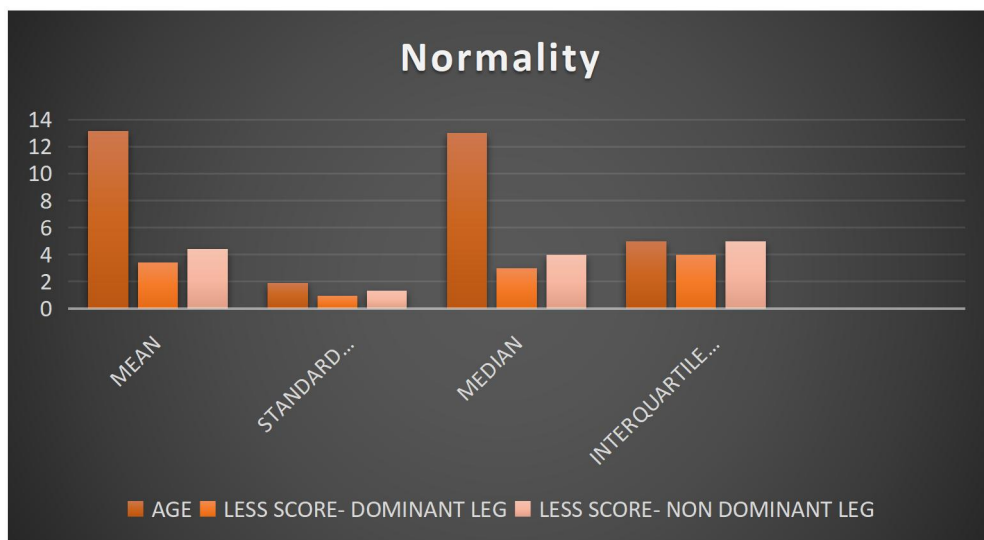
Between Group Comparison – Dominant Leg vs Non-Dominant Leg

Within Group Comparison – Recreational Players vs Elite Players

RESULT

	AGE	LESS SCORE- DOMINANT LEG	LESS SCORE- NON DOMINANT LEG
MEAN	13.17	3.42	4.42
STANDARD DEVIATION	1.88	0.974	1.316
MEDIAN	13	3	4
INTERQUARTILE RANGE	5	4	5

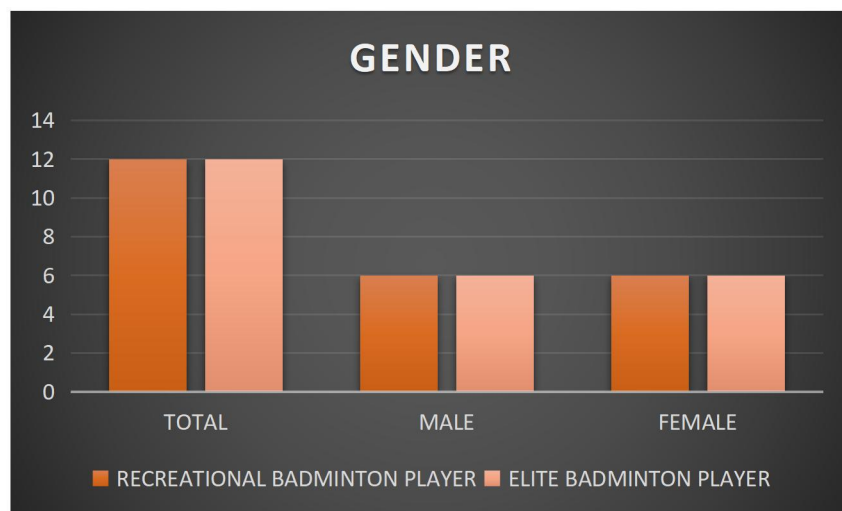
Table 1 : Normality of age and LESS score of dominant and non-dominant leg



Graph 1. Normality of age and LESS score of dominant and non-dominant leg

GROUPS	TOTAL	MALE	FEMALE	PERCENT
RECREATIONAL BADMINTON PLAYER	12	6	6	50.0
ELITE BADMINTON PLAYER	12	6	6	50.0

Table 2 : Normality of gender



Graph 2. Normality of gender

The above table (Table1 & Table 2) shows the normality of age and LESS score of dominant and non- dominant leg and normality of gender respectively which suggest that the data is **Not Normally distributed** using Shapiro Wilk Test.

GROUP	DOMINANT LEG Median(IQR)	NON DOMINANT LEG Median(IQR)	Z VALUE	p VALUE
RECREATIONAL	4(1.25)	5.5(1.25)	-2.859	(p >0.05)
ELITE	3(0.25)	4(1)	-1.469	(p >0.05)

Table 3 Within Group Comparison

The above table shows within the group data by using **Wilcoxon Signed Ranked Test**.

The result showed that there was **statistically significant difference (p>0.05)** between dominant leg score and non-dominant leg score in Recreational Badminton players. It reports that the LESS score is more in non-dominant leg than in dominant leg in recreational badminton players. It states that LESS score is higher in non-dominant leg than in dominant leg in Recreational Badminton Player.

It also showed that there was **statistically non-significant difference (p >0.05)** between dominant and non-dominant leg in Elite Badminton players. It reports that the LESS score has no difference in non-dominant leg than in dominant leg in Elite badminton players. It states that there is no difference in LESS score between non dominant and dominant leg in Elite Badminton Players



Graph 3. Within group Comparison

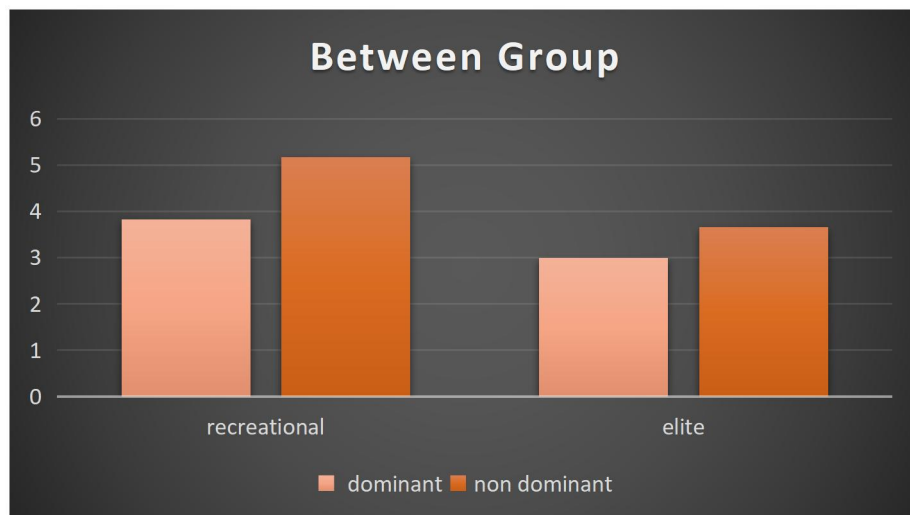
GROUPS	MEDIAN	IQR	p VALUE
RECREATIONAL DOMINANT	4	1.25	(p <0.05)
ELITE DOMINANT	3	0.25	
RECREATIONAL NON-DOMINANT	5.5	1.25	(p <0.05)
ELITE NON-DOMINANT	4	1	

Table 4 : Between Groups Comparison

The above table shows the between group data by using **Mann Whitney U Test**.

The result showed that there was a **statistically significant (p <0.05)** difference between the group. It reported that there was no difference in dominant leg between Recreational and Elite Badminton players. Which means LESS score has no difference (less landing error) in dominant leg in Recreational and Elite badminton players.

The result showed that there was a **statistically significant ($p < 0.05$)** difference between the group. It reported that there was no difference in non-dominant leg between Recreational and Elite Badminton players. Which means LESS score has no difference (less landing error) in dominant leg in Recreational and Elite badminton players.



Graph 4. Between group comparison

DISCUSSION

The current study aimed to investigate leg dominance in landing errors among recreational and elite badminton players using a modified Landing Error Scoring System (LESS). The findings provide valuable insights into the differences in neuromuscular control and movement symmetry between these two groups, highlighting the impact of training and skill level on athletic performance and injury risk.

Leg Dominance in Recreational Badminton Players-

The study found a statistically significant difference ($p < 0.05$) between the dominant and non-dominant legs in terms of landing errors among recreational badminton players. This suggests that these athletes have a greater reliance on their dominant leg, which may be more developed in terms of strength, coordination, and stability. This reliance could result from the habitual use of the dominant leg in various daily activities and sports-specific movements, leading to muscle imbalances and asymmetries in movement patterns.^[9]

These imbalances are common in recreational athletes, who typically do not engage in structured, comprehensive training programs that emphasize bilateral development. As a result, their non-dominant leg may exhibit weaker neuromuscular control, leading to a higher incidence of landing errors. The findings align with previous research that has documented significant asymmetries in muscle strength, balance, and coordination among recreational athletes, contributing to a higher risk of injury ^[11,15]

The presence of leg dominance in recreational players also suggests that they may be at a greater risk of lower extremity injuries, particularly during high-impact

activities like jumping and landing. Landing mechanics are critical in injury prevention, and asymmetrical landing patterns can place excessive strain on the musculoskeletal system, particularly the knee joint, increasing the likelihood of conditions such as anterior cruciate ligament (ACL) injuries ^[8,13]

Balanced Landing Mechanics in Elite Badminton Players

In contrast, elite badminton players did not show a statistically significant difference ($p > 0.05$) between their dominant and non-dominant legs concerning landing errors. This finding suggests that these athletes possess a more balanced neuromuscular control and symmetrical movement patterns, likely resulting from years of intensive training and sport-specific conditioning. Elite athletes undergo rigorous training regimens that focus on developing both sides of the body equally, enhancing bilateral coordination, and minimizing movement asymmetries ^[10]

The absence of significant leg dominance in elite players indicates a well-developed proprioceptive and neuromuscular system, which is crucial for the high-speed, multidirectional movements required in badminton. This balanced development is a hallmark of elite performance and is achieved through targeted training that includes plyometrics, strength conditioning, agility drills, and proprioceptive exercises designed to improve balance and reduce injury risk. ^[12,16]

Furthermore, elite players' ability to land symmetrically with both legs suggests that their training has effectively minimized the habitual reliance on a single limb, which is common in less experienced athletes. This balance is essential in sports like badminton, where athletes must frequently and rapidly change direction, requiring equal contribution from both legs to maintain stability and performance. ^[14]

Inter-group Comparisons

When comparing recreational and elite badminton players, the study revealed a statistically significant difference ($p < 0.05$) in landing errors between the two groups. Elite players exhibited fewer landing errors overall, highlighting the impact of advanced training, experience, and skill level on movement efficiency and neuromuscular control. These findings suggest that the training methodologies employed by elite athletes are effective in promoting symmetrical movement patterns and reducing the risk of injury.^[8]

The significant difference between the groups also emphasizes the importance of structured, sport-specific training programs in developing balanced and efficient movement mechanics. Recreational players, who may not have access to such training, are more likely to exhibit asymmetries and associated risks of injury.^[17] This reinforces the need for recreational athletes to engage in comprehensive training that includes bilateral exercises, proprioceptive training, and corrective exercises to address muscle imbalances and improve overall movement quality.^[16]

Implications and Future Directions

The findings of this study have several important implications for both coaches and athletes. For recreational players, it is crucial to incorporate exercises that focus on enhancing the strength, stability, and neuromuscular control of the non-dominant leg. This can help reduce the asymmetry observed in landing errors and potentially lower the risk of injury. Exercises such as single-leg squats, lateral lunges, and proprioceptive drills can be particularly effective in promoting balanced development.^[14]

For elite players, maintaining a focus on bilateral training is essential to prevent the development of leg dominance over time. Given the high physical demands of badminton, ongoing attention to symmetry in movement and muscle strength can help elite athletes sustain their performance levels and reduce the risk of overuse injuries.^[10]

Future research could explore the long-term effects of targeted bilateral training interventions on reducing leg dominance in recreational players and maintaining symmetry in elite athletes. Additionally, examining the relationship between landing errors, muscle asymmetry, and injury incidence across different skill levels and sports could provide further insights into effective injury prevention strategies. Studies could also investigate the role of fatigue in landing mechanics and whether asymmetries become more pronounced under conditions of physical stress.^[18]

In conclusion, this study highlights the importance of balanced neuromuscular control in preventing landing errors and associated injuries in badminton players. By understanding the differences in leg dominance between recreational and elite athletes, coaches and trainers can develop more effective training programs that enhance performance and reduce injury risk.

CONCLUSION

The study concludes that recreational badminton players exhibit significant leg dominance in landing errors, with a notable difference between their dominant and non-dominant leg scores. This indicates potential neuromuscular imbalances in recreational players. In contrast, elite badminton players show no significant difference between their legs, suggesting more symmetrical and balanced landing mechanics. The comparison between the two groups reveals that elite players have overall fewer landing errors, underscoring the impact of advanced training on movement efficiency and control. These findings highlight the importance of targeted bilateral training to reduce asymmetries and minimize injury risk, particularly in recreational athletes.

CLINICAL IMPLICATION

The findings of this study have several important clinical implications, particularly for injury prevention and performance enhancement in badminton players:

1. Targeted Training for Recreational Players: The significant leg dominance observed in recreational players suggests a need for targeted training programs that address neuromuscular imbalances. Clinicians and coaches should incorporate bilateral exercises focusing on strengthening the non-dominant leg, improving proprioception, and enhancing overall balance and coordination. This can help reduce asymmetries and lower the risk of injuries such as ACL tears, which are often associated with improper landing mechanics.

2. Injury Prevention for Elite Players: Although elite players demonstrated more symmetrical landing mechanics, ongoing monitoring and training are essential to maintain this balance. Regular assessments using tools like the modified LESS can help identify any emerging asymmetries that could increase injury risk over time. Preventative strategies, including sport-specific drills and neuromuscular training, should be maintained to support symmetrical movement patterns and prevent overuse injuries.

3. Customizing Rehabilitation Programs: For players recovering from lower limb injuries, understanding the differences in leg dominance can help tailor rehabilitation programs. Emphasizing exercises that promote bilateral strength and coordination may improve recovery outcomes and prevent re-injury by ensuring that both legs can handle the physical demands of the sport equally.

4. Performance Optimization: For both recreational and elite athletes, addressing leg dominance through targeted interventions can lead to more efficient movement patterns, improved performance, and reduced energy expenditure during play. Clinicians and trainers should use this information to optimize training regimens, enhancing the overall athletic capability of the players.

5. Long-term Athlete Development: The study highlights the importance of early intervention in addressing leg dominance. Implementing balanced training strategies from a young age could contribute to the long-term development of athletes, fostering better movement symmetry, reducing injury risks, and enhancing performance longevity.

By applying these clinical implications, coaches, physiotherapists, and sports medicine professionals can help badminton players at all levels improve their biomechanics, reduce injury risk, and enhance overall athletic performance.

SUMMARY

This study focused on evaluating leg dominance in landing errors among recreational and elite badminton players using a modified Landing Error Scoring System (LESS). The study included 24 participants, with an equal number of males and females in both the recreational and elite groups.

The findings revealed that recreational badminton players exhibited a significant difference in landing errors between their dominant and non-dominant legs, indicating leg dominance and potential neuromuscular imbalances. In contrast, elite players showed no significant difference between their legs, suggesting more symmetrical landing mechanics and better overall neuromuscular control, likely due to their advanced training.

Additionally, when comparing the two groups, elite players had significantly fewer landing errors overall, highlighting the impact of skill level and training on movement efficiency. The study emphasizes the importance of bilateral training for recreational players to address asymmetries, enhance performance, and reduce injury risk.

LIMITATIONS

1. Small Sample Size: The study included only 24 participants, which limits the generalizability of the findings. A larger sample size would provide more robust data and enhance the reliability of the results.

2. Limited Demographic Diversity: With only 12 participants in each group and an equal split between males and females, the study may not capture the full variability in landing mechanics across different ages, skill levels, and body types.

3. Single Observation Method: The study relied on a modified Landing Error Scoring System (LESS) for evaluating landing errors. While LESS is a useful tool, combining it with other assessment methods, such as motion analysis or force plate data, could provide a more comprehensive understanding of landing mechanics.

4. Lack of Intervention: The study did not include an intervention or training program to address the identified leg dominance, making it difficult to assess the effectiveness of targeted training on improving symmetry and reducing landing errors.

5. Generalization to Other Sports: The findings are specific to badminton players and may not be directly applicable to athletes in other sports with different movement patterns and demands. Further research is needed to explore leg dominance across various sports.

6. Gender Differences: Although the study included an equal number of male and female participants, it did not specifically analyze gender differences in landing mechanics, which could have provided additional insights into sex-specific neuromuscular control and injury risk.

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and confidentiality concerns but are available from the corresponding author on reasonable request. The detailed original data underlying the findings of this study, including raw measurements and analysis files, are securely stored and can be accessed upon request for research and verification purposes.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that the research was conducted in the absence of any commercial or financial relationships.

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ANNEXURE: 1

CONSENT FORM

TITLE:- LEG DOMINANCE IN LANDING ERROR USING MODIFIED LANDING ERROR SCORING SYSTEM (LESS) AMONG BADMINTON PLAYERS- AN OBSERVATIONAL STUDY

PARTICIPANT: -

I confirm that NIDDHI THAKUR has explained me the purpose of the research, the study procedure and the possible risks and benefits that I may experience. I have read and understood this consent to participate as a subject in this research project.

Name-

Signature

INVESTIGATOR: -

I have explained to _____ the purpose of the research, the study procedure and the possible risks and benefits to the best of my ability. I have made every effort to make the participant understand and clear all questions put forward.

Name of Investigator: - NIDDHI DEVENDRA THAKUR

Signature: -

ANNEXURE 2

PROFORMA

NAME: -

AGE: -

GENDER: -

CONTACT NO: -

PLAYING EXPERIENCE: -

LEG DOMINANCE: -

HEIGHT (in cm): -

WEIGHT (in kg): -

SR NO	ITEMS	RIGHT	LEFT
1	Forward Trunk Flexion at IC		
2	Knee Flexion at IC		
3	Ankle Plantarflexion at IC		
4	Forward trunk flexion displacement		
5	Knee flexion Displacement		
6	Ankle Dorsiflexion Displacement		
7	Knee Valgus at IC		
8	Lateral trunk flexion at IC		
9	Knee valgus Displacement		
10	Pelvic Drop		
11	Tibial Rotation (toe in /toe out)		

ANNEXURE 3

ETHICAL CLEARANCE LETTER



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/048

Date: 12/08/2023

APPROVAL LETTER

APPENDIX- VIII

To,

MEMBERS
Dr. Smaraki Mohanty, Clinician
Dr. Satyajit Mohanty, Basic Medical Scientist
Dr. Ashok Singh Chouhan Basic Medical Scientist
Mr. Shilb 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

NIDDHI THAKUR
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: Leg Dominance In Landing Error Using Modified Landing Error Scoring System (Less) Among Badminton Players – An Observational Study

Protocol ID.: ABS-IEC-2023-PHY-007

Subject: Approval for the conduct of the above referenced study

Dear Mr./Mrs./Dr NIDDHI THAKUR

With reference to your Submission letter dated 12/08/2023 the ABSMARI IEC has of the Ethics reviewed and discussed your application for conduct of clinical trial on dated 12/08/2023 (Sat Day).

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	08-08-2023
2	Informed Consent Form	08-08-2023
3	Undertaking form PI	08-08-2023
4	CRF	08-08-2023
5	COI from the investigators	08-08-2023

The following members were present at meeting held on 12-08-2023

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Satyajit Mohanty	Director-Medcare Hospital, BBSR	Basic Medical Scientist	M	N
3	Dr. Ashok Singh Chouhan	PhD. Pharmacology, Assoc. Prof. Dept. of Pharmacology, Hi-Tech Medical College & Hospital, BBSR	Basic Medical Scientist	M	N





ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/048

Date: 12/08/2023

MEMBERS
Dr. Smaraki Mohanty, Clinician
Dr. Satyajit Mohanty, Basic Medical Scientist
Dr. Ashok Singh Chouhan Basic Medical Scientist
Mr. Shilb 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

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
4	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
5	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
6	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
7	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
8	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
9	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the trial in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and requests to be provided a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.



Yours sincerely


Mr. Chinmaya Kumar Patra
Member Secretary

Member Secretary
ABSMARI ETHICS COMMITTEE
Pahal, Bhubaneswar

ANNEXURE 4
MASTERCHART