EFFICACY OF PLYOMETRIC TRAINING ON DYNAMIC LEAP BALANCE AND JUMP PERFORMANCES IN RECREATIONAL PLAYERS: A SINGLE-GROUP EXPERIMENTAL STUDY

by

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Utkal University, Bhubaneswar, Odisha

In partial fulfillment

of the requirements for the degree of

MASTER OF PHYSIOTHERAPY (MPT)

in

SPORTS

Under the guidance of

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Bhubaneswar, Odisha

2022 - 2024

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled "**Efficacy of Plyometric Training on Dynamic Leap Balance and Jump Performances in Recreational Players: A Single-group Experimental Study**" is a bonafide and genuine research work carried out by me under the guidance of **Dr. Asifuzzaman Shahriyar Ahmed, Associate Professor**, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar, Odisha.

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ENDORSEMENT BY THE PRINCIPAL

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LIST OF ABBREVIATIONS USED

1. ABSMARI - Abhinav Bindra Sports Medicine and Research Institute
2. BESS - Balance Error Scoring System
3. BMI – Body Mass Index
4. BOS – Base of support
5. DLBT – Dynamic Leap and Balance Test
6. HJT – Horizontal Jump Test
7. PJT – Plyometric Jump Training
8. SD - Standard Deviation
9. SEBT – Star Excursion Balance Test
10. SPSS - Statistical Package for Social Science
11. SSC – Stretch- Shortening Cycle
12. VJT – Vertical Jump Test
13. Y-SEBT – Y modification of Star Excursion Balance Test

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ABSTRACT

TITLE: Efficacy of Plyometric Training on Dynamic Leap Balance and Jump Performances in Recreational Players: A Single-Group Experimental Study

BACKGROUND AND OBJECTIVES: Dynamic balance and jump performance are critical components of athletic performance, particularly in sports that require explosive movements, agility, and stability. Despite its widespread use, the specific impact of plyometric training on these aspects of performance, particularly in recreational athletes, remains underexplored. Recreational players, who engage in sports for enjoyment rather than professional competition, may benefit significantly from targeted training programs that improve their athletic capabilities. This study aims to evaluate the efficacy of Plyometric Jump Training (PJT) on Dynamic leap balance and jump performances among collegiate recreational players.

METHODS: A single-group experimental study was conducted through purposive sampling to recruit 50 recreational players (25 males & 25 females) who were assigned Plyometric /Dynamic Leap and Balance Test (DLBT), Vertical Jump Test, and Horizontal Jump Test.

RESULTS: The single group of recreational players (n=50) showed a significant improvement in the Dynamic Leap and Balance Test (DLBT) ($p<0.05$), Vertical Jump Test (VJT) ($p<0.05$), and Horizontal Jump Test (HJT) ($p<0.05$) after 6 weeks of Plyometric Jump Training (PJT).

INTERPRETATION AND CONCLUSION: Our results indicate that there are significant improvements observed in the DLBT, VJT, and HJT following 6 weeks of Plyometric Jump Training, which underscores the efficacy of this training regimen in enhancing dynamic balance and jump performance among recreational players. These findings support the inclusion of plyometric exercises in training programs aimed at boosting athletic performance in non-professional athletes.

KEYWORDS: DLBT; Horizontal Jump Test; Plyometric; Recreational Players; Single group; Vertical Jump Test.

Efficacy of Plyometric Training on Dynamic Leap Balance and Jump Performances in Recreational Players: A Single-Group Experimental Study

INTRODUCTION

The Greek words plythein or plyo, which means to grow, and metric, which means to measure, are the roots of the English word plyometrics. Plyometrics' goal can be summed up as “to increase the measurement”. Plyometric training utilizes the stretch-shortening cycle (SSC) by using a lengthening movement (eccentric) which is quickly followed by a shortening movement (concentric). (1)

The Plyometric includes three phases: Eccentric pre-stretch, amortization phase, and concentric shortening phase. The strongest forces are produced by plyometrics during the concentric power production phase which is also termed as push off or propulsion phase. For a muscle to develop power as efficiently as possible, the short amortisation phases and the eccentric pre-stretch are crucial. (2)

Plyometric Jump Training (PJT) is a highly dynamic exercise type with various forms of dynamic jump-landing tasks which require high levels of postural control. PJT has the ability to increase measurements of balance as well as muscle strength and power. (3) The possible transfer effects of PJT on dynamic balance measures are less known. PJT frequently consists of exercises that can potentially engage major muscular groups, such as the quadriceps. (2)

Balance is the ability to align body segments against gravity to maintain or move the body (center of mass) within the available base of support without falling; the ability to move the body in equilibrium with gravity via interaction of the sensory and motor systems. [4] Athletes' ability to successfully execute sport-specific abilities depends on balance in addition to being necessary for daily tasks and avoiding falls. [5]

Dynamic Balance is the ability to perform a task while maintaining a stable position. [6] PJT also may improve balance at the same time as jumping (i.e., power), maximal strength, sprinting, and acceleration, thereby providing a time-efficient training method. [7]

A typical PJT program incorporates jump drills that leverage the stretch-shortening cycle of the musculotendinous unit, commonly through vertical/horizontal jumps. [8] Such drills may stimulate factors associated with balance ability, such as sensory information, joint range of motion, and neuromuscular control. [9]

The Dynamic Leap and Balance Test (DLBT) is a dynamic balance test that simulates everyday activities and sports activities. It calls for rapid changes in the base of support, alternating limb weight bearing, and an amount of effort that should be difficult for an active population.

“An acceleration or taking off from one limb and landing on the other limb” is the operational definition of a leap. Unfortunately, there aren't many clinically meaningful tests that can be used to measure dynamic balance. Moreover, the existing tests, like the SEBT, don’t adequately replicate the dynamic balance demands of common daily and sporting activities. The DLBT more closely resembles the difficulties with dynamic stability that are seen in everyday and athletic activity. [10]

Recreational players are those who do not perform sports at a professional or competitive level. Players who play for fun rather than for a living are considered recreational athletes. Tegner's activity level scale classifies sports activity as "recreational" if it receives a score of 7 or lower. [11]

NEED FOR STUDY

1. Further analysis of the Dynamic leap and balance test procedure is required for its general effectiveness as a clinical measure of dynamic stability.

2. This study will serve as a useful benchmark for the Dynamic Leap and Balance Test in future.

3. There is a need for the study to evaluate the effect of Plyometric jump training on Participants with normal (e.g., recreational athletes) physical performance or playing level.

4. Fewer literature (<2) was found addressing the Dynamic Leap and Balance Test (DLBT) as an outcome measure for the dynamic balance.

AIM OF THE STUDY

To evaluate the efficacy of Plyometric Jump Training on Dynamic leap balance and jump performance among collegiate recreational players.

OBJECTIVES OF THE STUDY

1. To evaluate the efficacy of Plyometric Jump training on Dynamic leap balance in recreational collegiate players using the Dynamic leap and balance test.

2. To evaluate the efficacy of Plyometric Jump training on Vertical and Horizontal jump performance in recreational collegiate players using the vertical and horizontal jump test.

HYPOTHESIS

NULL HYPOTHESES:

H_{01}: There will be no significant effect of Plyometric Jump Training on Dynamic Leap Balance in recreational collegiate players.

H_{02}: There will be no significant effect of Plyometric Jump Training on Jump performances in recreational collegiate players.

ALTERNATIVE HYPOTHESES:

H_{11}: There will be a significant effect of Plyometric Jump Training on Dynamic Leap Balance in recreational collegiate players.

H_{12}: There will be a significant effect of Plyometric Jump Training on Jump performances in recreational collegiate players.

REVIEW OF LITERATURE

1. Akhilesh Kumar Ramachandran, Utkarsh Singh, Rodrigo Ramirez-Campillo, Filipe Manuel Clemente, José Afonso, Urs Granacher (2021)
   "Effects of Plyometric Jump Training on Balance Performance in Healthy Participants: A Systematic Review with Meta-Analysis"
   [Frontiers in Physiology]

   This study stated that Plyometric Jump Training is a highly dynamic exercise mode with various forms of jump-landing tasks, high levels of postural control are needed to successfully perform Plyometric Jump Training exercises. The study concluded that Plyometric Jump Training can also be used as a potential training method for improving balance performance, in conjunction with other physical characteristics such as muscular strength and power. PJT appears to be an adequate training regime to improve balance in both, athletic and recreational settings.

2. George Davies, Bryan L Riemann, Robert Manske (2015)
   "Current Concepts of Plyometric Exercise"
   [International Journal of Sports Physical Therapy]

   The purpose of the clinical commentary was to provide an overview of plyometrics including definition, phases, the physiological, mechanical and neurophysiological basis of plyometrics, and to describe clinical guidelines and contraindications for implementing plyometric programs.

3. Abbis H Jaffri, Thomas M Newman, Brent I Smith, Sayers John Miller (2017)
   “The Dynamic Leap and Balance Test (DLBT): A Test-Retest Reliability Study”
   [International Journal of Sports Physical Therapy]

   The test-retest reliability study concluded that the Dynamic leap and balance test is a cost-effective, easy-to-administer, and clinically relevant novel measure for assessing dynamic balance with excellent test-retest reliability. The ICC was 0.93 with a 95% confidence interval from 0.84 to 0.96.

4. Abbis H Jaffri, Thomas M Newman, Brent I Smith, Giampietro L Vairo, Craig R Denegar, William E Buckley, Sayers J Miller (2020)
   “Dynamic Leap and Balance Test (DLBT): Ability to Discriminate Balance Deficits in Individuals with Chronic Ankle Instability”
   [Journal of Sport Rehabilitation]

   The case-control study stated that DLBT is a new dynamic balance task that requires serial changes in the base of support (BOS) with alternating limb support and recovery of dynamic stability, as compared to the Y modification of the Star Excursion Balance Test (Y-SEBT), which assesses dynamic stability over an unchanging BOS. The study concluded the results of the DLBT were found to be non-redundant with those of the Y-SEBT suggesting the tests provide different challenges to the postural control system.

   The DLBT is a cost-effective and easy-to-use tool for assessing dynamic balance that may be valuable for monitoring rehabilitation intervention progress and identifying those at risk of re-injury.

5. Peter Maulder, John Cronin (2005)

   “Horizontal and vertical jump assessment: reliability, symmetry, discriminative and predictive ability”

   [Physical Therapy in Sports]

   The study included eighteen sportsmen who performed unilateral jump assessments involving the horizontal squat jump, horizontal countermovement jump, horizontal repetitive jump, vertical squat jump, vertical countermovement jump, and vertical repetitive jump. The test-retest reliability of the horizontal jump (ICC=0.90), and vertical jump (ICC=0.84-0.90) concluded that the horizontal jump test is reliable for assessing leg power.

6. Zarizi Ab Rahman, Azlan Ahmad Kamal, Mohad Anizu Mohd Noor, Soh Kim Geok, Alnedral (2021)

   “Reliability, Validity, and Norm References of Standing Broad Jump”

   [Revista Geintec]

   This study involved 60 subjects and six raters for reliability and validity. The results suggest that Standing Broad Jump are reliable and valid with the norm for assessing leg power. The instrument's consistency was determined by test-retest, and Pearson Correlation showed (r=0.96) for male subjects, and (r =0.90) for female subjects was very high.

7. Rodrigo Ramírez-Campillo, Francisco Gallardo, Carlos Henriquez-Olguín, Cesar M P Meylan, Cristian Martínez, Cristian Álvarez, Alexis Caniuqueo, Eduardo L Cadore, Mikel Izquierdo (2015)
   “Effect of Vertical, Horizontal, and Combined Plyometric Training on Explosive, Balance, and Endurance Performance of Young Soccer Players. Journal of Strength and Conditioning Research”
   [Journal of Strength and Conditioning Research]

   The study aimed to compare the effects of 6 weeks of vertical, horizontal, or combined vertical and horizontal plyometric training on muscle explosive, endurance, and balance performance. The study demonstrated that vertical, horizontal, and combined vertical and horizontal jumps induced meaningful improvement in explosive actions, balance, and intermittent endurance capacity. Combining vertical and horizontal drills seems more advantageous to induce greater performance improvements.

METHODOLOGY

A single-group experimental study was conducted to investigate the balance and jump performances in recreational athletes. By using a purposive sampling method, participants were recruited from the Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Bhubaneswar. The participants selected were within the age group of 18-30 years playing a recreational sport for more than 1 year. The study duration was 1 year which included the ethical clearance of 6 months, sample selection and data collection of 4 months and statistical analysis, result and discussion in 2 months. Informed written consent was obtained from each participant. The ABSMARI Ethics Committee gave the ethical clearance to the study with a reference number ABSMARI/IEC/2023/064 in September 2023.

SAMPLE SIZE ESTIMATION

The sample size calculation was done by using the G*Power 3.1.9.4 Software, with

Effect size d = 0.5

α err prob = 0.05

Power (1-β err prob) = 0.8 [12]

The total sample size calculated was 34.

After adding a dropout of 16, **the total sample size calculated was 50.**

INCLUSION CRITERIA

1. Healthy, active, and asymptomatic participants

2. Age- 18-30 years [13]

3. Weight- <220lbs (<99kgs) [13]

4. Gender- Male and Female

5. Playing a recreational sport for more than 1 year

6. Play at least 3 days per week

EXCLUSION CRITERIA

1. Subjects with pain, inflammation, sprains, strains, joint instability, and soft tissue limitations based on postoperative conditions. [2]

2. Any kind of systematic illness like diabetes, hypertension, asthma, etc.

3. Any recent musculoskeletal injuries or fractures in the past 6 months.

4. Involved in any kind of plyometric, balance or jump training program.

MATERIALS USED

1. Measuring tape- 02
2. Stopwatch
3. Chalk
4. Cloth surgical tape
5. Agility Cones- 04
6. Box- height of 30cm [14]

OUTCOME MEASURES

Pre and Post intervention:

1. **Balance - Dynamic Leap and Balance Test (DLBT)**

2. **Jump Performance-**

    i. **Vertical Jump Test (Sargent Jump Test)**

    ii. **Horizontal Jump Test (Broad Jump Test)**

PROCEDURE

The present study was reviewed and approved by the Institutional Ethical Committee. A total of 50 samples were selected by using the purposive sampling method based on the inclusion criteria and exclusion criteria.

The study protocol was explained to all the participants and their informed consent was obtained.

Baseline assessments of the participants were taken, including the demographic data (age, gender, history of injury, dominant limb), and anthropometric data (height, weight, limb length). The Tegner Activity Level Score was registered to evaluate the activity level of the recreational player for inclusion in the study.

Pre-test was done which included assessment of balance using the Dynamic Leap and Balance Test (DLBT) and jump performance was assessed using the Vertical Jump Test and Horizontal Jump Test. The single group of 50 participants (25 males and 25 females) took intervention for a total of 6 weeks, 2 sessions per week with proper warm-up and cool-down periods. At the end of the 6th week, post-intervention data was collected and the data was analysed.

The difference between pre-intervention and post-intervention within the group was assessed using paired t-test.

DYNAMIC LEAP AND BALANCE TEST

The DLBT has shown adequate reliability (ICC=0.93). [10] Using the directional layout of the medial half of a SEBT matrix, this dynamic balance test challenges

participants to leap between targets on the matrix lines. The pattern of DLBT is made up of the same positional directions as the Medial half of the SEBT for each foot consisting of a total 11 targets, including 1 central target and 2 targets along each of the five directions i.e. anterior, anteromedial, medial, posteromedial and posterior for both the right and left limb. The directional lines were taped to the floor using a 1 ½ inch cloth surgical tape, and the central and peripheral targets were designated with 6-inch-diameter circles made with chalk. Each participant's measured leg length and SEBT normative values were used to normalise their short and long target distances. As a proportion of leg length, the proximal peripheral targets were positioned at 100% of the SEBT normative reach distance, while the distal targets were positioned at 150% of the same distance. The purpose of adding the 150% target in each direction was to increase the task's difficulty and motivate the participant to leap.

Starting at the centre target of the testing lines, participants stood on their dominant limb, placing their non-dominant limb foot adjacent to the medial malleolus of their stance leg. The investigator gave the verbal instruction to "Go" to commence the test. The individual next jumped to land on their non-dominant limb after leaping from their dominant limb to a predefined target.

The operational definition for a leap was “an acceleration or taking off from one limb and landing on the other limb”.

The participant leaped back to the centre target as soon as they reached the peripheral target, landing on their dominant limb and attempting to regain and then hold onto their balance for 2 seconds. The modified Balance Error Scoring System (BESS) criteria was used to evaluate the attainment of balance, which included:

(1) touching down with opposite foot,

(2) excessive hip abduction,

(3) out of testing position for more than two seconds and/or

(4) step, stumble or fall.

After the subject's balance was restored for 2 seconds, the investigator would give an audible command "Go", indicating that the subject could move forward to the next peripheral target. The participants made 10 leaps in all 5 directions by continuing this pattern of leaping and balancing. The participant was told to quickly reposition himself on the target if they missed it upon landing. Every participant started in the anterior direction and completed the task by leaping from the posterior direction. They progressed through all of the matrix directions in a clockwise (left leg dominant) or anticlockwise (right leg dominant) fashion. The individual jumped to the short target ahead of the long target in each direction. The investigator used a stopwatch to record the total amount of time (in seconds) needed to finish each trial.

The participants were provided with a verbal explanation of the DLBT as well as a test demonstration by the investigator. It was required for the participants to finish the DLBT as soon as possible. Before beginning 3 timed trials, the participants performed a practice trial. There was a 2 minute rest given between each of the 3 timed trials. For data analysis, the average duration of the three timed trials was used.

Fig 1: Layout of Dynamic Leap and Balance Test (DLBT)

Fig 2: Participant demonstrating DLBT starting position

VERTICAL JUMP TEST

The Vertical Jump Test (VJT) has shown adequate reliability (ICC=0.92) [15] and is also known as the ‘Sargent Jump Test’. The participant raised the hand closest to the wall while standing next to a wall. The point of the fingertips was marked with a piece of chalk while the feet remained flat on the ground. This height is referred to as the ‘standing reach height’. The participant then took a step back from the wall and leaps vertically as high as possible in the air while projecting the body upward with the help of the legs and arms. At the top of the jump, they tried to make contact with the wall and marked it with chalk. The score is the difference in height between the standing reach height and the jump height, which was measured using a measuring tape. Typically, the jump height was expressed as a distance score. The participants were provided with a verbal explanation of the VJT as well as a test demonstration by the investigator. Before beginning 3 timed trials, the participants performed a practice trial. There was a 2 minute rest given between each of the 3 timed trials. For data analysis, the average score of the three timed trials was used.

Fig 3: Vertical Jump Test

HORIZONTAL JUMP TEST

The Horizontal Jump Test (HJT) has shown adequate reliability (ICC=0.97) [16] and is also known as the 'Broad Jump Test'. The participant places their feet slightly apart and stands behind a line drawn on the ground with cloth surgical tape. A two-foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The participant aims to leap as far as they can and land on both feet without tripping over. The measurement was taken from the take-off line to the nearest point of contact on the landing (back of the heels) with the help of a measuring tape. The participants were provided with a verbal explanation of the HJT as well as a test demonstration by the investigator. Before beginning 3 timed trials, the participants performed a practice trial. There was a 2 minute rest given between each of the 3 timed trials. For data analysis, the average score of the three timed trials was used.

Fig 4: Horizontal Jump Test

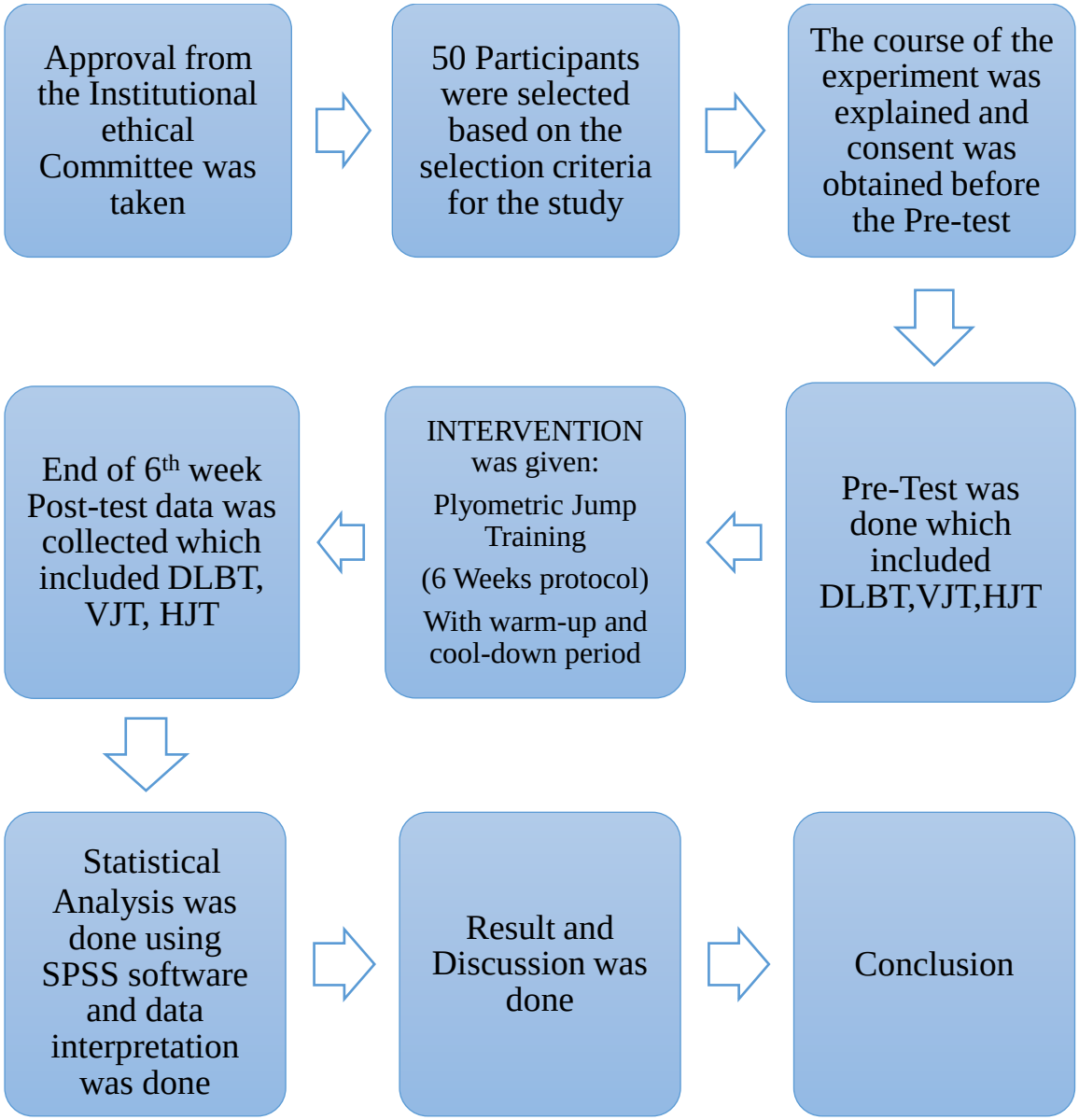

Fig 5: Flow chart of the study procedure

TRAINING PROGRAM:

WEEK	INTENSITY	PLYOMETRIC JUMP DRILLS	REPETITION	SET	REST
1	Low	Two-foot ankle hop Squat jump Vertical jump and reach Double-leg tuck jump Split squat jump	10	2	10-15 seconds
2	Low	Single leg tuck jump Cycled split squat jump Double-leg vertical jump Jump over barrier Single-leg vertical jump	10	2	10-15 seconds
3	Medium	Double leg hop Double leg zigzag hop Single leg hop Front barrier hop Lateral barrier hop	10	2	15-30 seconds
4	Medium	Skip Power skip Backward skip Single arm alternate leg bound Double arm alternate leg bound	10	2	15-30 seconds

WEEK	INTENSITY	PLYOMETRIC JUMP DRILLS	REPETITION	SET	REST
5	High	Single-leg push off Lateral push off Jump to box Squat box jump Jump from box	10	2	15-30 seconds
6	High	Depth jumps Squat depth jump Depth jump with standing long jump Single-leg depth jump	10	2	15-30 seconds

STATISTICAL ANALYSIS

The statistical analysis was performed using the SPSS statistical package of social science version 25. The normality of data was calculated using the Shapiro-Wilk test. The samples were normally distributed. Descriptive statistics was done to assess the mean and standard deviation of the group. The interferential statistics was used to find out the difference within the group using the paired t-test. The level of significance (p-value) was kept at ≤0.05.

RESULTS

- Table and figure show the Mean analysis of Age

TABLE 1: Mean Age Analysis

Variable	Mean
Age (Years)	22.96±2.65

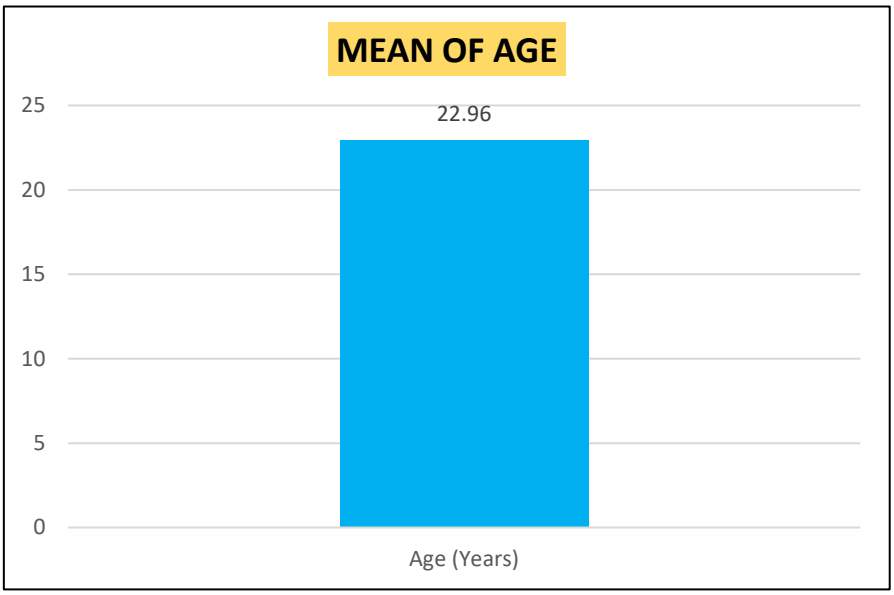

Fig 6: Graphical representation of Mean Age

- Table and figure show the mean of Anthropometric data.

TABLE 2: Mean Anthropometric data analysis

Variables	Mean
Weight (kg)	64.34±12.19
Height (cm)	166±8.21
BMI ((kg m^{-2})	23.30±3.77
Limb length (cm)	88.98±5.30
Tegner Activity Level Scale (0-10)	6.2±0.64

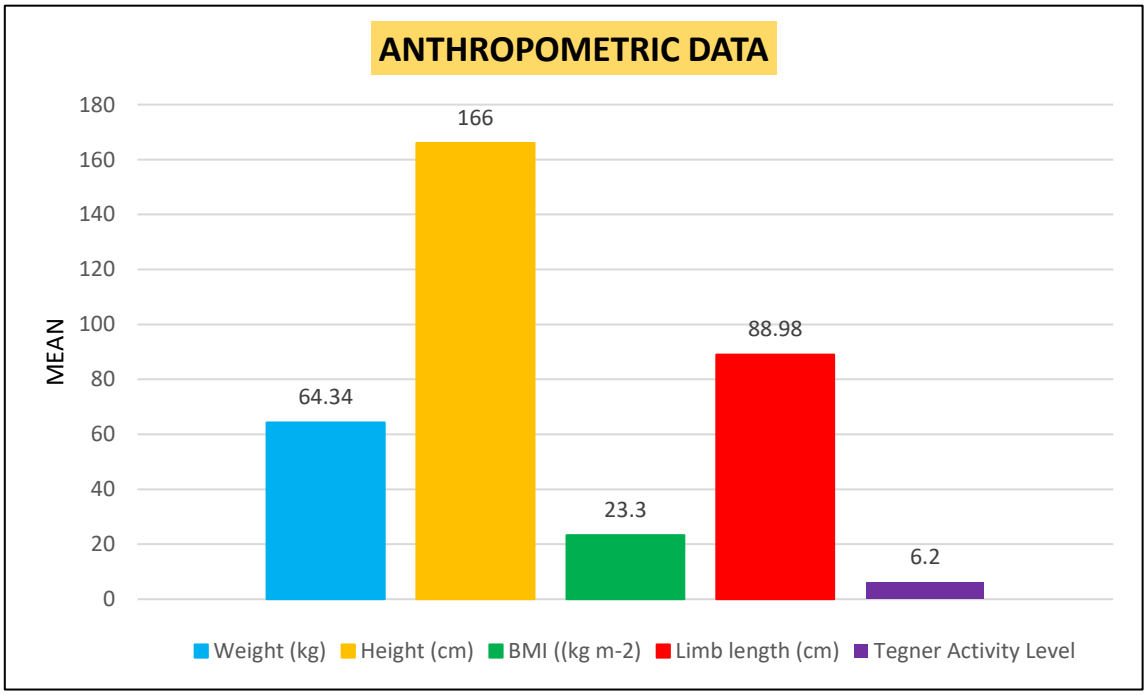

Fig 7: Graphical representation of Mean Anthropometric data

- Table and figure show the within the group comparison of pre and post-intervention of the Dynamic leap and balance test (DLBT) and found improvement among recreational players with a pre-test mean of 29.02±6.84, post-test mean of 24.64±5.1, mean difference 4.38 and the p-value of <0.05, which is statistically significant.

Table 3: Dynamic Leap and Balance Test (DLBT) within group comparison

Test	N	Mean Value		Mean Difference	P Value
		PRE	POST		
DLBT	50	29.02±6.84	24.64±5.10	4.38	0.00

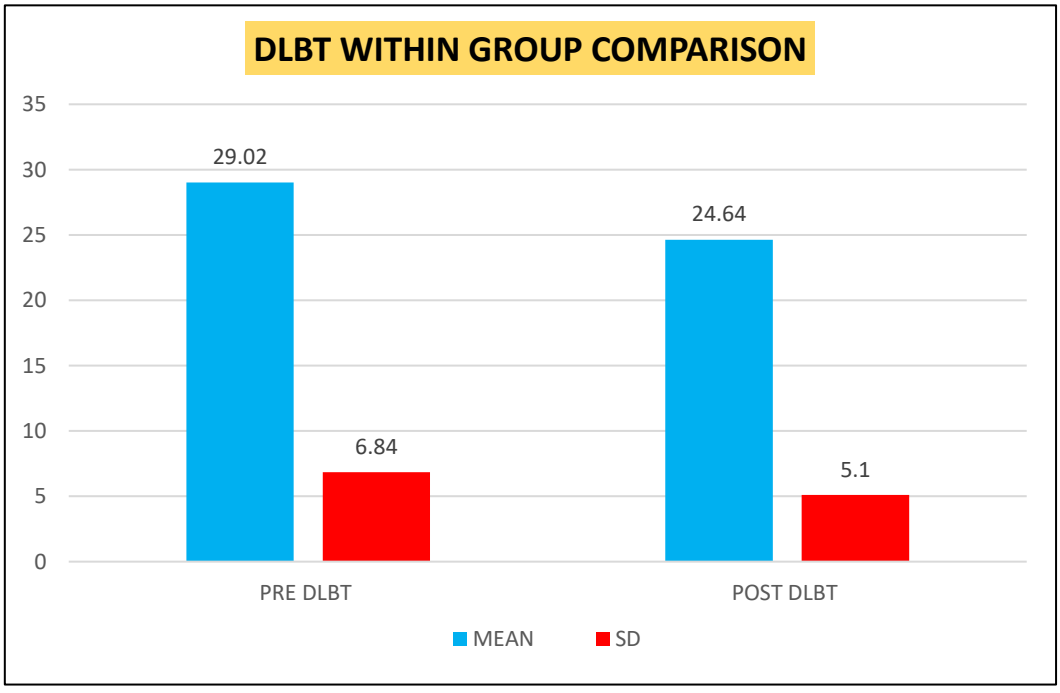

Fig 8: Graphical representation of within group comparison of DLBT

- Table and figure show the within the group comparison of pre and post-intervention of the Vertical Jump Test (VJT) and found improvement among recreational players with a pre-test mean of 29.22±8.76, post-test mean of 36.42±9.53, mean difference 7.2 and the p-value of <0.05, which is statistically significant.

Table 4: Vertical Jump Test within group comparison

Test	N	Mean Value		Mean Difference	P Value
		PRE	POST		
VJT	50	29.22±8.76	36.42±9.53	7.2	0.00

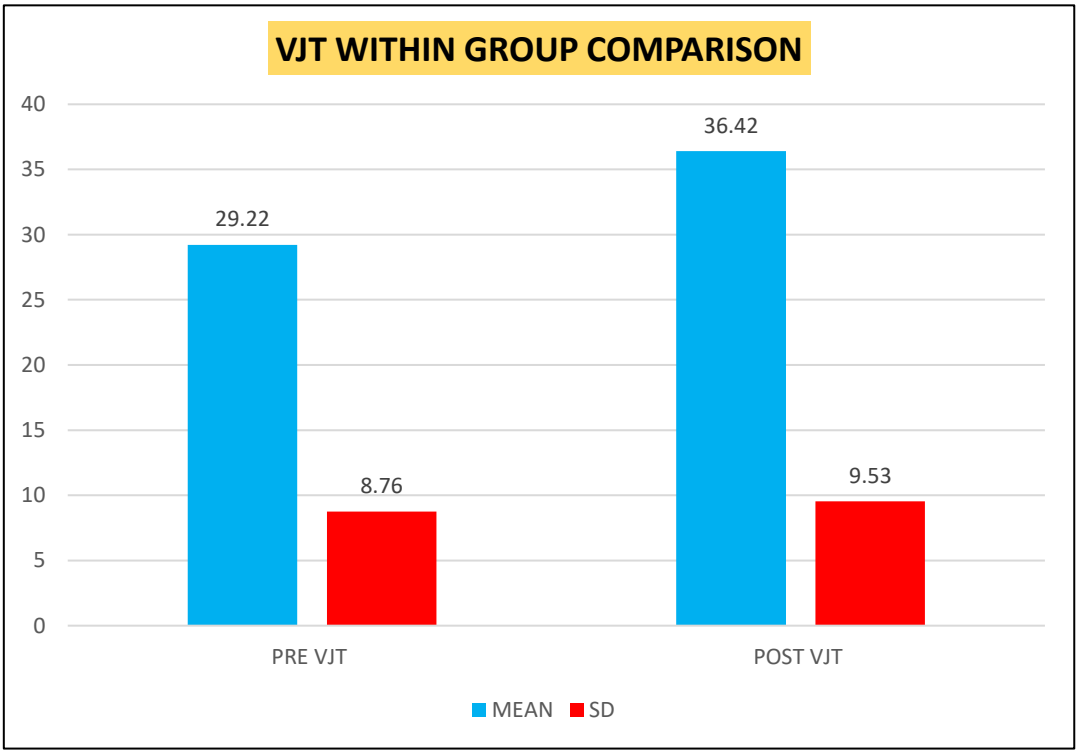

Fig 9: Graphical representation of within group comparison of VJT

- Table and figure show the within the group comparison of pre and post-intervention of the Horizontal Jump Test (HJT) and found improvement among recreational players with a pre-test mean of 137.1±34.97, post-test mean of 152.46±34.68, mean difference 15.36 and the p-value of <0.05, which is statistically significant.

Table 5: Horizontal Jump Test within group comparison

Test	N	Mean Value		Mean Difference	P Value
		PRE	POST		
HJT	50	137.1±34.97	152.46±34.68	15.36	0.00

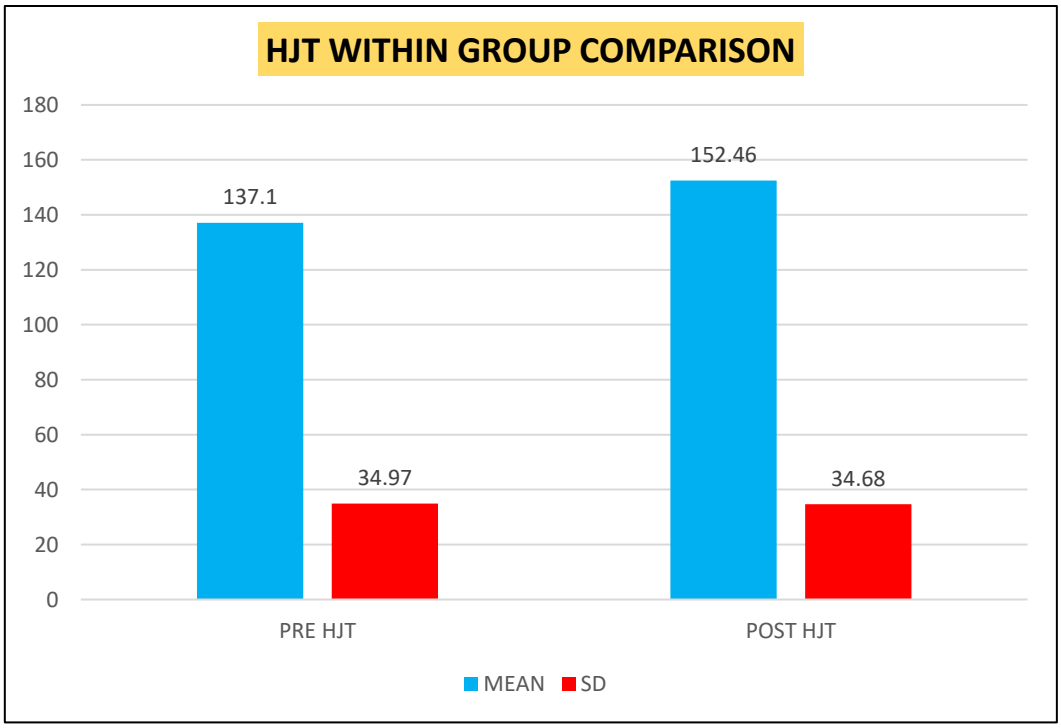

Fig 10: Graphical representation of within group comparison of HJT

DISCUSSION

The purpose of this study was to examine the efficacy of Plyometric Jump Training (PJT) in improving dynamic leap balance and jump performances in recreational players. After a 6-week PJT intervention, significant improvements were observed in all three tested parameters: the Dynamic Leap and Balance Test (DLBT), the Vertical Jump Test (VJT), and the Horizontal Jump Test (HJT). These findings suggest that PJT is an effective method for enhancing lower body power, balance, and overall athletic performance in recreational players.

The significant improvement in DLBT scores from Table 3 indicates that PJT effectively enhances dynamic balance and stability during complex movements. PJT incorporates exercises that require rapid stretch-shortening cycles, which likely contributed to the improved neuromuscular coordination and balance observed in the study participants. This finding aligns with previous research, that PJT has the potential to not only improve measures of muscle strength and power but also balance. (Myer et al., Huang et al., Surakhamhaeng et al.) [17-19] Similar to the present study, 7 weeks of PJT induced improvements in dynamic balance performance. (Myer et al.) [17] PJT induced similar improvements in balance performance when compared to other training methods (e.g., balance training). Therefore, PJT can also be used as a potential training method for improving balance performance, in conjunction with other physical characteristics such as muscular strength and power. [20]

The increase in VJT performance from Table 4 highlights the effectiveness of PJT in developing explosive power. The vertical jump is a critical measure of lower body

strength and power, and the observed improvement suggests that repeated high-intensity loading during PJT effectively stimulates muscle hypertrophy and enhances the rate of force development. This result corroborates earlier studies such as those by (Markovic et al.) [21] which showed significant increases in vertical jump height following a structured PJT program in physically active individuals and that done by Fatouros IG et al. which suggested that long-term plyometric training is capable of improving vertical jumping ability. [22]

Similarly, the HJT results from Table 5 reveal a notable enhancement in horizontal jump distance. Horizontal jumping requires a combination of strength, power, and coordination, and the significant improvement suggests that PJT is beneficial not only for vertical but also for horizontal propulsion. This finding is consistent with a study done by Ozbar N et al. which have observed increases in horizontal jump performance following PJT, suggesting that this training modality effectively transfers to various athletic movements requiring explosive power. [23]

According to this study, Plyometric Jump Training can be demonstrated to be an effective training technique for improving a recreational player's athletic performance.

PRACTICAL IMPLICATIONS

The improvements observed across all tests underscore the versatility and effectiveness of PJT for recreational athletes. For coaches and trainers working with this population, incorporating PJT into training routines could be a simple yet powerful strategy to enhance overall athletic performance. Given the low cost, minimal equipment requirements, and time efficiency of PJT, it is accessible for

recreational players and can be easily integrated into various sports training programs.

Additionally, the improvements in dynamic balance and both vertical and horizontal jumping abilities could translate to better performance in sports that require quick changes in direction, jumping, and landing—skills common in sports like basketball, volleyball, and soccer. Thus, PJT not only improves individual fitness components but also has the potential to enhance sport-specific performance.

CONCLUSION

The results of this study demonstrated that a six-week Plyometric Jump Training program significantly enhances dynamic leap balance, vertical jump, and horizontal jump performance in recreational players. These findings support the use of PJT as an effective training method for improving key athletic attributes in this population.

LIMITATIONS AND RECOMMENDATIONS

LIMITATIONS:

1. This study utilized a single-group experimental design without a control group, limiting the ability to attribute improvements solely to the PJT intervention.

2. The study sample was limited to recreational athletes, so the results may not be generalizable to more advanced or novice athletes.

3. The study focused on short-term effects over six weeks.

RECOMMENDATIONS / SCOPE FOR FUTURE STUDY:

1. Future research could benefit from incorporating a randomized controlled trial design to strengthen the evidence of causality.

2. Exploring the effects of PJT across different skill levels and age groups could provide a broader understanding of its efficacy.

3. Longitudinal studies are needed to determine whether the observed improvements are sustainable and to assess the long-term benefits of PJT.

4. To evaluate the DLBT's overall efficacy as a clinical measure of dynamic stability, it ought to be applied to a variety of skill-level sports.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be constructed as a potential conflict of interest.

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ANNEXURE 1

CONSENT FORM

Study Title: Efficacy of Plyometric Training on Dynamic Leap Balance and Jump Performances in Recreational Players: A Single-group Experimental Study

Subject's Name:

Date of Birth / Age:

Address of the Subject:

Occupation:

(i) I confirm that I have read and understood the information sheet dated 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 the Investigator, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

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

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

Signature of the Subject:

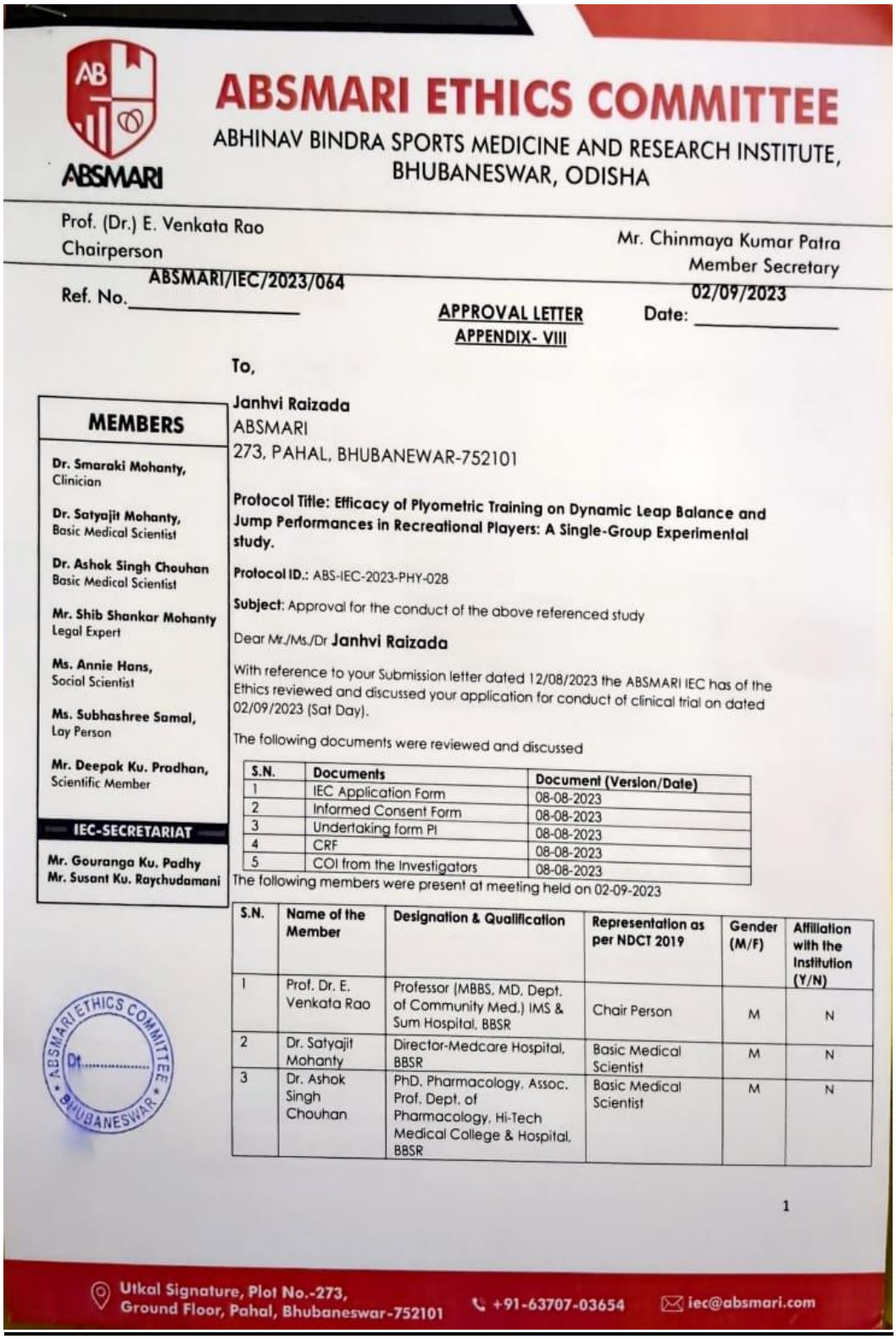
Signatory's Name:

Signature of the Investigator:

Date:

ANNEXURE 2

ETHICAL COMMITTEE CLEARANCE CERTIFICATE



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/2023/064

Date: 02/09/2023

APPROVAL LETTER
APPENDIX- VIII

To,

Janhvi Raizada
ABSMARI
273, PAHAL, BHUBANEWAR-752101

MEMBERS

Dr. Smaraki Mohanty, Clinician

Dr. Satyajit Mohanty, Basic Medical Scientist

Dr. Ashok Singh Chouhan Basic Medical Scientist

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

Protocol Title: Efficacy of Plyometric Training on Dynamic Leap Balance and Jump Performances in Recreational Players: A Single-Group Experimental study.

Protocol ID.: ABS-IEC-2023-PHY-028

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr **Janhvi Raizada**

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 02/09/2023 (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 02-09-2023

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 * BHUBANESWAR * Dt.....

1

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

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/2023/064

Date: 02/09/2023

MEMBERS

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Dr. Satyajit Mohanty, Basic Medical Scientist

Dr. Ashok Singh Chouhan Basic Medical Scientist

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

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.

ABSMARI ETHICS COMMITTEE * BHUBANESWAR * Dt.....

Yours sincerely

Mr. Chinmaya Kumar Patra
Member Secretary
ABSMARI Ethics Committee
Pahal, Bhubaneswar

Member Secretary
ABSMARI ETHICS COMMITTEE

2

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

ANNEXURE 3

TEGNER ACTIVITY LEVEL SCALE

Tegner Activity Level Scale

Please indicate in the space below the HIGHEST LEVEL of activity that you partipcate in CURRENTLY.

Current: Level _____

Level 10	Competitive sports - soccer, football, rugby (national, elite)
Level 9	Competitive sports - soccer, football, rugby (lower divisions), ice hockey, wrestling, gymnastics, basketball
Level 8	Competitive sports - raquetball or bandy, squash or badminton, track and field athletics (jumping, etc.), down-hill skiing
Level 7	Competitive sports - tennis, running, motorcars speedway, handball Recreational sports - soccer, football, rugby, bandy, ice hockey, basketball, squash raquetball, running
Level 6	Recreational sports - tennis and badminton, handball, raquetball, down-hill skiing Jogging at least 5 times per week
Level 5	Work - heavy labor (construction, etc.) Competitive sports - cycling, cross-country skiing Recreational sports- jogging on uneven ground at least twice weekly
Level 4	Work - moderately heavy labor (e.g. truck driving, etc.)
Level 3	Work - light labor (nursing, etc.)
Level 2	Work - light labor Walking on uneven groun possible, but impossible to back pack or hike
Level 1	Work - sedentary (secretarial, etc.)
Level 0	Sick leave or disability pension because of injury

ANNEXURE 4

ASSESSMENT FORM

- DEMOGRAPHIC DATA:

Name-

Age-

Gender-

Address-

Occupation-

Contact no.-

- ANTHROPOMETRIC MEASURES:

Height-

Weight-

Limb length (Dominant leg)-

- HISTORY OF INJURY:

Current injury (if any)-

Past injury-

- EXAMINATION:
  PRE-INTERVENTION:

Test	Trial 1	Trial 2	Trial 3	Average
DLBT				
VERTICAL JUMP				
HORIZONTAL JUMP				

POST-INTERVENTION

Test	Trial 1	Trial 2	Trial 3	Average
DLBT				
VERTICAL JUMP				
HORIZONTAL JUMP				

ANNEXURE 5

SCORING SHEET FOR DLBT

Dynamic Leap and Balance Test (DLBT)

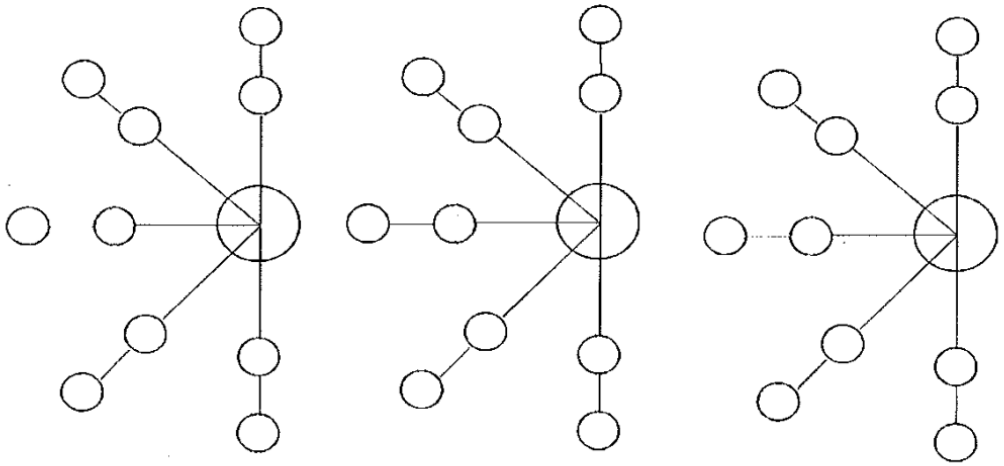
DLBT Scoring Sheet

Day _____ Errors: ✓ Box error missing the box Subject # _____

X Hip error > 30°

0 Step, Stumble or Fall error

Trial 1 Trial 2 Trial 3



Time _____ _____ _____

MASTERCHART

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	GENDEF	AGE(yr)	WEIGHT	HEIGHT(	BMI (kg r	LIMB LE	TEGNEF	STANDIN	VERTIC/	VERTIC/	HORIZOI	HORIZOI	DLBT TII	DLBT TIN
1	Male	24	56	159	22.15	84	7	197	43	50	193	216	35	24
2	Male	25	86	165	31.59	88	6	207	28	32	145	151	48	39
3	Male	26	58	173	19.38	92	6	212	22	25	152	162	33	26
4	Male	25	57	168	20.20	87	7	205	42	51	160	172	30	27
5	Male	21	52	164	19.33	85	7	197	25	37	130	148	32	28
6	Male	25	59	186	17.05	103	6	225	22	25	98	105	24	29
7	Male	24	64	174	21.14	92	7	217	53	62	193	201	31	25
8	Male	18	72	178	22.72	86	5	205	33	40	108	125	36	27
9	Male	25	86	182	25.96	96	6	223	34	42	157	168	16	16
10	Male	22	74	171	25.31	90	6	216	46	52	168	175	26	25
11	Male	18	70	174	23.12	92	5	210	32	38	180	193	35	29
12	Male	19	67	165	24.61	85	6	210	22	31	125	144	37	31
13	Male	19	88	170	30.45	94	5	210	21	26	138	143	34	29
14	Male	18	57	174	18.83	94	7	218	38	45	182	196	21	18
15	Male	19	62	170	21.45	92	6	218	39	46	166	171	28	26
16	Male	18	62	178	19.57	101	7	220	22	32	112	137	35	30
17	Male	23	72	178	22.72	96	7	213	38	42	170	187	27	24
18	Male	24	65	171	22.23	89	7	206	45	51	231	240	26	25
19	Male	21	95	173	31.74	94	7	223	43	52	195	211	14	14
20	Male	24	50	166	18.14	90	7	208	34	40	180	192	29	27
21	Male	23	64	171	21.89	96	7	213	40	52	195	205	19	17
22	Male	27	82	166	29.76	87	7	203	24	33	155	176	21	19
23	Male	25	75	177	23.94	95	6	202	33	42	169	181	30	26
24	Male	25	67	169	23.46	96	7	208	32	47	155	185	26	20
25	Male	25	86	175	28.08	95	7	220	50	59	197	211	31	25
26	Female	23	55	163	20.70	84	7	204	24	32	121	147	31	25
27	Female	25	63	166	22.86	90	6	204	22	33	109	137	28	22
28	Female	24	54	159	21.36	89	6	199	25	32	120	131	21	20
29	Female	25	60	160	23.44	83	6	197	25	28	105	126	31	26
30	Female	25	56	163	21.08	89	6	203	24	28	119	140	32	25
31	Female	23	66	163	24.84	89	5	203	24	27	94	99	20	18
32	Female	25	78	173	26.06	97	6	216	27	32	109	115	31	28
33	Female	24	90	164	33.46	90	6	193	29	31	138	142	20	19
34	Female	25	75	163	28.23	83	6	200	26	34	96	107	16	16
35	Female	22	63	159	24.92	81	6	195	24	38	125	147	34	26
36	Female	23	50	152	21.64	82	5	196	21	27	120	139	33	32
37	Female	18	44	154	18.55	85	6	186	20	26	89	104	27	26
38	Female	19	49	160	19.14	87	6	198	25	37	118	129	35	29
39	Female	21	53	164	19.71	88	6	200	25	29	120	132	32	27
40	Female	19	54	162	20.58	84	6	200	22	27	115	137	29	25
41	Female	24	51	150	22.67	80	6	184	22	29	81	93	22	22
42	Female	24	56	162	21.34	87	6	201	26	32	116	127	28	22
43	Female	24	65	162	24.77	88	6	200	27	32	123	146	22	18
44	Female	24	68	162	25.91	87	6	200	25	31	117	125	29	25
45	Female	26	47	158	18.83	89	7	200	27	37	120	171	29	19
46	Female	26	57	154	24.03	86	5	197	29	35	127	156	42	28
47	Female	21	58	151	25.44	83	6	193	25	27	107	121	36	29
48	Female	23	57	162	21.72	84	6	208	16	29	94	112	41	35
49	Female	25	59	164	21.94	85	6	197	22	30	104	120	27	17
50	Female	27	63	153	26.91	80	6	198	18	26	114	125	31	27