

**PLYOMETRIC TRAINING VS DEADLIFT TRAINING ON
HAMSTRING'S MUSCLE STRENGTH ASYMMETRY, FLIGHT
TIME AND REACTIVE STRENGTH INDEX ON
RECREATIONAL VOLLEYBALL PLAYERS.**

By

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In

SPORTS PHYSIOTHERAPY

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DECLARATION BY THE CANDIDATE

I hereby declare that dissertation/thesis entitled "**Plyometric training vs Deadlift training on hamstring's muscle strength asymmetry, flight time and reactive strength index on recreational volleyball players**" is a bonafide and ethical research work carried out by me under the guidance of Dr.Deepak Kumar Pradhan (PT) , Assistant Professor, Abhinav Bindra Sports Medicine & Research Institute Bhubaneswar Odisha.

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LIST OF ABBREVIATIONS USED

ABSMARI - Abhinav Bindra Sports Medicine and Research Institute

CD – Computerised Dynamometer

DJ – Drop Jump

PT – Plyometric Training

PTD – Portable Traction Dynamometer

RSI – Reactive strength Index

SJ – Squat Jump

SPSS – Statistical Package of Social Sciences

VJ – Vertical Jump

ABSTRACT

Background: Recreational volleyball players often experience hamstring muscle strength asymmetry, which can increase the risk of injury and diminish athletic performance. Improving muscle balance, flight time, and reactive strength index are essential for enhancing playing ability and preventing injuries.

Objective: This study aims to compare the effects of plyometric training and deadlift training on hamstring muscle strength asymmetry, flight time, and reactive strength index in recreational volleyball players.

Method : A total of participants will undergo baseline assessments of hamstring strength, jump height, flight time, and reactive strength. They will be randomly assigned to either a plyometric training group or a deadlift training group. The interventions will be administered over six months, with evaluations conducted before and after the training period to measure changes in the targeted parameters.

Results : Both plyometric and deadlift training significantly improved flight time, reactive strength index (RSI), and asymmetry percentages in volleyball players. The plyometric group showed larger effect sizes with significant improvements in flight time ($d=7.5$, $p<0.001$), RSI ($d=8.87$, $p<0.001$), and asymmetry reduction ($p<0.001$), compared to the deadlift group. Between-group differences were not statistically

significant, but effect size analysis indicated more substantial performance gains in the plyometric group.

Interpretation: The findings suggest that while both training modalities enhance explosive and reactive capabilities, plyometric training is more effective in optimizing neuromuscular adaptations associated with stretch-shortening cycle efficiency. This specificity likely account for greater improvements in jump performance, asymmetry reduction, and reactive strength, making plyometric exercises a superior choice for enhancing explosive athletic performance in volleyball players.

Conclusion : The findings from this research could contribute to developing targeted training strategies to enhance athletic performance and reduce injury risk, supporting the advancement of sports science and training methodologies.

Keywords: Plyometric Training; Deadlift; Volleyball; Explosive Performance; Reactive Strength Index; Inter-limb Asymmetry; Jump Height; Neuromuscular Adaptation; Strength Training; Sports Performance.

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INTRODUCTION

Volleyball is a hard oxygen - independent sport requiring both rapid forceful actions (both upward and sideward) and brief recovery moments. Thus, explosive strength, which is an attribute where one's nervous - muscle system can express tension in the least amount of time possible, is a basic component of successful athletic competition.^[1]

Actually, combining quickness and agility with peak strength generates power. Force - generating capacity allows an individual muscle to generate the identical workload in a shorter period of time, or a larger magnitude of work within the same period, that is crucial for acceleration, leaping and rapid changes of direction .Indeed, power measures have been found to have close relationships with upward height efficiency , indicating that power determines vertical jumping performance.^[3]

Jump training can be identified with explosive power drills and more specifically with drills that emphasize the muscle - muscle complex. Indeed, de Villarreal discovered that the combination of bodyweight plyometrics such as reactive jumps, box drops and squatting jumps produced an increase in vertical jump performance ranging between 4.7% and 15%. However, this form of training enhances motor synchronisation by training the nervous system ,thereby enabling the eccentric - concentric sequence that is a lengthening movement (i.e., eccentric) followed rapidly by a shortening movement (i.e., concentric) to respond faster. Also, since this training involves lengthening of muscles, it has the potential to enhance flexibility, store more elastic energy in the muscles, activate more muscular components, be associated with greater (neural) activation rate and enhance joint position sense.^{[1][4]}

Plyometric training in volleyball consists of hopping, bounding and jumping exercises as well as quick and explosive throws. These movements also pertain to agility development. This ability is believed to be a neuromuscular conditioning strengthening of motor programming and neural adaptation of muscle spindles, Golgi tendon organs and joint proprioceptors.^[2]

Volleyball is a high-explosive sport consisting of numerous explosive attempts, with numerous successive short periods of high-intensity exercise and small amounts of rest.^[6] High demands are put on the neuromuscular system during the repeated various plane motions on the court (e.g., sprints, dives, jumps). Consequently, it can be reasoned logically that volleyball players need highly evolved speed and muscular strength since successful court travel and vertical jumping are the most valued player abilities according to coaches and sport scientists. Moreover, volleyball players need to be able to accomplish these repeated maximal efforts with short recovery for the duration of the game.^[5]

The hamstring group is composed of three major large muscles at the back or rear of the thigh. They consist of the semimembranosus as the medial most, long and short heads of the biceps femoris as the lateral most, and semitendinosus in between. These muscles are physiologically significant as they are highly susceptible to damage, particularly in the sportsmen. Semimembranosus and long head of biceps femoris share a share the same site of origin at the posterolateral aspect of the ischial tuberosity whereas semitendinosus originates from anterolateral aspect of the ischial tuberosity. Short head of biceps originates medial to the linea aspera on the distal side of the posterior segment of the femur. Both the short and long head of biceps femoris still insert above the fibular head while semimembranosus inserts above the medial condyle of tibia. Semitendinosus inserts on pes anserine area on the medial surface of the tibia. All the hamstring muscles cross two joints (hip and knee) from origin to insertion with the exception of the short head of biceps femoris, which crosses knee joint only from origin to insertion. The primary action of the hamstring muscles is knee joint flexion and hip joint extension. Hamstring injury largely happens when players are sprinting or running. These muscle groups are especially prone to injury because of their anatomic distribution. Measurement of hamstring muscle strength with isokinetic muscle strength devices is considered as the gold standard.^{[7][8]}

The eccentric - concentric contractions represents a key neuromuscular mechanism that supports explosive jumping and plyometric actions.^[4] A person's capacity to perform the SSC, or the capacity of the musculotendinous structure to generate a high-force concentric action, shortly after a muscle lengthening movement, typically during movements where body segments are subjected to impact forces causing stretch (e.g., drop jump), is referred to as reactive strength and is generally assessed with the reactive strength index (RSI). In jump - related activities, SSC is often classified as fast when ground contact time is 250 ms and slow when it exceeds 250 m.^[7]

Volleyball is characterized by frequent explosive actions, with players performing around 250–300 such movements per match, consisting mainly of 50–60% jumps, 27–33% attacks, and 12–16% landings. These asymmetric unilateral movements might make team sport athletes predisposed to inter-limb asymmetries.^[9]

The biomechanics of a volleyball jump, crucial for practical force application and ball impact, involve synchronized leg propulsion balanced by the attacking arm's forward swing.^[12] Moreover, the sport's typical landing mechanics, particularly the unilateral landings that account for 40% of all landings, also play an important role in lateral muscular imbalances. Moreover, some zone-specific movements, such as blocking movements, are normally performed towards the same direction. Thus, these repeated activities during practice sessions and competitive games may play a role in developing asymmetries in volleyball players.^[11]

The vertical jump (VJ) test is widely accepted as a reliable measure of lower body explosive strength of lower-body power. Strength and conditioning professionals, coaches, and health professionals generally use the VJ test when establishing an athlete's or client's ability to jump. Numerous coaches regard vertical jumping as a fundamental aspect of sport performance that can lead to enhanced success in many sports, such as basketball, volleyball, and football.^{[8][13]}

Following the invention of smartphones, High-frame-rate, high-resolution digital cameras are now readily available to everyday consumers, therefore, application of mobile applications towards time-based measurement using video analysis for sport sciences has increased. With video analysis, the user must manually identify and digitize specific events after the movement and has been recorded. For measuring vertical jump height, high- speed recordings allow users to visually select the frames closet to take-off and landing. The software then calculates flight time by counting the frames between these key events and applying a basic kinematic formula ^[15].

The most widely used smartphone application, My Jump, has been proved with video frame rates of current for vertical jump height in the case of measurement, high-speed video recording enables the user to visually choose the frames nearest to both take-off and landing events manually. Next, the app measures the number of video frames between such events and calculates flight time based on frame rate duration and a simple kinematic equation^[15]. One of the leading smartphone applications, My-Jump, has been cross-validated using video frame rates from modern smartphones, 120 Hz and 240 Hz as well as tablets operating at 60 Hz.^[10]

Some smartphone models have been released very recently, enabling very high frame rate video recording, which levels the sampling capability of sport sciences instrumentation. Owing to the advances in technology, consumer end segment smartphone is anticipated to integrate very high video sampling frame rates, just like laboratory-based instruments.^{[10][17]}

Vertical jump is one of the most significant physical abilities for effective volleyball performance. The more a player can jump, the more his/her opportunity for effective performance in offense and defense. The tracking of different performance qualities of athletes is an important aspect in strength and conditioning training.^[4] Approach jump performance is one of the sport-specific activities in volleyball play that deserves

the investigation of its underlying biomechanical determinants that can be utilized for training optimization.^{[4][12]}

The countermovement jump (CMJ) is frequently used to measure the maximal dynamic function of the lower extremity's primary extensor muscle groups. The ease and consistency of the CMJ make it well-suited for evaluating cross-sectional differences and tracking longitudinal changes in maximal dynamic performance in the applied setting. Reactive strength index modified is a reduced measure that is determined as the CMJ height to time to take-off (TtT) ratio. In plain English, the RSI_{mod} therefore reflects how much jump height (JH) one gets for how long it takes one to bend and straighten the legs in the CMJ. In general, the RSI is supposedly being a measure or representing the degree of "explosiveness" an athlete has. The quality of jumping technique certainly impacts landing characteristics and greater jumps impart more kinetic impact on landing quality.^[16]

Muscle strength is a performance-related physical attribute, and it is credited with aiding sportsmen in many sports and also daily living activities. For instance, knee extensors carry out crucial movements during sitting and standing from the sitting position, walking, ascending and descending stairs. When there is a loss of strength in the knee extensors, it may lead to limitations, which affect the functional capacity and independence of the person. Strength asymmetry is defined as an absence of equality between limbs or muscle groups, and the effect of this asymmetry on the risk of injury and athletic performance has been researched extensively in the literature, especially in strength and conditioning science.^{[17][6]}

In clinical settings, the use of portable traction dynamometers (PTD) has been convenient as they provide ease of administration with being cost-effective. A new PTD with Bluetooth data transfer has recently been innovated and applied to assess isometric strength of soccer players' knee extensors and flexors as well as muscle strength of haemodialysis patients aged. Hence, one can ensure that assessment of strength by means of the isometric technique with a PTD is an adequate method in functional capacity assessment.^[20]

Muscle power of the leg in general, and vertical jump capacity in specific, are regarded as equally important determinants of effective athletic performance as they are of performing daily activities and occupational tasks.^[9] Plyometric training (PT) is widely applied to enhance physical performance in most sport activities involving sprinting, jumping, and change of direction ability. While numerous training techniques, such as heavy-resistance training, explosive-type resistance training, electro-stimulation training and vibration training, have proven effective for vertical jump performance enhancement, most coaches and researchers appear to be of the opinion that plyometric training (PT) is a treatment of choice when attempting to enhance vertical jump capacity and leg muscle power.^{[17][9]}

PT refers to the performance of stretch-shortening cycle (SSC) movements involving a high-intensity eccentric contraction after a strong and fast concentric contraction. For the lower limbs, PT entails the performance of varied types of body weight jumping-type exercise including drop jumps (DJs), countermovement jumps (CMJs), alternate-leg bounding, hopping and other SSC jumping activities. Vertical jump performance has been widely examined following PT. Improved vertical jump height was reported in several studies that were done on PT.^[18]

Both lower extremity (LE) and upper extremity (UE) sports apply the plyometric concept in the context of functional movement patterns and skill during playing the sport. Plyometric training also utilizes the stretch-shortening cycle (SSC) by using a lengthening This sudden deceleration-acceleration creates an explosive reaction which aids in increasing speed and power of the limb to sport. This explosive reaction enables maximal force generation within the shortest time possible. Plyometric training is also described as the missing link between strength and return to performance.^{[18][11]}

The deadlift is a compound, multi-joint lower body lift. Due to the fact that the lift can be done with heavy weights, there is a significant mechanical stimulus imposed on the body that is conducive to strength and

power adaptation. The deadlift is an excellent exercise for developing posterior chain muscles (e.g., back, hips, and hamstrings) due to its setup (i.e. initial position).^[13]

Romanian Deadlift is associated with reduced erector spinae activation in contrast to biceps femoris and semitendinosus. Deadlift is usually performed primarily when the focus is on the development of muscles in posterior chain and thigh muscles; i.e., gluteus, hamstrings, erector spinae and quadriceps. Thus, Deadlift belongs to one of most frequent resistance exercise for posterior lower limb strengthening, and also to its variations. Moreover, Deadlift has been cited in most comparative research studies between this exercise and other variants such as Stiff Leg Deadlift, Hexagonal Bar Deadlift or Romanian Deadlift.^{[19][13]}

The need for this study arises from the increasing demand for effective training interventions that can enhance explosive performance and mitigate injury risks among volleyball players. Existing literature suggests that plyometric training positively influences vertical jump, strength, and neuromuscular coordination, which are crucial for volleyball performance. However, comparative analyses between plyometric and other strength training modalities, such as deadlift training, remain limited, particularly concerning their effects on hamstring muscle strength asymmetry, flight time, and reactive strength index in recreational athletes. Therefore, this study aims to fill this gap by evaluating and contrasting the efficacy of plyometric and deadlift training programs, thereby providing valuable insights into the most effective strategies for improving performance and reducing injury potential in volleyball players.

AIM

To investigate the impact of plyometric training vs deadlift training on hamstring asymmetry, flight time and reactive strength index.

OBJECTIVES

1. To analyse the influence of plyometric training on hamstring muscle strength asymmetry, flight time, reactive strength index in recreational volleyball players.
2. To examine effects of deadlift training on hamstring muscle strength asymmetry, flight time, reactive strength index in recreational volleyball players.
3. To differentiate the effects of outcomes of plyometric training and deadlift training regarding hamstring muscle strength asymmetry, flight time, and reactive strength index in recreational volleyball players.

HYPOTHESIS

1. **Null Hypothesis:** There will be no significant difference between plyometric training vs deadlift training on Hamstrings strength asymmetry , flight time and Reactive Strength index.
2. **Alternate Hypothesis:** There will be Significant Difference between Plyometric training vs Deadlift training on Hamstrings strength asymmetry , flight time and Reactive Strength Index.

REVIEW OF LITERATURE

1. **The Effect of Plyometric Training in Volleyball Players: A Systematic Review (2019)** : Ana Filipa Silva , Filipe Manuel Clemente, et al, aimed to review the effects of plyometric training on volleyball players' performance. Results showed that the vertical jump (15 studies) was the major ability studied in plyometric training interventions, followed by strength (four studies), horizontal jump (four studies), flexibility (four studies) and agility/speed (three studies). In addition, it was observed that young (under 18 years old) female athletes were the most studied. The included studies indicated that plyometric training seems to increase vertical jump performance, strength, horizontal jump performance, flexibility and agility/speed in volleyball players.
2. **Relationship of jumping and agility performance in female volleyball athletes (2007)** : Jacques L Barnes , Brian K Schilling, aimed to quantify vertical and horizontal force during a COD task, secondly to identify possible predictors of court-sport-specific agility performance, and thirdly to examine performance difference between National Collegiate Athletic Association Division I, II, and III athletes.
3. **Hamstring Injury (2023)**: Bikash Poudel; Shivalal Pandey, identified the aetiology of a hamstring injury and outlined the appropriate evaluation of hamstring injury. Also, they reviewed the management options including the rehabilitation and return to sports criteria available for a hamstring injury. Describe the importance of inter-professional communication and coordination in the management of patients with a hamstring injury.
4. **Association between pre-season lower limb inter-limb asymmetry and non-contact lower limb injuries in elite male volleyball players (2025)** : Pu Wang, Zhikai Qin, aimed to quantify lower limb inter-limb asymmetries in elite male volleyball players by assessing key performance measures, including vertical jumps, change of direction, and muscle strength. It further explored the potential association between these asymmetries and the occurrence of non-contact lower limb injuries.
5. **Accuracy of flight time and countermovement-jump height estimated from videos at different frame rates with My Jump.(2023)** : This study by Basilio Pueo , Will G Hopkins aims to evaluate the accuracy of jump height estimated from videos at different frame rates. It also shows that the coaches and trainers can use a video frame of 240hz with My Jump to monitor athletes' countermovement jump height.
6. **Accuracy of a Vertical Jump Contact Mat for Determining Jump Height and Flight Time.(2015)**: Tyler Whitmer, determined the accuracy of a VJ mat for measuring flight time and VJ height compared with a VJ tester or a force plate , wherein vertical VJ tester was used to measure jump reach. Compared with the force plate, the VJ mat reported greater VJ height.
7. **The Acute Effects of Heavy Deadlifts on Vertical Jump Performance in Men. (2015)** : Jerry C. Arias conducted a study to investigate the effects of deadlifts as a post activation potentiation stimulus on vertical jump performance. He concluded that lack of a positive PAP effect of deadlifts on VJ height or pGRF may be attributed to three main findings; firstly, the deadlift exercise may not have had enough specificity to the CMJ. Secondly, the results may have been affected by the recovery time chosen and lastly; using only recreationally trained subjects, and not a stronger population of athletes, may have contributed to the lack of PAP response.

8. **Does plyometric training improve vertical jump height? A meta-analytical review.(2017):** Goran Markovic , conducted a study to determine the precise effect of plyometric training (PT) on vertical jump height in healthy individuals. The study showed PT provides a statistically significant and practically relevant improvement in vertical jump height with the mean effect ranging from 4.7% (SJ and DJ), over 7.5% (CMJA) to 8.7% (CMJ). These results justify the application of PT for the purpose of development of vertical jump performance in healthy individuals.
9. **Clinical commentary current concepts of plyometric exercise.(2015) :** George Davies , conducted a study 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. He included the use of Plyometrics for training UL and LL, contraindications and empirically based suggestions for criteria to begin a plyometric program. Lack of evidences are there to support the dosage for plyometric training and its progression.
10. **Reliability and Validity of a Portable Traction Dynamometer in Knee-Strength Extension Tests: An Isometric Strength Assessment in Recreationally Active Men.(2023) :** Danielle Garcia, determined the validity and reliability of measurements obtained using the portable traction dynamometer (PTD) (E-Lastic, E-Sports Solutions, Brazil) and the reproducibility between evaluators (precision) in the evaluation of the isometric muscle strength of the knee extensors of healthy male adults, compared to measurements obtained with the "gold standard" computerized dynamometer (CD).
11. **Effects of Plyometric Training on Lower Body Muscle Architecture, Tendon Structure, Stiffness and Physical Performance- A Systematic Review and Meta-analysis.(2020):** María Ramírez-delaCruz determined the precise effect of plyometric training (PT) on vertical jump height in healthy individuals. The study showed PT increased the thickness, and fascicle length of the evaluated muscles. In addition, plyometrics is an effective tool for increasing tendon stiffness and improving jump and strength performance of the lower body.
12. **The influence of jumping performance and coordination on the spike ability of young volleyball athletes.(2022):** Mohd Izwan Shahril ,conducted this study to determine the influence of jumping performance and coordination parameters in young volleyball athletes. The study showed coaches can use the information in this study as a guideline to develop the training programmed to improve their athletic effectiveness in spiking.
13. **Reactive strength index modified is a valid measure of explosiveness in collegiate female volleyball players.(2015) :** Kristof Kipp, Michael T. Kiely , investigate the validity of the Reactive Strength Index modified (RSImod) as a measure of lower body explosiveness.
14. **The association between reactive strength index and reactive strength index modified with approach jump performance (2022) :** Jernej Pleša , Žiga Kozinc , Darjan Smajla, was to assess the associations between reactive strength index (RSI), reactive strength index modified (RSImod) and approach jump performance in male volleyball players. The results indicated that the

relationships among different RSI variants and approach jump in volleyball players were moderate to strong, with the highest correlations being observed for RSI_{mod} from bilateral CMJ.

15. **Effects of Plyometric Jump Training on the Reactive Strength Index in Healthy Individuals Across the Lifespan: A Systematic Review with Meta-analysis(2023):** Rodrigo Ramirez-Campillo, Rohit K Thapa, aimed to examine the effects of PJT on the RSI of healthy individuals across the lifespan compared with active/specific-active controls. They concluded that the effects of PJT on the RSI were greater compared with active/specific-active controls, including traditional sport-specific training as well as alternative training interventions (e.g., high-load slow-speed resistance training). This conclusion was derived from 61 articles with low risk of bias (good methodological quality), low heterogeneity, and moderate certainty of evidence, comprising 2576 participants. PJT-related improvements on RSI were greater for adults versus youths, after > 7 training weeks versus ≤ 7 weeks, with > 14 total PJT versus ≤ 14 sessions, and with three versus < three weekly sessions.
16. **The Relationship Between Maximum Jump Performance and Force-time Variables of Block Landing Skill in Junior Elite Volleyball Players (2021) :** Ali Fatahi , Razieh Yousefian Molla , aimed to investigate the possible correlation between Maximum Jump (MJ) performance and force-time variables of volleyball block landing. Peak vertical impact forces were reported in a range of 1.8-3.5 BW (F1, F2) during 27 to 83 ms of peak times (T1, T2). Significant positive correlations were obtained between temporal variables of time of peaks (T1, T2), the time elapsed between peaks (TP), and end of landing time (Tf). A significant negative correlation was found between F2 and T2 and a significant positive correlation between MJ performance with peak vertical forces (F1, F2).
17. **Examination of Hamstring Eccentric Muscle Strength and Limb Asymmetry with Nordbord Devices (2025):** Elif Sibel Atış , Özgür Aktürk , aimed to investigate the hamstring eccentric muscle strength and limb asymmetry in young football players. They concluded that the asymmetry values of U17 and U19 football players (30 males) were found well below the value ($8,55 \pm 5,13$) recommended by the experts. The low correlation results between right muscle strength and asymmetry in our study indicate that right hamstring muscle strength does not notably effect the asymmetry of the players. In contrast, it was found to have an effect on asymmetry for the left hamstring muscle group strength.
18. **Understanding the deadlift and its variations (2019) :** Clifton J. Holmes , aimed to make the reader understand what the deadlift exercise is and how it can be beneficial for anyone going through a resistance training program; gain foundational knowledge about the similarities and differences between deadlift exercise variations; be able to avoid the common errors associated with the deadlift exercises in order to stay safe and injury-free; and know how to determine which deadlift exercise variation is best for a particular individual.
19. **Effects of Plyometric Training on Physical Performance: An Umbrella Review (2023) :** Rafael L. Kons , Lucas B. R. Orsatto , aimed to systematically review, summarize the findings, and access the quality of published meta-analyses investigating the effects of plyometric training on physical performance. The available evidence indicated that plyometric training improved most related physical fitness parameters and sports performance.

20. **Investigating the impact of inter-limb asymmetry in hamstring strength on jump, sprint, and strength performance in young athletes: comparing the role of gross force (2023) :** Dongting Jiang , Zijian Liu , conducted a study to examine the impact of the inter-limb asymmetry of hamstring strength on jump, sprint and strength performance and to compare the effects of inter-limb asymmetry of hamstring strength with gross force (GF) of the hamstring on these physical qualities in youth volleyball athletes.

| Sr. No | Authors (Year) | AIM | METHO D | FINDING S | INSIGHT S | ROL |
|---------------|---|--|--|---|--|--|
| 1 | Ana Filipa Silva, Filipe Manuel Clemente, et al. (2019) | To review the effects of plyometric training on volleyball players' performance. | Systematic review of 15 studies on vertical jump, 4 on strength, 4 on horizontal jump, 4 on flexibility, 3 on agility/speed. | Plyometric training increases vertical jump, horizontal jump, flexibility, agility/speed. | Young female athletes under 18 most studied. | Plyometric training improves multiple performance factors in volleyball players. |
| 2 | Jacque L Barnes, Brian K Schilling (2007) | To quantify vertical and horizontal force during COD task | Study compared NCAA Div I, II, III female volleyball athletes in jump and | Identified predictors of court-sport-specific agility performance. | Force production linked with agility differences across divisions. | Jumping and agility performance closely related in volleyball athletes. |

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| | | and examine predictors of agility performan ce. | agility tests. | | | |
| 3 | Bikash Poudel; Shivlal Pandey (2023) | To identify etiology, evaluation, and manageme nt of hamstring injury. | Narrative review of literature on hamstring injuries. | Outlined evaluation methods, rehab strategies, and RTS criteria. | Highlighte d inter- profession al coordinati on in manageme nt. | Comprehe nsive hamstring injury manageme nt requires multi- disciplinar y approach. |
| 4 | Pu Wang, Zhikai Qin (2025) | To quantify inter-limb asymmetry and its association with non- | Study on elite male volleyball players assessing jumps, COD, and | Inter-limb asymmetri es linked with risk of non- contact | Pre-season screening of asymmetri es may help | Lower limb asymmetry is a predictor of injury risk. |

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|---|-------------------------------------|--|--|---|--|---|
| | | contact injuries. | strength asymmetries. | lower limb injuries. | prevent injuries. | |
| 5 | Basilio Pueo, Will G Hopkins (2023) | To evaluate accuracy of jump height estimation from videos at different frame rates. | Compared My Jump app using 240Hz vs other frame rates. | 240Hz video provides accurate CMJ height estimation. | Coaches can reliably monitor jump performance using My Jump. | Video-based tools are valid alternatives for jump monitoring. |
| 6 | Tyler Whitmer (2015) | To determine accuracy of vertical jump (VJ) contact mat vs force plate. | Compared jump height and flight time using VJ mat, VJ tester, and force plate. | VJ mat overestimated jump height compared to force plate. | Caution needed when using VJ mats for precise measurement. | Force plates remain gold standard for jump analysis. |

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| 7 | Jerry C. Arias (2015) | To investigate deadlifts as a PAP stimulus on VJ performance. | Tested heavy deadlifts followed by counterme jumps. | No significant PAP effect observed. | Lack of specificity, recovery time, and participant strength may explain findings. | Deadlifts may not be optimal PAP stimulus for VJ. |
| 8 | Goran Markovic (2017) | To determine effect of plyometric training on vertical jump height. | Meta-analysis of plyometric training studies in healthy individuals. | Statistically significant improvements: SJ/DJ +4.7%, CMJA +7.5%, CMJ +8.7%. | Confirms plyometric training efficacy for jump performance. | PT significantly enhances jump height across jump types. |
| 9 | George Davies (2015) | To provide overview of plyometric | Narrative clinical commentary. | Explained physiology, mechanics, | Discussed contraindications and progression | Provides clinical framework for safe |

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|----|--------------------------------|--|--|---|--|---|
| | | exercises and guidelines. | | phases, UL & LL applications. | n guidelines. | plyometric training. |
| 10 | Danielle Garcia (2023) | To determine validity of portable traction dynamometer (PTD). | Compared PTD results with computerized dynamometer in knee extensor tests. | PTD reliable and valid for measuring isometric strength. | Can be used in sports settings for strength monitoring. | Portable tools are effective alternatives for lab devices. |
| 11 | María Ramírez-de laCruz (2020) | To review effects of plyometric training on muscle and tendon structure. | Systematic review and meta-analysis. | PT increased muscle thickness, fascicle length, tendon stiffness, and | Supports use of PT for strength and performance development. | Plyometrics improves both muscle architecture and function. |

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|----|---|--|---|---|---|---|
| | | | | performan ce. | | |
| 12 | Mohd Izwan Shahril (2022) | To study influence of jumping performan ce and coordinati on on spiking ability. | Study with young volleyball athletes assessing coordinati on and jump measures. | Jumping and coordinati on strongly correlated with spike performan ce. | Coaches can use findings to design spiking programs. | Spiking ability is influenced by coordinati on and jump ability. |
| 13 | Kristof Kipp, Michael T. Kiely (2015) | To validate RSImod as measure of explosiven ess. | Tested RSImod in collegiate female volleyball players. | RSImod valid for measuring lower body explosiven ess. | Provides a practical measure for coaches. | RSImod is a valid explosiven ess assessment tool. |
| 14 | Jernej Pleša, Žiga Kozinc, Darjan | To assess association between RSI, RSImod | Male volleyball players tested on RSI | Moderate to strong correlation s, highest with | RSImod best predictor of | RSImod strongly linked to volleyball- |

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|----|--|--|---|--|--|---|
| | Smajla (2022) | and approach jump. | variants and jump. | RSI mod from bilateral CMJ. | approach jump. | specific jumps. |
| 15 | Rodrigo Ramirez- Campillo, Rohit K Thapa (2023) | To examine PJT effects on RSI across lifespan. | Systematic review and meta- analysis of 61 studies (2576 participant s). | PJT improves RSI vs controls, greater in adults, >7 weeks, >14 sessions, ≥3 sessions/w eek. | Training volume and duration are key for RSI gains. | PJT enhances RSI with optimal programm ing. |
| 16 | Ali Fatahi, Razieh Yousefian Molla (2021) | To correlate MJ performan ce and block landing | Junior elite volleyball players tested on MJ and block | Significant positive and negative correlation s found between | MJ performan ce linked with peak vertical forces | Landing mechanics tied to jump performan ce. |

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|----|--------------------------------------|--|---|--|---|--|
| | | force-time variables. | landing forces. | jump and landing metrics. | during landing. | |
| 17 | Elif Sibel Atış, Özgür Aktürk (2025) | To investigate hamstring eccentric strength and asymmetry with NordBord. | U17 and U19 male football players tested. | Asymmetry values lower than expert cutoff; left hamstring strength affected asymmetry. | Left hamstring strength influences asymmetry more than right. | Asymmetry patterns differ by limb dominance. |
| 18 | Clifton J. Holmes (2019) | To explain deadlift and variations for training and safety. | Narrative overview. | Outlined benefits, variations, errors, safety tips. | Helps trainers choose appropriate deadlift type. | Deadlifts are foundational but require proper technique. |

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|----|---|---|--|---|--|--|
| 19 | Rafael L. Kons, Lucas B. R. Orssatto (2023) | To summarize findings of meta-analyses on plyometric training. | Umbrella review of PT studies. | PT improves physical fitness parameters and sports performance. | Strong evidence for PT efficacy. | Confirms PT as effective for multiple sports outcomes. |
| 20 | Dongting Jiang, Zijian Liu (2023) | To study hamstring asymmetry effects on performance in youth volleyball athletes. | Tested hamstring strength asymmetry vs gross force for jump, sprint, strength. | Asymmetry negatively impacts performance, gross force more influential. | Both asymmetry and gross force affect performance, GF more strongly. | Hamstring GF plays bigger role than asymmetry in youth athletes. |

METHODOLOGY

●**STUDY POPULATION:** Recreational Volleyball players

●**STUDY SETTING:** Local clubs and academy , Bhubaneswar.

●**SAMPLING DESIGN:** Purposive sampling

●**SAMPLING CRITERIA:**

INCLUSION:

- Participants were aged between 18 and 30 years.
- Both male and female recreational volleyball players were considered eligible.
- Only those who were actively engaged in recreational volleyball were included.
- Participants did not have any ongoing musculoskeletal injuries or medical conditions that could have interfered with their ability to undergo the training programme.

EXCLUSION:

- Individuals who had sustained musculoskeletal injuries within the previous six months were excluded from the study.
- Those with a history of cardiovascular, musculoskeletal, or neurological disorders, or any past illness or injury that could have influenced the outcomes, were not included.

●**SAMPLE SIZE:** 60

●**DURATION:** 06 months

●**MATERIALS TO BE USED:** Mobile phone with good video quality , Tripod, Isometric Dynamometer, jump mat, Pen, paper and assessment form, Jump box

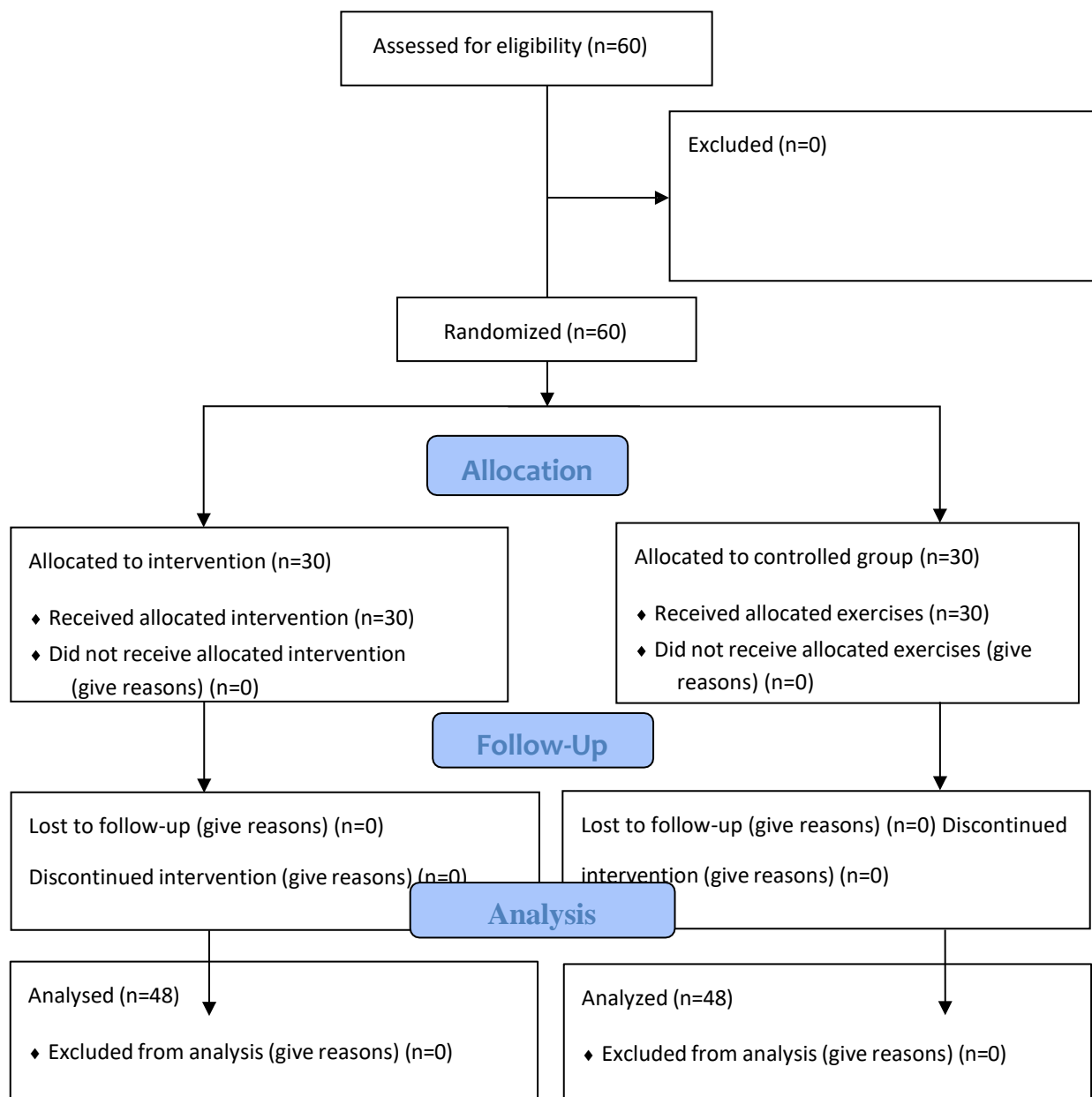
● **Outcome Measures:**

Primary Outcome :My Jump 2 Application, Flight Time, Reactive Strength Index (RSI) .

Secondary Outcome: Isometric Dynamometer, Hamstring Strength Asymmetry.

PROCEDURE

CONSORT 2010 Flow Diagram



Ethical Clearance from the Institutional Ethics Committee was taken. Participants were evaluated and then according to the basis of inclusion standards. After properly informing about the procedure, basic demographic data was obtained and consent forms were signed by the participants. Following selection, the participants were subjected to an initial pre-intervention appraisal to obtain baseline measurements of their physical capabilities, including strength and jump performance. Once the participants undergo screening they were divided in two groups broadly, which later were sub-divided according to gender (Male, Female) .One group receiving Plyometric training and the other receiving Deadlift training. The training interventions, which consists of plyometric training and deadlift training, were then administered over a period of six months, with careful monitoring of each participant's progress. Throughout the study, data collection was conducted at regular intervals to track improvements and any operational ability metrics. After the completion of the training period, a post-intervention assessment was performed to examine the efficacy of methods of training on the hamstring muscle strength asymmetry, flight time, and reactive strength index. The entire process was conducted under ethical guidelines, ensuring participant consent and confidentiality were maintained throughout the study.

RESULTS

60 recreational volleyball players fitting the inclusion criteria and consenting to participate were recruited and were randomised using the chit method. Allocation of 60 players with 30 players in the plyometric group and 30 deadlift group. Data analysis was conducted with the technical usage of SPSS. Descriptive statistics were analysed for each treatment group. Data was then tested for Normality using the Shapiro-Wilk test. Students t test and Wilcoxon sign rank test for intragroup & the independent t test and Mann Whitney U test was used for intergroup comparison. For all analyses, statistical tests were one-tailed, set at 95% confidence interval and the threshold of the p-value considered significant was set at <0.05 or <0.001

Table 1: Tests used for calculating p- value

| Outcome Measure | Within group | Between Group |
|-----------------|----------------|--------------------|
| Assymetry % | Student t test | Independent t test |
| Flight time | Student t test | Independent t test |
| RIS | Student t test | Independent t test |

BASELINE ANALYSIS

| | Plyometric group | Deadlift group |
|-----|------------------|----------------|
| Age | 23.6 ± 2.5 | 23.8 ± 3.07 |

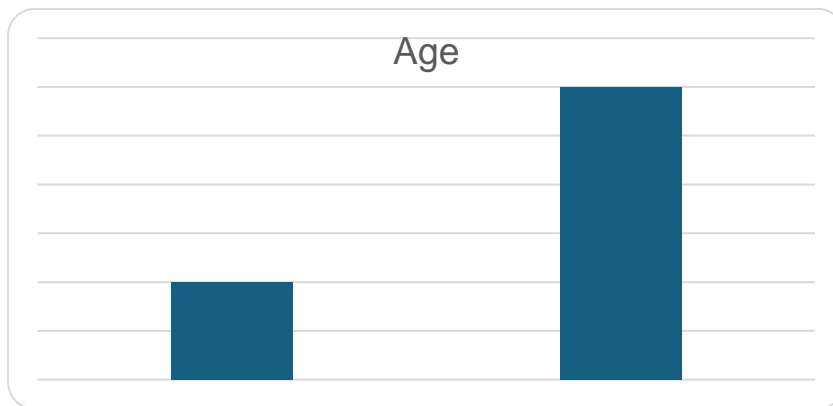


Figure 1: shows mean of age in both groups

Plyometric group

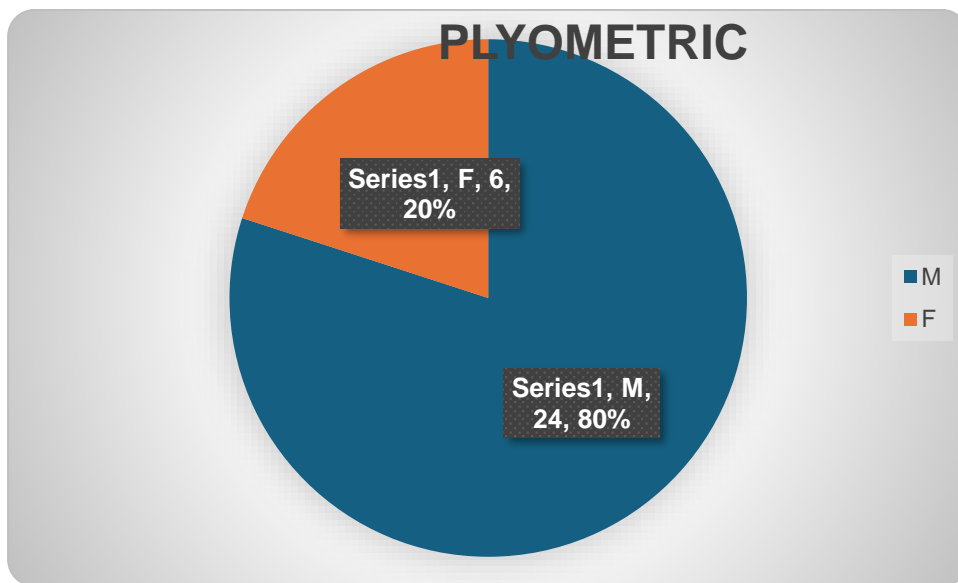


Figure 2 : Demonstrates distribution of gender in Plyometric group.

Deadlift group

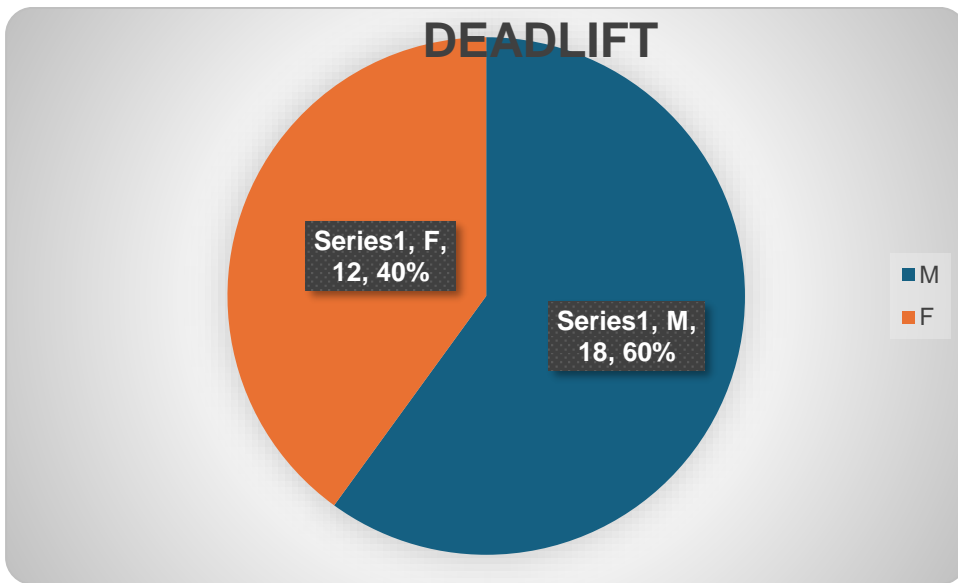
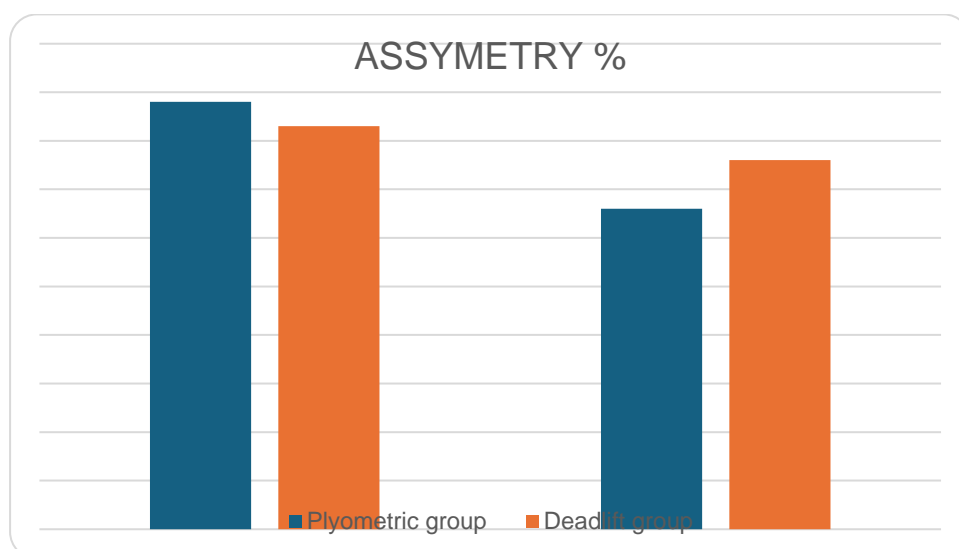


Figure 3: Demonstrates distribution of gender in Deadlift group

INTERGROUP ANALYSIS

Asymmetry %

| Groups | Pre mean | Post mean | Mean difference | Pvalue | Effect size |
|------------------|-----------|-----------|-----------------|----------|-------------|
| Plyometric group | 8.8 ± 5.8 | 6.6 ± 5.6 | 2.2 | p<.001 | 0.71 |
| Deadlift group | 8.3 ± 6.1 | 7.6 ± 6.1 | 0.7 | p = .075 | 0.34 |



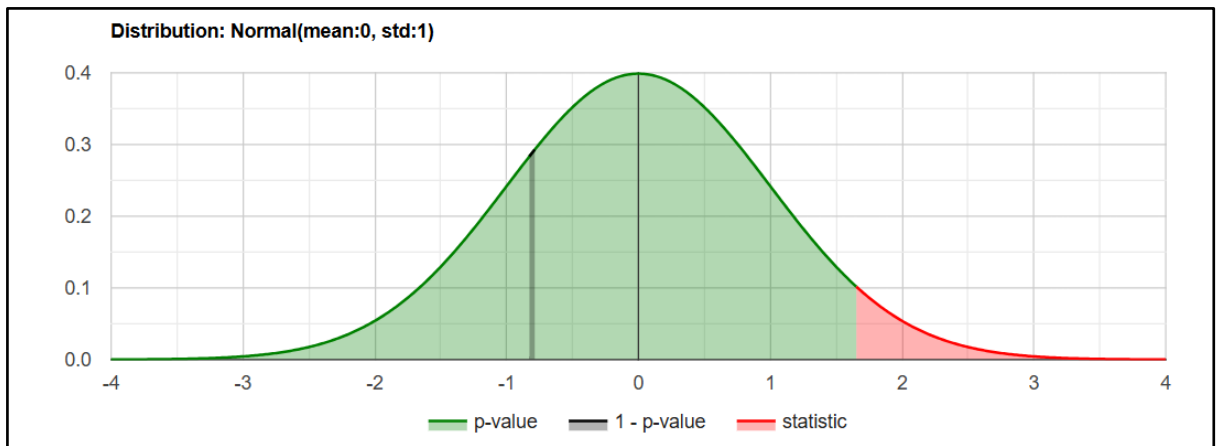


Figure 4: Plyometric Hamstrings asymmetry

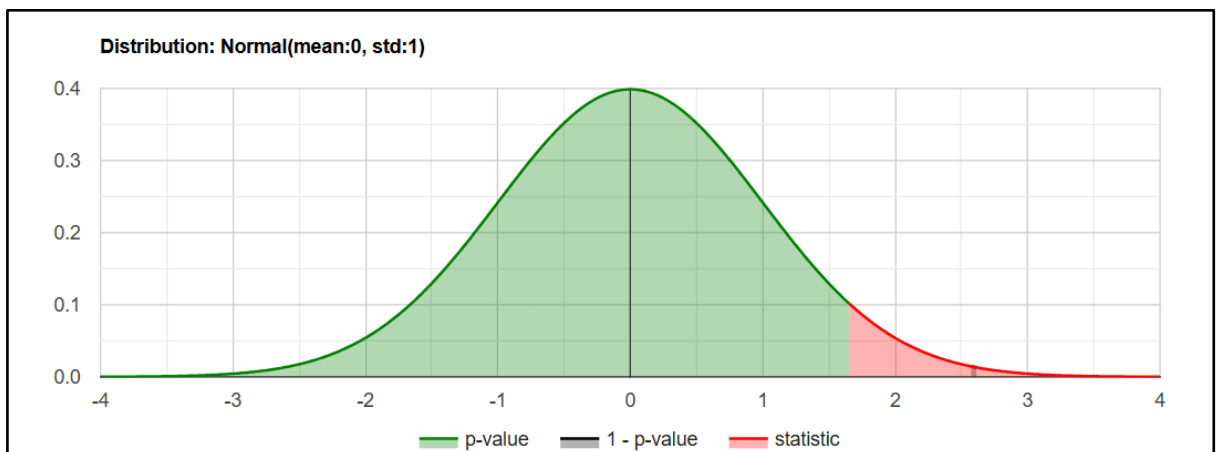


Figure 5 : Deadlift Hamstrings asymmetry

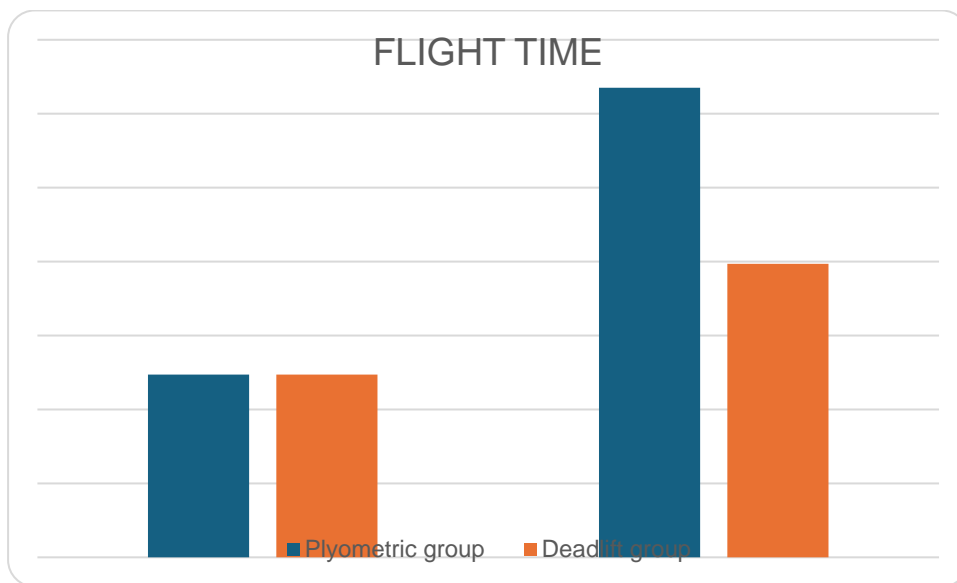
Hamstring Strength Asymmetry Distribution : The distribution appears approximately bell-shaped, suggesting normality. Shapiro-Wilk test results indicated a p-value greater than 0.05 (though exact values are not provided).

Interpretation: The data likely follow a normal distribution, justifying the use of parametric tests like the t-test.

Pre-Intervention Hamstring Asymmetry Distribution : The initial distribution appears normal, with a symmetrical bell shape. Normality confirmed via Shapiro-Wilk test ($p > 0.05$). Interpretation: The baseline asymmetry data are suitable for parametric analysis.

Flight time

| Groups | Pre mean | Post mean | Mean difference | Pvalue | Effect size |
|------------------|--------------|--------------|-----------------|--------|-------------|
| Plyometric group | 274.7 ± 8.7 | 313.5 ± 10.3 | 38.8 | p<.001 | 7.5 |
| Deadlift group | 274.7 ± 11.6 | 289.7 | 15 | p<.001 | 3.14 |



For both the groups, there is a significant difference in pre- and post-values for the Flight time with large effect size for plyometric group.

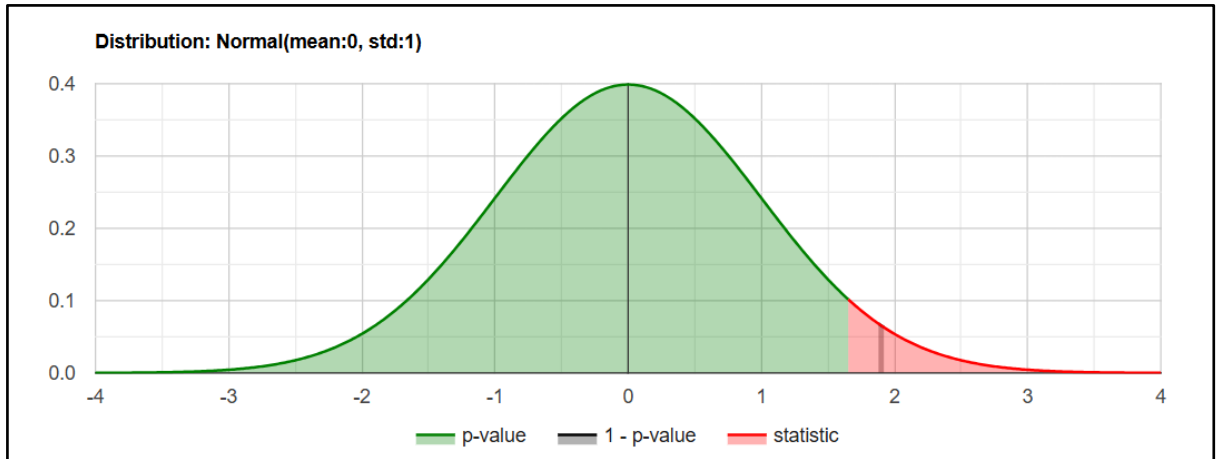


Figure 5: Plyometric flight time

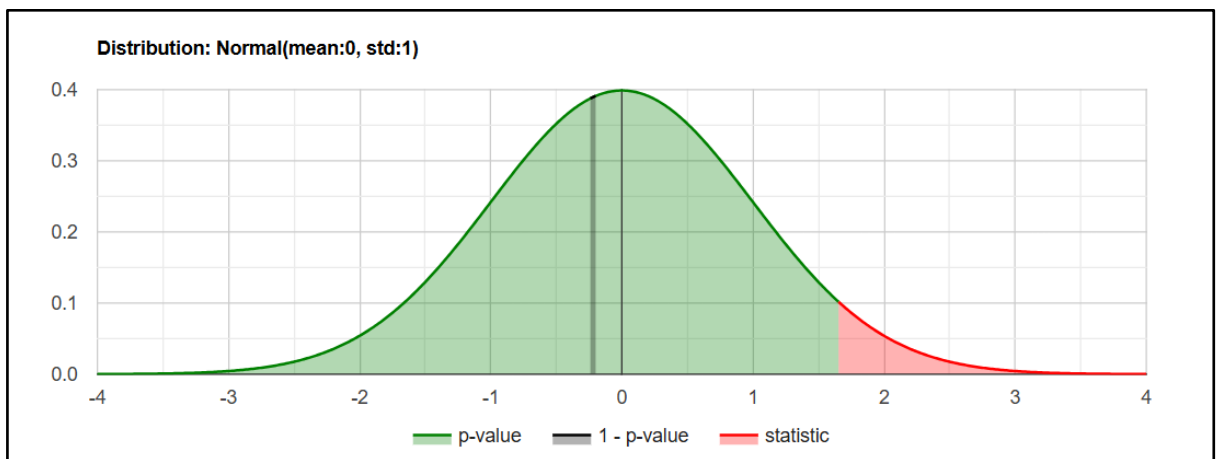


Figure 8 : Deadlift flight time

Flight Time Distribution : The bell curve demonstrates a symmetric shape with a peak near the mean, indicative of normality. Shapiro-Wilk test yielded a p-value above 0.05, confirming the assumption of normality.

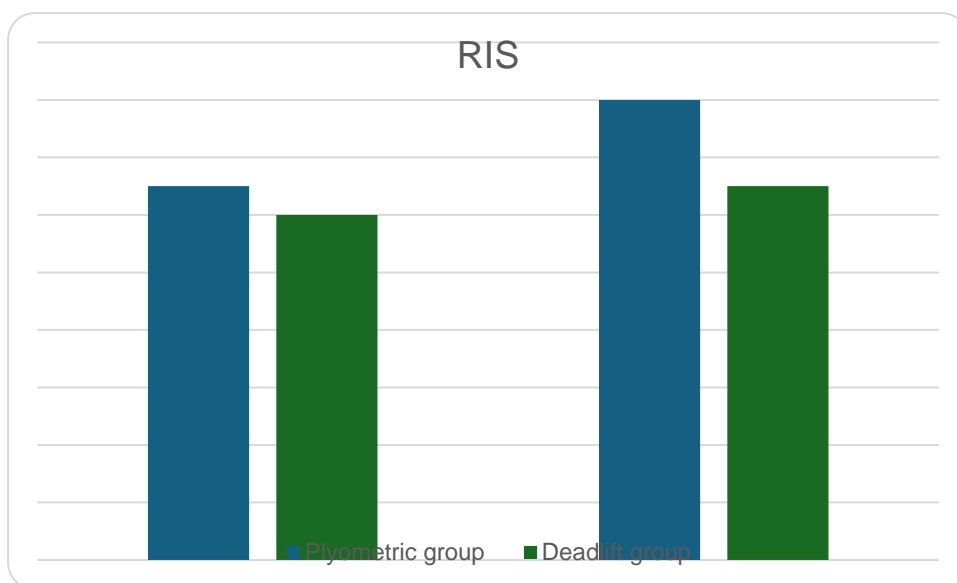
Interpretation: The distribution of flight time data can be considered normal.

Pre-Intervention Flight Time Distribution: The curve displays good symmetry with a peak at the mean. Shapiro-Wilk test indicates $p > 0.05$.

Interpretation: The data are normally distributed at baseline.

RSI

| Groups | Pre mean | Post mean | Mean difference | Pvalue | Effect size |
|------------------|------------|------------|-----------------|--------|-------------|
| Plyometric group | 1.3 ± 0.04 | 1.6 ± 0.05 | 0.3 | p<.001 | 8.87 |
| Deadlift group | 1.2 ± 0.04 | 1.3 ± 0.06 | 0.1 | p<.001 | 4.92 |



For both groups, there is a significant difference in pre- and post-values for the RSI. Plyometric training seems more effective for performance improvement in this outcome measure than Deadlift training.

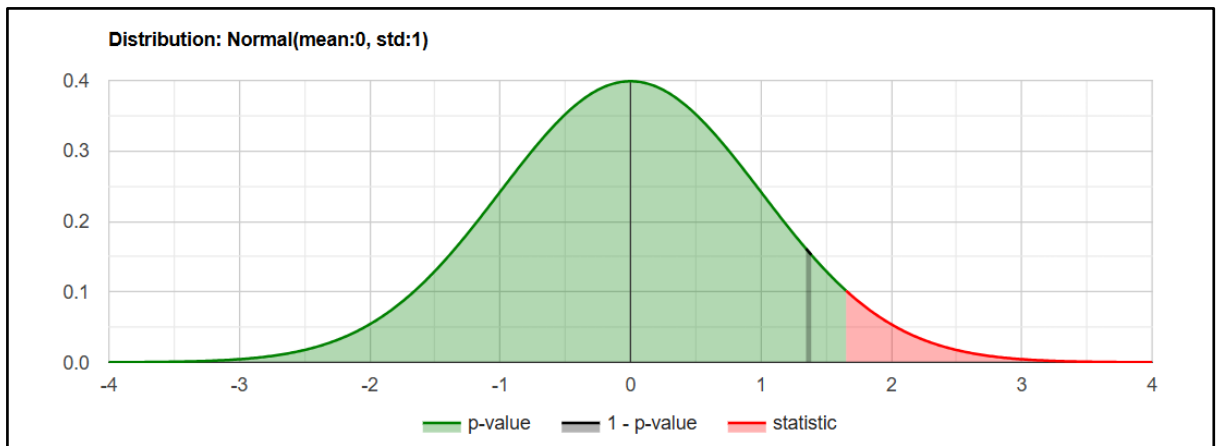


Figure 6: Plyometric RSI

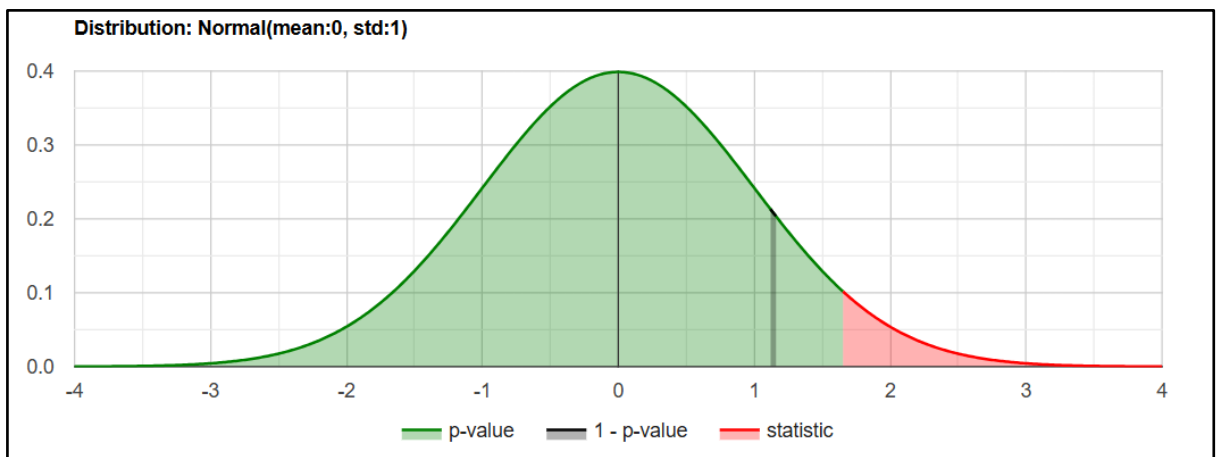


Figure 9 : Deadlift RSI

Reactive Strength Index (RSI) Distribution : The shape is symmetrical with no apparent skewness; however, some slight kurtosis may exist. The Shapiro-Wilk test suggests $p > 0.05$, supporting normality.

Interpretation: The RSI data are normally distributed, justifying parametric testing.

Pre-Intervention RSI Distribution : The distribution resembles a normal curve, as confirmed by the Shapiro-Wilk test ($p > 0.05$). Interpretation: The baseline RSI data follow a normal distribution.

INTRAGROUP ANALYSIS

| Outcome measure | Plyometrics | Deadlift | P value | Effect size |
|-----------------|-------------|-----------|---------|-------------|
| Inter asymmetry | 2.2 ±0.2 | 0.7 | p>0.05 | 0.18 |
| Flight time | 38.8 ±1.6 | 15 ±0.2 | p>0.05 | 2.2 |
| RIS | 0.3 ± 0.01 | 0.1± 0.02 | p>0.05 | 3.91 |

Between-group analysis there is found to be no significant difference between all outcome measures in the plyometric and deadlift groups.

DISCUSSIONS

The aim of this study sought to compare the efficacy of plyometric training and deadlift training on three key performance outcomes: asymmetry percentage, flight time, and reactive strength index (RSI). Both interventions resulted in meaningful improvements, though the magnitude and nature of changes differed between groups. The findings provide important insights into how different strength and power training modalities influence neuromuscular performance.

The results demonstrated that plyometric training produced a significant reduction in asymmetry percentage ($\Delta = 2.2\%$, $p < .001$, $d = 0.71$), while the deadlift group showed only a small and non-significant change ($\Delta = 0.7\%$, $p = .075$, $d = 0.34$). Inter-limb asymmetry is a critical factor in sports performance, as excessive asymmetry has been linked with decreased motor efficiency, impaired coordination, and heightened injury risk ⁽¹⁾

The greater improvement in the plyometric group can be explained by the unilateral and dynamic nature of plyometric drills, which inherently challenge athletes to use both limbs symmetrically during take-off and landing. These repeated, high-velocity actions may enhance proprioceptive feedback, neuromuscular coordination, and muscular balance across limbs.⁽²⁾ In contrast, deadlift training, though effective for increasing bilateral strength, is less likely to address subtle imbalances between limbs, since it is predominantly a bilateral and sagittal-plane movement. Thus, while deadlifts may enhance overall force output, they do not provide the same corrective stimulus for asymmetry as plyometric training.⁽³⁾

Both groups showed significant gains in flight time, but the magnitude was considerably higher in the plyometric group ($\Delta = 38.8$ ms, $d = 7.5$) as shown in study of Markovic G et al compared to the deadlift group ($\Delta = 15$ ms, $d = 3.14$).⁽⁴⁾ Flight

time is a proxy for jump performance and reflects the athlete's ability to generate explosive power and utilize the stretch-shortening cycle (SSC) effectively.

Plyometric movements based on the body weight of the athlete condition the muscles, connective tissue, and nervous system to effectively perform the stretch-shortening cycle.⁽²⁾ Plyometric training targets SSC efficiency most directly by focusing on quick eccentric loading and then explosive concentric movement, such as in jump squats, bounds, and drop jumps.. This training likely enhances neuromuscular recruitment, motor unit synchronization, and rate of force development (RFD), all of which contribute to longer flight times. Prior studies confirm that plyometric training can improve vertical jump performance and sprint acceleration according to study of Markovic & Mikulic et al published in year 2010)⁽⁵⁾. Exercises like Plyometric induces improvement in neuromuscular control in female athletes⁽⁶⁾

Deadlift training, on the other hand, focuses on building maximum strength in the posterior chain muscles, specifically the hamstrings, gluteals, and erector spinae, which strengthens the lower body's foundation. The transfer to explosive sport-specific actions is somewhat limited, even though such increases in maximal strength are significant for overall athletic development and can lead to modest improvements in jump height. This is due to the fact that deadlifts do not require the velocity-specific and stretch-shortening cycle (SSC) demands that are characteristic of plyometric exercises. Enhancing flight time and reactive strength in volleyball requires the ability to quickly absorb and reapply force during high-velocity eccentric-concentric transitions. The neuromuscular demands of repeated jumping tasks are not adequately replicated by deadlifts because they are executed at slower movement velocities with longer force application times. Therefore, plyometric training is more effective than deadlift training at eliciting the neural and mechanical

adaptations needed to improve flight time and explosive jump performance, even though deadlift training may provide a solid foundation for force production⁽³⁾

Both groups demonstrated significant gains in RSI, but the plyometric group achieved markedly larger improvements ($\Delta = 0.3$, $d = 8.87$) than the deadlift group ($\Delta = 0.1$, $d = 4.92$). RSI is an important indicator of an athlete's ability to rapidly switch from eccentric to concentric muscle actions, which is critical in movements such as sprinting, cutting, and rebounding.

Given the training specificity principle, it is not surprising that the plyometric group's RSI improved more than the others. Plyometric exercises mimic the high-velocity stretch-shortening demands of athletics, resulting in neuromuscular adaptations that directly improve RSI. Deadlift training, on the other hand, strengthens the relevant muscles but does so more slowly and under controlled circumstances with less involvement of the SSC. This explains why the deadlift group's RSI improved more modestly but significantly.

Although there were notable within-group gains in the plyometric and deadlift groups, the between-group analysis showed no statistically significant differences in asymmetry, flight time, or RSI ($p > .05$). Methodological and contextual factors are largely responsible for this lack of separation. Even when the mean differences seemed significant, the study's ability to identify genuine between-group differences was hampered by the comparatively small sample size, which also limited statistical power. The statistical signal was further diluted by high group variability, especially in asymmetry measures, where large standard deviations represented inconsistent individual training responses. While longer programs might have allowed structural and mechanical adaptations to diverge more clearly between groups, the relatively

short training duration may also have played a role, as both interventions probably produced early-phase neural adaptations. Furthermore, there may have been less contrast in short-term results due to some overlap in training effects, where plyometrics indirectly reinforce force production and deadlifts improve foundational strength. Subtle variations may have been masked by measurement sensitivity and daily performance variations, and individual adaptation patterns may have been further impacted by participant training backgrounds and baseline fitness. All of these factors work together to explain why the study found significant improvements within groups but no statistically significant differences between groups. This underscores the need for larger cohorts, longer intervention periods, and stricter control over participant characteristics in future research to better distinguish the unique advantages of strength-based and plyometric training.

However, effect size analysis revealed meaningful practical differences. For example, plyometric training showed larger effects for flight time ($d = 2.2$) and RSI ($d = 3.91$), even though p values were non-significant. This suggests that, from a performance standpoint, plyometric training may be more beneficial despite the lack of statistical significance in direct group comparisons

Plyometric training works especially well for improving reactive ability, explosive power, and jump performance⁽⁷⁾ For athletes participating in sports like basketball, volleyball, soccer, and tennis, where high-intensity movements are supported by SSC efficiency, it is therefore extremely relevant. A primary skill required in volleyball is the ability to jump high for spikes, blocks, and serves. Plyometric exercises such as depth jumps, squat jumps, and bounding improve the stretch–shortening cycle (SSC) of muscles. This enhances rate of force development (RFD), enabling players to generate greater force in shorter ground contact times, leading to higher vertical

jumps. Research consistently shows that plyometric programs improve jump height in volleyball athletes by 7–15% over short training periods. Moreover, Volleyball is not only about vertical jumps but also about quick lateral shuffles, dives, and transitions between offense and defence. Plyometric drills such as lateral hops, single-leg bounds, and multidirectional jumps enhance neuromuscular coordination and proprioception, leading to faster and more efficient movement transitions. This contributes to better court coverage and defensive agility. ⁽⁷⁾

Although deadlift training is less useful for enhancing SSC-specific results, it is still beneficial for building posterior chain robustness, maximal strength, and trunk stability. These characteristics are essential for both preventing injuries and producing power. ⁽⁷⁾ Exercises like plyometric along with jumps are frequently incorporated into the mid-stage and final phases of return-to-play or return-to-progression (RTP) programs, as they play a crucial role in restoring explosive power, neuromuscular control, and sport-specific movement patterns.⁽⁸⁾

Coaches might think about incorporating both plyometric and deadlift training into a periodized training program rather than treating them as mutually exclusive. Deadlifts can develop the foundation of strength that supports power expression, while plyometrics can offer the velocity-specific stimulus for explosive actions.⁽⁹⁾

It is important to recognize a number of limitations. First, the statistical power to identify differences between groups was constrained by the comparatively small sample size. Second, the study only used brief interventions; group contrasts might be more pronounced with longer training times. Third, only three outcome measures were looked at; a more thorough evaluation would be obtained by including other performance indicators like sprint speed, agility, and rate of force development.

Future studies should look into various periodization models, the combined effects of plyometric and deadlift training, and the long-term retention of adaptations.

Furthermore, evaluating underlying physiological alterations (such as tendon stiffness, muscle architecture, and electromyography) may help clarify the processes underlying performance gains.

The present study concluded that both plyometric and deadlift training were effective in improving performance-related outcomes, but the magnitude of improvement was consistently greater with plyometric training. Plyometric training produced significant reductions in asymmetry, larger gains in flight time, and superior improvements in RSI compared to deadlift training. Although between-group differences did not reach statistical significance, effect size analysis suggests that plyometric training provides greater practical benefits for athletes seeking to maximize explosive and reactive performance capacities

CONCLUSION

The present study examined the comparative efficacy of plyometric training and deadlift training on hamstring muscle strength asymmetry, flight time, and reactive strength index (RSI) in recreational volleyball players. Based on the findings, both trainings led to significant improvements in the targeted performance parameters, highlighting their beneficial roles in enhancing explosive strength and neuromuscular coordination. Notably, plyometric training demonstrated a greater magnitude of effect, with larger effect sizes observed in flight time, RSI, and reduction of muscle strength asymmetry.

This aligns with existing literature indicating that plyometric exercises enhance the stretch-shortening cycle efficiency, neuromuscular recruitment, and explosive power, which are vital for volleyball performance. The findings suggest plyometric training may produce better efficacy than deadlift training in optimizing athletic performance and addressing muscle strength imbalances, which are common injury risk factors in volleyball players. Consequently, incorporating plyometric exercises into regular training regimens could lead to improved vertical jumps, faster reaction times, and reduced injury susceptibility.

Furthermore, this study underlines the importance of sport-specific conditioning programs that address muscle asymmetries and neuromuscular coordination, essential for both performance enhancement and injury prevention. The results support the hypothesis that targeted plyometric interventions yield superior neuromuscular adaptations compared to traditional strength training modalities such as deadlifts.

In conclusion, training protocols aimed at improving explosive power and muscular symmetry should consider prioritizing plyometric exercises for their demonstrated efficacy. Coaches, trainers, and sports physiotherapists are encouraged to incorporate

such evidence-based methods into athlete conditioning programs. Future research may explore long-term effects, different age groups, and competitive levels to refine training strategies further.

LIMITATIONS

1. The study included a relatively small sample size (n=60), limiting generalization to larger or elite populations.
2. The intervention lasted only six months, which may not reflect long-term effects or retention of training gains.
3. Only three parameters (hamstring asymmetry, flight time, and RSI) were evaluated, leaving out other performance indicators such as sprinting ability, agility, and endurance.
4. Participants were drawn from a single geographic region, reducing external validity.

FUTURE SCOPE

1. Future studies should recruit larger and more diverse samples, including elite and professional volleyball players.
2. Longer-term follow-up is needed to assess the sustainability of training adaptations.
3. Additional performance outcomes such as sprint speed, agility, and rate of force development should be evaluated.
4. Comparative protocols combining plyometric and deadlift training may be explored to identify synergistic benefits.

SUMMARY

This research explored the comparative impacts of plyometric training versus deadlift training on key performance parameters in recreational volleyball players, focusing on hamstring muscle strength asymmetry, flight time, and reactive strength index (RSI). The rationale stemmed from the need to optimize training interventions that enhance explosive movements and reduce injury risks, which are critical in a sport characterized by rapid, high-intensity actions.

The methodology involved baseline assessment of all participants, who were then randomly assigned to either plyometric or deadlift training groups. Over a six-month intervention period, both groups engaged in targeted training routines, with subsequent post-intervention evaluations. The results revealed significant improvements across all parameters in both groups, with the plyometric group exhibiting larger effect sizes, indicating a more substantial enhancement in explosive power, neuromuscular coordination, and muscle balance.

The findings corroborate existing research that supports the efficacy of plyometric training in athletic performance, especially for sports requiring rapid stretch-shortening cycle activity such as volleyball. The increased flight time and RSI reflect improved neuromuscular responsiveness, while the reduction in hamstring asymmetry suggests a lower injury risk profile. Although both training modalities were beneficial, the superior effectiveness of plyometric exercises underscores their importance in athletic conditioning programs.

In essence, this study emphasizes the strategic role of plyometric training in sports performance and injury prevention. It advocates for the integration of plyometric routines tailored to the athletes' needs, potentially offering a cost-effective, efficient

approach to athletic development. The insights derived contribute valuable evidence for practitioners aiming to design optimal training environments that foster peak performance and athlete safety.

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ANNEXURES

Annexure 1

Informed Consent form to participate in a clinical trial

Study Title:

Study Number:

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) Annual Income of the subject _____ if applicable

Name and address of the nominee(s) and his relation to the subject _____ (for the purpose of compensation in case of trial related death).]

Please initial box

(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 the Sponsor of the clinical trial, others working on the [] Sponsor 's behalf, 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 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: _____

*Copy of the Patient Information Sheet and duly filled Informed Consent Form shall be handled over to the subject or his/her attendant.

Annexure 2

Recreational Volleyball Player Assessment Form

a) Participant Information

- Name: _____
- Age: _____
- Gender: Male Female
- Club/Academy: _____

b) Inclusion Criteria:

- Age between 18–30: Yes No
- Actively playing recreational volleyball: Yes No
- Any musculoskeletal injury in past 6 months: Yes No

▪ Any cardiovascular, neurological, or other relevant health conditions: Yes

No

c) Injury History

Have you experienced any hamstring or lower limb injuries in the past? Yes

No

If yes, specify: _____

Past injuries affecting sports participation? _____

Section 1

Training Intervention Details

Group Allocation: Plyometric Training Deadlift Training

Any Adverse Events During Training? Yes No

Section 2

Baseline Measures (Pre-Intervention)

Reading

Hamstring Strength (Right)

Hamstring Strength (Left)

Hamstring Strength Asymmetry

Flight Time

Reactive Strength Index (RSI)

Section 3

Post-Intervention Measures

Reading

Hamstring Strength (Right)

Hamstring Strength (Left)

Hamstring Strength Asymmetry

Flight Time

Reactive Strength Index (RSI)

Consent and Declaration

- I declare that the above information is accurate to the best of my knowledge.
- I understand the purpose of the study and agree to participate voluntarily.
- I acknowledge that I will be informed of any risks involved in the training program.

Signature: _____ Date: _____

Participant Information

Name of Athlete

Age

Gender

Male Female

Weight

Height

Dominant Hand

Right Left

Playing experience

Date

Trial Number

Trial 1 Trial 2 Trial 3

Test Administrator

Warm-Up Details

Warm-Up Type

Duration

Completed (✓)

Dynamic Warm-Up

15 min

Hitting Warm-Up

5 min

Annexure 3

Master-chart

| Player | Column | Age (years) | Gender | Group | Pre RHS (kg) | Post RHS (kg) | Pre LHS (kg) | Post LHS (kg) | Pre Asym (%) | R Asym (%) | ht Time (m:ht) | Time (m) | Pre RSI | Post RSI |
|-------------------|--------|-------------|--------|------------|--------------|---------------|--------------|---------------|--------------|------------|----------------|-----------|-----------|-----------|
| Suraj Patra | | 22 | M | Plyometric | 29.75106228 | 32 | 22.85698023 | 25.4681791 | 26.20923236 | 22.731957 | 270.832865 | 311.27283 | 1.2619544 | 1.5705542 |
| Chinnay Chetri | | 27 | M | Plyometric | 25.63736489 | 29.32817608 | 27.42965893 | 30.33705316 | 6.754831547 | 3.817923 | 281.366253 | 323.82243 | 1.2455402 | 1.6083257 |
| Amiket saho | | 21 | M | Plyometric | 25.50094185 | 28.07212122 | 29.83984875 | 32 | 15.68068275 | 13.07721 | 286.652393 | 323.6083 | 1.2602951 | 1.5719249 |
| Sudhan sethi | | 24 | M | Plyometric | 27.3243716 | 31.19399058 | 24.89669891 | 27.97682536 | 9.29767493 | 10.874162 | 282.806037 | 328.52999 | 1.2166602 | 1.4782837 |
| Pritam acharya | | 20 | M | Plyometric | 30.3979859 | 32 | 28.11817471 | 31.37964899 | 7.814651097 | 1.9575716 | 273.160608 | 303.51299 | 1.2086552 | 1.5441148 |
| Nilima jena | | 21 | F | Plyometric | 31.28301767 | 32 | 28.35517561 | 31.80366491 | 9.818681265 | 6.154351 | 266.521885 | 306.45231 | 1.2653255 | 1.5753886 |
| Sambit chhetri | | 24 | M | Plyometric | 29.30302322 | 32 | 26.65926145 | 30.36918201 | 9.448369693 | 5.2295635 | 280.227037 | 319.09625 | 1.2614075 | 1.6086431 |
| Rajat parida | | 25 | M | Plyometric | 26.46399318 | 29.58918344 | 27.35196703 | 30.23056981 | 3.30039078 | 2.1443966 | 271.797994 | 307.30577 | 1.2771121 | 1.5676229 |
| Biswajeet saho | | 21 | M | Plyometric | 27.23090204 | 29.59446651 | 24.36178973 | 27.07826315 | 11.12216562 | 8.8797676 | 274.322669 | 306.37621 | 1.2722825 | 1.5185882 |
| Saurav patra | | 19 | M | Plyometric | 27.98527357 | 30.01084561 | 26.05006207 | 28.6792715 | 7.162762953 | 4.5376434 | 277.952006 | 308.95839 | 1.216805 | 1.4739659 |
| Susant rao | | 21 | M | Plyometric | 27.2992931 | 30.347333 | 26.56030382 | 30.25549495 | 2.744132223 | 0.3030817 | 254.154153 | 292.09581 | 1.2397728 | 1.5346644 |
| Shiva patra | | 23 | M | Plyometric | 28.84562466 | 31.72893149 | 24.92751459 | 27.26194335 | 14.57274066 | 15.144675 | 282.410542 | 313.51598 | 1.2054953 | 1.4892018 |
| Dilip saho | | 27 | M | Plyometric | 26.95856438 | 29.5096359 | 23.48697986 | 26.51021207 | 13.76369141 | 10.708433 | 273.696882 | 310.32906 | 1.2664741 | 1.5763033 |
| Basudev kumar | | 27 | M | Plyometric | 28.42495345 | 32 | 27.08943404 | 29.6005305 | 4.811435249 | 7.7904183 | 283.657316 | 330.53009 | 1.256816 | 1.581921 |
| Jayanta patra | | 26 | M | Plyometric | 27.60597577 | 30.57815688 | 25.32891443 | 29.258835443 | 8.603253265 | 4.4113616 | 276.856807 | 307.21895 | 1.1551949 | 1.5061515 |
| Maheshwar acharya | | 25 | M | Plyometric | 26.67496091 | 29.52400234 | 26.78364224 | 30.5818165 | 0.406599946 | 3.5198395 | 281.110601 | 322.57432 | 1.2377397 | 1.491302 |
| Sagar rao | | 25 | M | Plyometric | 30.91063819 | 32 | 29.71884142 | 32 | 3.931410221 | 0 | 272.752026 | 309.00676 | 1.2810932 | 1.6110091 |
| Jitendra panda | | 25 | M | Plyometric | 25.53868429 | 27.87508114 | 29.82444942 | 32 | 15.48237912 | 13.778416 | 278.416958 | 322.40117 | 1.2514 | 1.5219662 |
| Surya naik | | 23 | M | Plyometric | 29.07482588 | 31.96463248 | 29.4825271 | 32 | 1.392485142 | 0.1105846 | 282.048145 | 318.38166 | 1.2806288 | 1.5338291 |
| Trinaku sethi | | 25 | M | Plyometric | 28.17118419 | 30.36801801 | 25.23080395 | 29.26449952 | 11.01225008 | 3.7010629 | 288.316659 | 337.20943 | 1.2654335 | 1.5962997 |
| Sweta gautam | | 22 | F | Plyometric | 28.03427274 | 30.379219 | 25.34915371 | 29.75733206 | 10.05974779 | 2.0682494 | 271.090618 | 317.80582 | 1.3183493 | 1.672998 |
| Binay saho | | 21 | M | Plyometric | 28.25611234 | 31.11952183 | 29.15157068 | 32 | 3.119646324 | 2.7898759 | 271.405112 | 308.61806 | 1.2254846 | 1.4951137 |
| Bandhan mohapatra | | 26 | M | Plyometric | 26.77349861 | 31.07488633 | 25.86275121 | 28.97174239 | 3.46053299 | 7.0050359 | 299.908191 | 318.49528 | 1.2517519 | 1.535926 |
| Minathi saho | | 23 | F | Plyometric | 25.60625682 | 28.460949 | 29.82449285 | 31.85303447 | 15.21984117 | 11.248244 | 252.724683 | 293.62428 | 1.3396033 | 1.6747989 |
| Lipika patra | | 28 | F | Plyometric | 27.42167305 | 30.27336717 | 23.36199713 | 26.46984474 | 15.98811548 | 13.406088 | 273.428526 | 310.4402 | 1.2014674 | 1.5047135 |
| Shivani naik | | 27 | F | Plyometric | 30.59639013 | 32 | 27.60815236 | 30.45673563 | 10.26805691 | 4.9418669 | 274.306594 | 313.35122 | 1.2679659 | 1.5557218 |
| Sangham digal | | 27 | M | Plyometric | 28.65025435 | 31.92507243 | 26.46385067 | 28.666197629 | 7.934098459 | 10.756912 | 258.838576 | 293.73115 | 1.2674698 | 1.5383957 |
| Manaswi saho | | 21 | F | Plyometric | 27.14759936 | 29.7597894 | 26.6727367 | 29.60016329 | 1.76462168 | 0.5378242 | 271.068832 | 313.70673 | 1.3006225 | 1.5645728 |
| Bikas jena | | 22 | M | Plyometric | 27.83513294 | 30.30112829 | 27.40731056 | 30.89854878 | 1.548890117 | 1.9252846 | 266.658835 | 273.02581 | 1.2808392 | 1.5648289 |
| Munna goudo | | 20 | F | Plyometric | 27.79041276 | 30.72809871 | 24.50315949 | 28.02167675 | 12.57230352 | 9.2133666 | 282.45424 | 321.4225 | 1.2157601 | 1.5408344 |
| Nirmal Pradhan | | 20 | F | Deadlift | 23.6879624 | 25.09966582 | 24.46218729 | 26.29917645 | 3.215877412 | 4.6674617 | 282.570365 | 296.67998 | 1.2388058 | 1.2997122 |
| Tapan pradhan | | 29 | M | Deadlift | 28.39495945 | 29.97766647 | 23.72887101 | 25.30529583 | 17.90385856 | 16.903474 | 274.278728 | 282.76805 | 1.2537409 | 1.3658333 |
| Prabhat shetty | | 21 | M | Deadlift | 24.10689496 | 26.531379 | 26.32298163 | 27.74268452 | 8.78784809 | 4.4636625 | 282.544395 | 287.9707 | 1.1891295 | 1.2907811 |
| Sushila acharya | | 23 | F | Deadlift | 25.84912328 | 28.15004067 | 27.1783742 | 28.62749882 | 5.013440123 | 1.6818557 | 258.117969 | 275.45026 | 1.230819 | 1.3472631 |
| Milan digal | | 22 | M | Deadlift | 30.80456376 | 32 | 25.10100969 | 27.1109914 | 19.43529665 | 16.541397 | 290.502389 | 311.33449 | 1.2518229 | 1.3370228 |
| Kamit saho | | 25 | F | Deadlift | 25.2873625 | 27.6715098 | 30.12622868 | 32 | 17.46307971 | 14.507728 | 267.062465 | 280.44534 | 1.200713 | 1.2748937 |
| Sanjay | | 21 | M | Deadlift | 28.31687431 | 29.77485271 | 25.45258763 | 27.28757613 | 10.65395328 | 8.177382 | 254.428774 | 275.67118 | 1.1628659 | 1.2829575 |
| Debashish | | 23 | M | Deadlift | 25.29723388 | 27.45928264 | 25.77226666 | 27.90223918 | 1.860377998 | 1.6002325 | 267.700999 | 280.81912 | 1.2182153 | 1.3553004 |
| Suchana | | 28 | F | Deadlift | 26.61994937 | 29.03149731 | 25.63042837 | 28.09414726 | 3.787612823 | 3.2811737 | 273.985693 | 294.68559 | 1.1702677 | 1.293325 |
| Shilpa rao | | 27 | F | Deadlift | 26.14937597 | 28.2683299 | 27.81606421 | 30.0482525 | 6.176872593 | 6.1041574 | 269.321741 | 285.00249 | 1.1669472 | 1.2636128 |
| Latika behera | | 22 | F | Deadlift | 29.29513026 | 32 | 27.26964075 | 29.82420415 | 7.161664324 | 7.0386538 | 277.7623 | 287.68091 | 1.264899 | 1.4132955 |
| Latika saho | | 23 | F | Deadlift | 30.1633632 | 32 | 26.5624652 | 29.27221553 | 12.69579737 | 9.9038219 | 292.297961 | 306.69553 | 1.236291 | 1.3649404 |
| Namrat patra | | 21 | M | Deadlift | 26.55808144 | 28.81503247 | 27.9621603 | 29.9614324 | 5.150669967 | 8.9088008 | 281.46795 | 295.14621 | 1.201961 | 1.327486 |
| Sultra digal | | 24 | F | Deadlift | 27.45243392 | 29.54691761 | 27.37983652 | 29.79196413 | 0.264798064 | 0.8259223 | 278.55789 | 296.02136 | 1.23835 | 1.3628415 |
| Tanmay kumar | | 22 | M | Deadlift | 29.03762887 | 32 | 24.35620233 | 27.15510601 | 17.53545845 | 16.380307 | 289.663389 | 306.11126 | 1.220353 | 1.3662318 |
| Priyanka das | | 21 | F | Deadlift | 26.05630579 | 29.51309849 | 22.49038082 | 24.25673285 | 14.69102573 | 15.51356 | 280.241915 | 298.33375 | 1.2340678 | 1.4683916 |
| Lipi kumar | | 19 | F | Deadlift | 24.50446913 | 25.97840832 | 26.39617178 | 28.77165772 | 7.432922724 | 10.203638 | 281.65925 | 288.74099 | 1.2891891 | 1.4589597 |
| Megha sethi | | 20 | F | Deadlift | 29.52932926 | 30.64371345 | 26.27911964 | 28.32964765 | 11.64773321 | 7.8478342 | 258.501366 | 275.35992 | 1.2220257 | 1.4705853 |
| Manoj das | | 22 | M | Deadlift | 24.68387839 | 27.08916788 | 26.98821771 | 29.18779122 | 8.919104104 | 7.4581974 | 269.508006 | 293.18949 | 1.2272954 | 1.3420557 |
| Suryaprakash rao | | 27 | M | Deadlift | 23.8960617 | 25.63836774 | 29.36615548 | 27.35329047 | 20.54024057 | 17.939002 | 272.161085 | 284.46367 | 1.2192982 | 1.3206766 |
| Shrikant gautam | | 29 | M | Deadlift | 27.78932517 | 28.97986638 | 27.30429575 | 28.80365775 | 1.760746234 | 0.6098923 | 297.091704 | 307.04497 | 1.172856 | 1.3105412 |
| Satwik rao | | 23 | M | Deadlift | 27.64640626 | 29.62863422 | 26.1921885 | 27.8557003 | 5.402138623 | 6.1684072 | 263.229898 | 275.16559 | 1.2518455 | 1.3682889 |
| Deepak acharya | | 21 | M | Deadlift | 29.23964318 | 30.66528136 | 28.66694635 | 31.13354628 | 1.978002296 | 1.515492 | 273.791772 | 287.95532 | 1.2445972 | 1.3456295 |
| Navin kumar | | 27 | M | Deadlift | 27.12403154 | 29.55584347 | 27.68915577 | 29.67644573 | 2.062000994 | 4.07218 | 293.133482 | 307.7745 | 1.1943039 | 1.2936663 |
| Abinash mishra | | 27 | M | Deadlift | 25.50191228 | 27.09055423 | 24.1892125 | 26.14427453 | 5.283437565 | 3.555115 | 271.820082 | 285.19664 | 1.2631605 | 1.3832908 |
| Kumud kumar | | 25 | F | Deadlift | 23.90224383 | 25.50115677 | 28.44667522 | 30.15397903 | 17.362083 | 16.72019 | 263.998785 | 273.34604 | 1.226576 | 1.3492086 |
| Vishal molapatra | | 29 | M | Deadlift | 28.02943895 | 30.59571952 | 29.34940324 | 31.7801492 | 4.60087463 | 3.7977176 | 254.375699 | 269.29564 | 1.2234984 | 1.397528 |
| Prashanta behera | | 21 | M | Deadlift | 29.9374355 | 31.96545526 | 28.2261232 | 29.23304419 | 5.89691176 | 8.296669 | 262.41414 | 288.90215 | 1.1596542 | 1.2617095 |
| Shiva | | 28 | M | Deadlift | 28.92145382 | 31.80037339 | 29.99751677 | 32 | 3.652687543 | 0.6257851 | 279.977472 | 297.14195 | 1.1711477 | 1.3098873 |
| Bijay patra | | 24 | M | Deadlift | 27.69673983 | 29.45344846 | 28.23926923 | 31.03817905 | 1.93982163 | 5.2359039 | 278.968955 | 296.27701 | 1.2163532 | 1.3415437 |





ABSMARI

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/135

Date: 02/05/2025

APPROVAL LETTER APPENDIX- VIII

To,

KARAD VAIBHAV VINAYAK
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: Plyometric training vs Deadlift training on hamstring's muscle strength asymmetry, flight time and reactive strength index on recreational volleyball players.

Protocol ID.: ABS-IEC-2025-PHY-047

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr **Karad Vaibhav Vinayak**

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 |

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

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



1

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

+91-63707-03654

iec@absmari.com



ABSMARI

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/135

Date: 02/05/2025

| 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 | |

| 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. Smaraki Mohanty | Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med) | Clinician | F | N |
| 3 | Mr. Chinmaya Kumar Patra | Principal-ABSMARI, MPT | Member Secretary | M | Y |
| 4 | Ms. Annie Hans | Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work | Social Scientist | F | N |
| 5 | Ms. Subhashree Samal | Ref. Reader-Pol Sc. | Lay Person | F | N |
| 6 | Mr. Deepak Kumar Pradhan | Asst. Prof-ABSMARI, MPT | Scientific Member | M | Y |

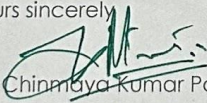
This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the study 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/assent and request to provide 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
 ABSMARI ETHICS COMMITTEE
 Pahal, Bhubaneswar



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Sports Medicine & Research Institute

A Unit of the Abhinav Bindra Foundation Trust

Recognised by DMET, Health & FW Dept., Govt. of Odisha, Affiliated to Utkal University
Recognised by Odisha State Council for Occupational Therapy and Physiotherapy
Affiliated to Odisha University of Health Sciences, Bhubaneswar

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Letter no-ABSMARI/ADMIN/2025/2649

Date:-28.05.2025

TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr. KARAD VAIBHAV VINAYAK is a bonafide student of MPT 2ND YEAR batch of ABSMARI bearing Roll No ABS-MPT-2023-14. With reference to his requisition this institute has no objection in allowing him to carry out his research work as per the following details under the guidance of Dr. DEEPAK KUMAR PRADHAN.

Ref: ABSMARI/IEC/2025/135

Title – “Plyometric training vs Deadlift training on hamstring’s muscle strength asymmetry, flight time and reactive strength index on recreational volleyball players”.

Population – Recreational Volleyball Players

study settings – Freedom Volleyball Academy

Duration – 6 weeks

from – 01.06.2025 To – 15.07.2025

under the following conditions subject to thorough permission from their end -

1. He has to produce her official engagement plan issued by study setting
2. He has to submit her certificate of attendance at last
3. He is liable to respond to institute when required
4. He must attend all examinations scheduled by the institution or university during this period
5. Daily report to Research- Guide and Course-Coordinator is highly required

This NOC is effective from 01.06.2025 to 15.07.2025

CC –The Dean, ABSMARI, The Course -Coordinator, The Research- Guide, Admin office



Principal, ABSMARI
PRINCIPAL, ABSMARI

Utkal Signature, Plot No 273, NH-5, Pahal, Bhubaneswar, 752101
Phone: 6370703650, 6370703651

Vaibhav Karad

PLYOMETRIC TRAINING VS DEADLIFT TRAINING ON HAMSTRING'S MUSCLE STRENGTH ASYMMETRY, FLIGHT TIM...

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PLYOMETRIC TRAINING VS DEADLIFT TRAINING ON HAMSTRING'S MUSCLE STRENGTH ASYMMETRY, FLIGHT TIM...

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