

**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL  
SKILLS AMONG DEVELOPMENTAL BASKETBALL  
PLAYERS - A RANDOMIZED CONTROL TRIAL**

By,

**KARISHMA P ASHER**

Dissertation Submitted to the

**Odisha University of Health Sciences, Bhubaneswar, Odisha**

In partial fulfillment of the requirements for the degree of

**MASTER OF PHYSIOTHERAPY (M.P.T)**

In

**SPORTS PHYSIOTHERAPY**

Under the guidance of

**Dr. CHIMAYA KUMAR PATRA[PT]**

**PRINCIPAL**

**Dr. JOYDIP SAHA [PT]**

**ASSOCIATE PROFESSOR**



**ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE**

**Bhubaneswar, Odisha**

**2023-2025**

**Odisha University of Health Sciences**

**DECLARATION BY THE CANDIDATE**

I hereby declare that this dissertation/thesis entitled “**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS - A RANDOMIZED CONTROL TRAIL**” is a Bonafide and genuine research work carried out by me under the guidance of Dr. Chinmaya Kumar Patra, Principal, and Co-guide Dr. Joydip Saha, Associate Professor Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, and there is no conflict of interest associated with this dissertation work.

**Date**

**Signature of the Candidate**

**Place: Bhubaneswar, Odisha**

**Name: Karishma P Asher**

**University Registration No:**

**23MP435056**

## **CERTIFICATE BY THE GUIDE**

This is to certify that the dissertation entitled “**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS - A RANDOMIZED CONTROL TRAIL**” is a bonafide research work done by **Karishma P Asher** under my guidance in partial fulfilment of the requirement for the degree of **MPT - Master of Physiotherapy**.

**Date:**

**Seal & Signature of the Guide**

**Place: Bhubaneswar, Odisha**

**Dr. CHINMAYA KUMAR PATRA [PT]**

**Department of Community**

**Physiotherapy**

## **CERTIFICATE BY THE CO-GUIDE**

This is to certify that the dissertation entitled “**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS - A RANDOMIZED CONTROL TRAIL**” is a bonafide research work done by **Karishma P Asher** in partial fulfilment of the requirement for the degree of **MPT - Master of Physiotherapy**.

**Date:**

**Seal & Signature of the Co-Guide**

**Place: Bhubaneswar, Odisha**

**Dr. Joydip Saha [PT]**

**Associate Professor, ABSMARI**

**Department of Movement Science**

## **ENDORSEMENT BY THE HEAD OF DEPARTMENT**

This is to certify that the dissertation entitled “**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS - A RANDOMIZED CONTROL TRAIL**” is a bonafide research work done by **Karishma P Asher** under the guidance of **Dr. Chinmaya Kumar Patra**, Principal and **Dr. Joydip Saha**, Associate Professor of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar.

**Date:**

**Seal & Signature of the HOD**

**Place: Bhubaneswar, Odisha**

**Dr. Asifuzzaman Shahriyar Ahmed [PT]**

**Associate Professor, ABSMARI**

**Department of Sports Science**

## **ENDORSEMENT BY THE PRINCIPAL**

This is to certify that the dissertation entitled “**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS - A RANDOMIZED CONTROL TRAIL**” is a bonafide research work done by **Karishma P Asher** under the guidance of **Dr. Chinmaya Kumar Patra**, Principal and **Dr. Joydip Saha**, Associate Professor of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar.

**Date:**

**Seal & Signature of the Principal**

**Place: Bhubaneswar, Odisha**

**Dr. Chinmaya Kumar Patra [PT]**

**Principal ABSMARI**



## **ODISHA UNIVERSITY OF HEALTH SCIENCES**

### **CERTIFICATE OF ACCEPTANCE**

This is to certify that the dissertation entitled: **“EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS – A RANDOMIZED CONTROL TRIAL”** carried out by **Ms. Karishma P Asher** bearing University Registration Number 23MP435056 has been **evaluated and accepted by me as an Examiner / Evaluator**, appointed by the **Odisha University of Health Sciences, Bhubaneswar**, in partial fulfilment of the requirements for the award of the degree of **Master of Physiotherapy in Sports**.

**Place: Bhubaneswar, Odisha**

**Signature of Examiner / Evaluator**

**Date:**

**Name:**

**Institution:**

**Designation:**

## **COPYRIGHT**

### **DECLARATION BY THE CANDIDATE**

I Karishma P Asher, Student of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha hereby declare that the Odisha University of Health Sciences and Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha shall have the rights to preserve, use and disseminate this dissertation/ thesis in print or electronic format for academic/ research purpose.

**Date:**

**Signature of the Candidate**

**Place: Bhubaneswar, Odisha**

**Karishma P Asher**

**© Odisha University of Health Sciences, Bhubaneshwar, Odisha**

**© Abhinav Bindra Sports Medicine and Research Institute Bhubaneswar, Odisha**

## ACKNOWLEDGEMENT

I would like to express my heartfelt gratitude to Almighty, my family and friends for their unwavering encouragement, understanding, and love. Their support has been a constant source of strength during this academic journey. I extend my sincere gratitude and appreciation to the management and administration of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, and those who have supported and guided me throughout the journey of this dissertation. Without their valuable contributions, this work would not have been possible.

I am also immensely grateful to Dr. Chinmaya Kumar Patra, the Principal, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar. Your encouragement and belief in my abilities have been a source of motivation and confidence. I would like to express my deepest gratitude to my dissertation guide, Dr. Chinmaya Kumar Patra, the Principal, and Co-guide Dr. Joydip Saha Associate Professor, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar. Your unwavering support, expert guidance, and insightful feedback have been instrumental in shaping this research. Your dedication to excellence in academia has inspired me to strive for higher goals in my academic pursuits.

Furthermore, I would like to extend special thanks to Dr. Deepak Pradhan for their valuable assistance and support throughout this research. Your expertise and constructive criticism have helped me refine my work and explore new dimensions in my study. I am also thankful to all the faculty members, staff, fellow students and subjects who have contributed to my academic growth and provided a stimulating environment for learning. In conclusion, this dissertation stands as a testament to the collaborative efforts of the individuals mentioned above, and I am deeply grateful for their contributions to my academic success.

Thank you.

**Date:**

**Place: Bhubaneswar, Odisha**

**Signature**

**KARISHMA P ASHER**

## LIST OF ABBREVIATION USED

1.	Abhinav Brinda Sports Medicine and Research Institute (ABSMARI)	ABSMARI
2.	Basketball skill and performance test	BSPT
3.	Certified strength and conditioning Specialist	CSCS
4.	Seated Medicine ball throw	SMBT
5.	Stress shortening cycle	SSC
6.	Upper body plyometric training	UBPT

## ABSTRACT

### EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS – A RANDOMIZED CONTROL TRIAL

**Background:** Basketball, played by around 11% of the global population, requires high technical proficiency in dribbling, passing, and shooting, all of which depend on motor control and upper-limb power. Research on the role of structured ballistic training in these skills is limited. The “Ballistic-Six” program, comprising explosive upper-body movements, aims to enhance upper-limb power and potentially improve game performance.

**Objective:** This study aimed to investigate the effect of a six-week Ballistic-Six exercise intervention on basketball-specific skills (shooting accuracy, field goal speed, dribbling ability, and passing speed) and upper-limb power among developmental basketball players.

**Methods:** A randomized controlled trial was conducted with developmental-level basketball players, who were randomly assigned to either a Ballistic-Six training group or a control group continuing standard basketball training. Pre- and post-intervention assessments included Johnson's Basketball Test—comprising throwing accuracy, field goal speed, and dribbling components—as well as the Speed Passing Test. Upper-limb power was evaluated using the Seated Medicine Ball Throw Test (SMBT).

**Results:** Within-group analysis showed significant improvements in shooting accuracy ( $18.50 \pm 3.06$  to  $21.39 \pm 3.51$ ,  $p = 0.02$ ), dribbling ( $18.42 \pm 5.88$  to  $21.00 \pm 6.19$ ,  $p =$

0.00), passing ( $35.39 \pm 6.34$  to  $32.80 \pm 6.68$  sec,  $p = 0.006$ ), and upper limb strength measured by seated medicine ball throw ( $4.89 \pm 0.58$  m to  $5.02 \pm 0.63$  m,  $p = 0.00$ ), while field goal speed did not show significant change ( $p = 0.79$ ). Between-group comparisons revealed that the experimental group outperformed the control group in accuracy ( $p = 0.000$ ) and medicine ball throw ( $p = 0.000$ ), whereas no significant differences were observed in field goal speed, dribbling, and passing.

**Conclusion:** These findings indicate that Ballistic-Six training effectively improved accuracy, dribbling, passing, and upper limb strength, with the most pronounced gains in accuracy and throwing power.

**KEY WORDS:**

Ballistic six exercises; Basketball; Basketball skills; Johnson basketball test; Medicine ball throw test; Speed passing test; Upper limb power.

## TABLE OF CONTENTS

Sl. No.	Content	Page No.
1	Introduction	01-08
2	Aim & Objectives	9-10
3	Hypothesis	11-12
4	Review of Literature	13-22
5	Methodology & Procedure	23-34
6	Statistical Analysis	35-36
7	Result	37-48
8	Discussion	49-53
9	Conclusion	54-55
10	Limitation & Recommendations for future study	56-57
11	Summary	58-59
12	Statement of funding	60-61
13	Bibliography	62-64
14	Annexures	65-71

## LIST OF TABLES

Sr. No.	Content	Page No.
1	Dosage and progression of the training	34
2	Demographic values of Experimental group	38
3	Demographic values of Control group	40
4	Data distribution of Pre-outcome measures	42
5	Data distribution of outcome measures characteristics within the group	43
6	Data distribution between different groups with mean rank	45
7	Data distribution of within group with mean rank	47

## LIST OF FIGURES

Sl. No.	Content	Page No.
1	FLOW CHART FOR ALLOCATION OF PARTICIPANTS	28
2	ELASTIC EXTERNAL ROTATION	31
3	90-90 EXTERNAL ROTATION	32
4	OVERHEAD SOCCER THROW	32
5	90-90 EXTERNAL ROTATION SIDE THROW	33
6	DECELERATION BALL THROW	33
7	BASEBALL THROW	34

## LIST OF GRAPHS

Sl. No.	Graphs	Page No
1	Normality of Demographic values of Experimental group	39
2	Normality of Demographic values of Control group	41
3	Between group comparison Bar Diagram	46
4	Control group Pre and Post Bar Diagram (within group)	48
5	Experimental group Pre and Post Bar Diagram (within group)	48

# **INTRODUCTION**

## **INTRODUCTION**

Basketball is a widely played international sport that involves two opposing teams, each consisting of five active players on the court during gameplay. The fundamental aspects of basketball include catching, throwing, dribbling, and shooting, all of which are critical to both individual and team success. In addition to the five players on the court, each team can have up to five substitute players on the bench, with no restriction on the number of substitutions that can be made throughout the game. This allows coaches to strategically rotate players based on game dynamics, fatigue, and performance. Success in basketball requires not only tactical awareness and teamwork but also a high level of physical fitness. Core technical skills such as dribbling, passing, and shooting are vital components of a player's performance, serving as the foundation for effective play at all levels—from beginners to elite athletes. Mastery of these skills enables players to execute plays efficiently, maintain ball control under pressure, and contribute to the overall success of their team. <sup>[1]</sup> Basketball is played recreationally by approximately 11% of the global population, making it one of the most widely participated sports in the world. Originally designed as a non-contact sport, the rules were intended to prevent rough play by prohibiting players from running with the ball, thereby eliminating the need for tackling. However, over time, basketball has evolved into a more physically demanding sport, where player contact is not only common but often expected as part of competitive gameplay. <sup>[2]</sup>

The primary point of contact for the ball is the upper extremities, so skills and coordination are required. The upper extremities must sometimes execute powerful movements to contain an opponent's offensive player, or create space around the basket for rebounds, but their main demands are on skills like dribbling, passing, and

shooting. Upper limb power is required in basketball for shooting, passing, rebounding, dunking, defensive actions and dribbling. [3]

“The Ballistic Six program includes 6 upper extremity plyometric exercises performed with quick, powerful movements requiring a pre-stretch of the involved shoulder musculature, thereby activating the stretch-shortening cycle. The stretch-shortening cycle is what makes a plyometric exercise unique, and it consists of 3 phases: the eccentric phase, the amortization phase, and the concentric phase. Peak performance and injury prevention for the overhead throwing athlete often depend on shoulder muscle activity, particularly the rotator cuff. Because of this, strengthening the muscles of the rotator cuff may be advantageous. This training offers recommendations for the implementation of a sport-specific upper extremity plyometric training program for overhead throwing athletes.” Pretz et.al. [4]

“Johnson's basketball test” evaluates three key skills: “shooting accuracy, field goal speed, and dribbling ability”. Throwing accuracy tests consistent accuracy of the throw. “Field goal speed tests” successive field goals under the pressure of time. “The dribble test” measures speed and bouncing ability under stress of time. “Speed passing test” is to measure the ability of passing skill. [5]

“The seated medicine ball throw test (SMBT)” is a field test that evaluates the strength of the pectoralis, shoulder, and elbow flexor muscles. It is a practical, safe, and reliable technique of testing. The SMBT is a valid and reliable tool for assessing upper-body power across various populations. [6]

Technical training is a foundational component in the development of basketball performance. Core skills such as ball handling, passing, and shooting are crucial for enabling efficient movement both with and without the ball, making them essential to a team's offensive and defensive strategies. These skills not only support individual performance but also contribute to cohesive team play and tactical execution on the court. Skill-based drills are widely recognized as effective because they simulate real-

game scenarios, making them particularly suitable for both training and assessment. Among these, ball-handling drills are especially important, as they integrate and reinforce the application of multiple technical skills in dynamic situations. Optimal skill development requires these core elements—dribbling, passing, and shooting—to be practiced together in realistic and game-like contexts. In addition to enhancing physical performance, technical basketball training also supports psychosocial development. Participation in structured sports settings encourages social interaction through teamwork, communication, and healthy competition. For student athletes, these experiences can enhance motivation, build peer relationships, and foster a sense of belonging. <sup>[1]</sup>

Basketball demands a high level of upper-body strength, power, and coordination—particularly for executing essential skills such as passing, shooting, and dribbling. These actions involve rapid, explosive movements that must be performed efficiently under conditions of speed and physical pressure. Traditional strength training may not adequately replicate the dynamic, high-velocity nature of these movements. In contrast, ballistic exercises—specifically those incorporating plyometric principles—are uniquely suited to enhance neuromuscular performance in ways that directly translate to basketball skill execution.

“The Ballistic Six program consists of six upper-extremity plyometric exercises designed to engage the stretch-shortening cycle (SSC), a neuromuscular mechanism that enhances power output through a rapid sequence of muscle actions. This cycle includes three phases: eccentric, amortization, and concentric. In the eccentric phase, a muscle is quickly stretched, triggering a stretch reflex through activation of muscle spindles—sensory receptors that respond to changes in muscle length and velocity. This reflexive response primes the muscle for a stronger contraction.” Pretz et.al <sup>[4]</sup>

The amortization phase, the brief interval between the eccentric and concentric contractions, is critical for maximizing energy transfer. A quick amortization phase enables the body to convert stored elastic energy into forceful movement. If this transition is delayed, the energy dissipates and the performance benefit is lost. In ballistic training, minimizing this phase ensures an optimal force output in the subsequent movement. Finally, the concentric phase—the execution of the movement—benefits directly from the potentiated muscle response initiated in the earlier phases. This phase, often called the “payoff phase,” results in an enhanced muscular contraction that mimics the explosive actions required in basketball. Applying these principles, the Ballistic Six program targets upper-extremity muscles that are vital for basketball performance, including the pectorals, deltoids, triceps, and shoulder stabilizers. By conditioning these muscles through the SSC, athletes can improve their shooting accuracy, passing speed, and dribbling control. In developmental basketball players—whose neuromuscular systems are still adapting—such ballistic training may offer a critical advantage in enhancing skill performance and physical capacity in a sport-specific manner. [4]

In baseball, the "Ballistic Six" exercises help pitchers strengthen the shoulder muscles used when throwing a baseball. These exercises mimic the throwing motion, allowing pitchers to build power, improve shoulder stability, and enhance endurance. By doing so, they can throw faster and more accurately, while also reducing the chance of shoulder injuries like strains or tears. Essentially, these exercises prepare the shoulder for the stresses of pitching, helping players perform better and stay healthier throughout the season. [4]

Ballistic six exercises help tennis players by significantly improving upper limb explosive power, strength, and speed. These plyometric movements enhance the recruitment of fast-twitch muscle fibers, which are crucial for powerful serves and strokes. As a result, players experience increased serve velocity, better stroke accuracy, and overall improved performance. Additionally, these exercises improve intermuscular coordination and elasticity, allowing for quicker and more efficient movement during play, which is particularly beneficial for developing players. [7]

The "Ballistic Six" exercises help volleyball players by enhancing their upper-extremity explosive power, strength, endurance, and reaction time. These improvements are directly related to key volleyball actions such as serving, spiking, and blocking, which require rapid, powerful, and precise arm movements. Specifically, the exercises mimic the dynamic overhead movements in volleyball, allowing players to develop muscular control and quick muscle responses. Additionally, the training can help prevent injuries by strengthening the muscles and tendons involved in these overhead actions, making players more resilient during matches. [8]

“The Johnson Basketball Skill Test” is regarded as the best assessment for shooting accuracy, speed, field goal speed and dribbling because it has demonstrated strong reliability and validity. Reliability refers to the consistency of the test results over time or across different evaluators; although specific reliability coefficients are not detailed in the provided excerpts, the test’s consistent scoring and use by trained evaluators suggest high reliability. Validity refers to whether the test actually measures what it claims to measure—namely, basketball skills. The significant correlations between the test outcomes and actual performance indicators (e.g., a correlation of  $r = 0.700$ ,  $p <$

.05, between skill test and accuracy) support its validity, indicating that the test effectively reflects real-world basketball abilities. <sup>[9]</sup>

The chest passing test is highly effective for assessing passing skills because it directly measures a key technique used in basketball. It has good validity, with expert assessment scores reaching 0.91, indicating it accurately reflects passing ability. Its reliability is also strong, as shown by a Cronbach's alpha of 0.918, which suggests consistent internal performance, and an ICC value of 0.912 for interrater reliability, indicating excellent agreement between testers. These values confirm the test's effectiveness in providing valid and reliable assessment results. <sup>[10]</sup>

The SMBT is considered an effective tool for assessing upper-limb power because it demonstrates high reliability, with correlation coefficients between trials ranging from  $r=0.85$  to  $0.97$ , indicating consistent performance measurement. Moreover, it has been shown to have strong concurrent validity, evidenced by its high correlation with other measures of upper-body muscular power, such as the bench press ( $r=0.86$ ) and the Wingate test. Its straightforward protocol requires minimal equipment and technical expertise, making it suitable for field settings, and it effectively captures the explosive strength of the upper limbs in various populations. <sup>[11]</sup>

The existing literature on basketball players is limited, and the effect of ballistic-six workouts on basketball skills (shooting accuracy, field goal seed, dribbling and passing) and upper limb power. Given the unique demands of basketball, where players rely heavily on their upper extremities for skillful ball manipulation and powerful movements, there is a need to explore effective training methods. Investigating the

impact of exercises like the “Ballistic-Six” program could enhance skills and improve performance.

## **AIM AND OBJECTIVES**

## **AIM**

To investigate if ballistic-six exercises can improve basketball skills (shooting accuracy, field goal speed, dribbling and passing) and upper limb power.

## **OBJECTIVE**

To investigate the effect of ballistic-six exercise on shooting accuracy using the Johnson Basketball shooting accuracy test.

To investigate the effect of ballistic-six exercise on field goal speed using the Johnson Basketball field goal speed test.

To investigate the effect of ballistic-six exercise on dribbling using the Johnson Basketball dribbling test.

To investigate the effect of ballistic-six exercise on passing using speed passing test.

To investigate the effect of ballistic-six exercises on upper limb power in basketball players using the seated medicine ball throw test.

## **HYPOTHESIS**

## **HYPOTHESIS**

### **Null hypothesis:**

There will be no significant impact of ballistic-six exercises on basketball skills (shooting accuracy, field goal speed, dribbling and passing) and upper limb power in basketball players.

### **Alternate hypothesis:**

There will be significant impact of ballistic-six exercises on basketball skills (shooting accuracy, field goal speed, dribbling and passing) and upper limb power in basketball players.

## **REVIEW OF LITERATURE**

## **REVIEW OF LITERATURE**

### **Methodology of literature review:**

The articles were explored with appropriate keywords under relevant sections.

The literature search was conducted from electronic databases PubMed and Google Scholar. Keywords included were selected for individual section with or without using Boolean operator AND, IN. The databases used were PubMed and Google scholar. The search was then narrowed by adding keywords. Articles other than the English language and human trials were excluded. The narrowed article titles and abstracts were screened.

## **Section A**

Title – Introduction to basketball and its skills

Objective – Prevalence of basketball injuries and importance of skills

Keywords were combined with Boolean terms (AND, IN) to find appropriate articles.

Databases – PubMed

Inclusion – Articles with full text, articles in English language and human trials

### **Articles included for section A**

1. Mendhe S, Borkar P. “Epidemiology of musculoskeletal injuries in basketball players: Systematic review”. (2021)

[International Journal of Physical Education, Sports and Health]

The purpose of the study on the prevalence of musculoskeletal injuries in basketball players is to investigate injury patterns, assess risk factors, inform preventive strategies, contribute to evidence-based practice. Upper limb showed more percentage injury in wrist and fist (10.9%) and compared to shoulder and arm (6.8%). The study indicates that upper limb injuries, particularly in the wrist and fist, head/neck, and trunk/spine regions, are significant among basketball players, although less prevalent than lower limb injuries.

2. Hussen E, Yirga B, Aychiluhim W. “The Effects of Twelve Weeks Technical Training to Improve Basic Skills of Basketball”. (2020)

[Annals of Yoga and Physical Therapy]

The study's goal was to evaluate the training intervention's effectiveness in improving participants' dribbling, passing, shooting, and rebounding skills. Furthermore, the study intended to determine whether there were significant variations in the mentioned abilities following the training period between the experimental and control groups. The results showed that, in comparison to the control group, the experimental group's participants' skills in dribbling, passing, shooting, and rebounding had improved significantly following the 12-week intervention. The study emphasized the value of structured training programs in basketball players' skill development and the efficacy of technical training in enhancing basketball abilities and performance.

3. Lior Laver, Baris Kocaoglu Brian Cole, Annunziato Amendola. “Basketball Sports Medicine and Science” (Biomechanics of Upper Extremity Movements and Injury in Basketball) (2020)

The study aims to explore the relationship between basketball injury frequency and upper extremity biomechanics. The study aims to provide insights into the demands placed on the upper body during basketball activities like shooting, passing, dribbling, and defending. The project aims to improve injury prevention tactics and basketball players' rehabilitation regimens by comprehending the biomechanics of these actions and possible risk factors for injuries. This study focuses on the biomechanics of upper extremity movements

and injuries in basketball. It emphasizes the need for a balance of force and precision in skills like shooting, dribbling, and passing. The study aims to improve injury management and prevention methods in basketball players, ultimately enhancing their safety and on-court performance.

## **Section B**

Title: Ballistic-Six exercises in different sports

Objective: To identify the effect of Ballistic-Six exercises on different sports

Keywords were combined with Boolean operators (AND) to find the appropriate articles.

Database: PubMed and Google scholar

Inclusion – Articles with full text, articles in the English language and human trails.

### **Articles included for section B**

1. Pretz, Ryan MPT, CSCS. “Ballistic Six Plyometric Training for the Overhead Throwing Athlete.” (2004)  
[Strength and Conditioning Journal]

The purpose of this study is to develop a comprehensive plyometric training program tailored to the specific needs of overhead throwing athletes, with the overarching goals of improving shoulder stability, enhancing performance, and reducing the risk of injuries. The study advocates for the use of plyometric

training, progressive overload principles, and sport-specific interval training to optimize shoulder stability, enhance performance, and reduce the risk of injuries in overhead throwing athletes, particularly baseball pitchers.

2. Turgut E, Cinar-Medeni O, Colakoglu FF, Baltaci G. “Ballistic Six upper-extremity plyometric training for the pediatric volleyball players.” (2019)  
[The Journal of Strength & Conditioning Research]

This study investigated the effects of a 12-week "Ballistic Six" upper-extremity plyometric training program on upper-body explosive power, endurance, and reaction time in pediatric volleyball players. It aimed to assess the impact of specialized training on parameters like medicine ball throwing distance, push-up performance, and reaction time. The goal was to provide insights into the effectiveness of such training for enhancing physical fitness and athletic performance in young athletes, particularly those in sports involving overhead movements like volleyball. The Ballistic Six program is an effective upper-body plyometric training that improves overhead medicine ball throwing distance, push-up performance, and reaction time in non-throwing arms. It can also enhance upper-body power strength and endurance in pediatric volleyball players, making it a useful training protocol for young volleyball players.

3. Ebada MO. “Effect of ballistic six exercises on certain physical variables and flat serve performance in tennis for female beginners.” (2022)  
[Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH]

The study aimed to investigate the impact of ballistic six exercises on improving upper limb muscle performance and overall physical fitness in novice female tennis players. The 7-week intervention assessed the effectiveness of these exercises on specific physical variables and flat serve performance of female beginners in tennis. The findings imply that introducing ballistic six exercises into female tennis novices' training programs can improve their physical fitness and serve performance, potentially leading to better overall tennis performance.

4. Narang S, Patil D. "Determination of ballistic six exercises and theraband exercises on physical performance in badminton players: a randomized controlled clinical trial." (2021)

[Journal of Pharmaceutical Research International]

The aim of the study was to evaluate the differences in shoulder strength, agility, speed, and function between Ballistic Six training and Theraband exercises in beginner badminton players. The findings showed that, in comparison to Theraband exercises, a six-week Ballistic Six program improved shoulder strength, agility, speed, and function. In order to potentially prevent injuries and enhance upper body performance, the study suggested that young adult badminton players use Ballistic Six exercises in their training regimen.

5. Singh A, Gopal AR, Sandhu JS. The effect of 'Ballistic Six' plyometric training on performance of medium pace Asian Indian cricket bowlers. (2014)

[Saudi Journal of Sports Medicine]

The aim of the study was to provide insightful information on training techniques that might improve the velocity and general performance of cricket bowlers. The study revealed that medium-pace bowlers experienced a statistically significant improvement in bowling velocities after participating in the 'Ballistic Six' plyometric training program. This increase in bowling velocity shows that plyometric training can improve the performance of medium-paced bowlers. Consequently, it was determined that medium-pace cricket bowlers may effectively increase their bowling velocity using Ballistic Six plyometric training, which would improve their total on-field performance.

### **Section C**

Title – Evaluation of basketball skills

Objective – To find out different outcome measures to measure basketball skills

Keywords were combined with Boolean terms (AND, IN) to find appropriate articles.

Databases – PubMed

Inclusion – Articles with full text, articles in English language and human trials.

### **Articles included for section C**

1. Sakshi Singh<sup>1</sup>, Dr. Akhil Mehlotra<sup>2</sup>, Prof. (Dr.) Abhimanyu Singh “Evaluating Kinesthetic Perception Among Female Basketball Players At The Sports Authority Of India, Dharamshala” (2024)  
[IOSR Journal of Sports and Physical Education]

The aim is to investigate the correlation between kinesthetic perception abilities and basketball skills performance. The researchers aimed to understand how players' kinesthetic awareness influences their proficiency in basketball skills using Johnson basketball test. Test used in the study provided a comprehensive evaluation of participants' proficiency in various aspects of basketball skills, including shooting accuracy, dribbling and game awareness. Jonson basketball test is a reliable (0.89) and valid (0.88) scale to measure basketball basic skills.

2. Salafi MIE, Suherman WS, Suhartini B, Antoni MS, Pratama KW, Nurfadhila R, Nugroho W, Miftachurohmah Y. “Design, Validation, and Reliability of a Basketball Skill and Performance Test Instrument in Adolescent Players.” (2023)

[Physical education Theory and Methodology]

The purpose of the study on the design, validation, and reliability of a basketball skill and performance test instrument in adolescent players is to develop a comprehensive and reliable assessment tool specifically tailored for young basketball players. The conclusion suggests that the BSPT has the potential to benefit not only basketball coaches but also physical education teachers by providing a reliable and valid (0.91) tool for evaluating young basketball players.

3. Biggar C, Larson A, DeBeliso M. “Establishing normative reference values for the Utah seated medicine ball throw protocol in adolescents.” (2021)

[The Sports Journal]

The purpose of the study was to develop a protocol and normative reference value dataset for the SMBT specifically for middle-school-aged (12-15 years) physical education students. The study aimed to provide a valuable tool for coaches and physical educators to assess upper-body muscular power in this specific age group. In the following findings normative values for SMBT were found.

## **METHODOLOGY AND PROCEDURE**

## **METHODOLOGY**

**Study population:** Developmental Basketball Players

**Study design:** A Randomized Controlled Trial

**Sampling technique:** Convenience sampling

**Sampling criteria (Inclusion and Exclusion criteria)**

### **INCLUSION CRITERIA**

Basketball players age between 15-19 years both male and females

1. At least 6 months of basketball training
2. Developmental basketball players
  - Local level representation
  - Regular training 3 times per week
  - Training with a purpose to compete

### **EXCLUSION CRITERIA**

1. Basketball players having history of recent surgery (6months)
2. Unresolved musculoskeletal conditions since 6 months

**Sample size is:** 24

**Study setting:** GIH Sports Complex Bapuji Nagar

**Study duration:** 1 year

**Ethical clearance:** 6 months

**Sample selection, data collection:** 4 months

**Statistical analysis, results, discussion:** 2months

### **MATERIALS USED**

- Basketball
- Cones
- Measuring tape
- Medicine balls (1kg, 2kg, 3kg, 4kg, 5kg)
- Stopwatch
- Theraband

### **OUTCOME MEASURES**

- 1. Johnson Basketball Test (including 3 separate tests)**
- 2. Speed passing test**
- 3. Seated Medicine Ball Throw Test**

#### **1. "JOHNSON BASKETBALL TEST**

- i. Basketball-throw for accuracy
- ii. Field goal speed
- iii. Basketball dribble test"

Sakshi Singh et.al

- i. "Basketball-throw for accuracy**

This test measures the ability of a consistently accurate throw and strength of the shoulder. In this test, a rectangular target is placed on the wall which is installed 14 inches above the ground. The player is placed 40 feet away from the target and is asked to hit the ball in the center. The player can use the hook pass or over-head pass method to hit the target with ball.

#### Scoring

Three points are awarded for each hit in the middle or line of the inner rectangle or circle; two points are awarded for each hit in the middle rectangle and its line. A total of 10 trails, scores are used to evaluate the basketball passing test item of the test.

#### Position of the player, examiner and recorder

Player stands immediately behind the line 40 feet from the target, the examiner stands 5 to 10 feet within the line 40 feet to the players right and the recorder stands approximately from the target stands 4 to 5 feet away on the right.” Sakshi Singh et.al

#### **ii. “Field goal speed test**

The tester asks the basketball player to stand at any position under the basket and the maximum number of baskets he needs to make in 30 seconds which provides a score for this test. This item measures the players ability to consistently score field goals as quickly as possible under the pressure of time.

#### Scoring

Number of baskets in 30 seconds will be the score.” Sakshi Singh et.al

#### **iii. “Dribble test**

This basketball test item has been designed with the aim of measuring the ability to control the ball and the level of agility of a player.

The player has to cover the maximum distance in 30 seconds while zigzag dribbling around the obstacle. 4 cones or obstacles are placed in a straight line at a distance of six feet. The first cone or obstacle is to be placed at a distance of 12 feet from the starting line which is 6 feet wide. The player must start dribbling from one end of the starting line and reach the opposite side of the starting point, dribbling around all the cones or obstacles.

#### Scoring

The score is equal to the number of zones covered in 30 seconds. In short, the player gets one point for each obstacle he crosses. However, the two distinct points because they each represent the boundaries of the two.” Sakshi Singh et.al

## 2. “Speed passing test

Speed passing test is to measure the ability of passing skill. A line marked on the floor 5 meter from the wall and parallel to it. The subject stands behind the line and rebounds the basketball from the wall as rapidly as possible fifteen times, using the chest pass. Stopwatch, balls, floor, coins and papers are use in this test. The score will be registered the number of seconds from the signal “go” until the ball hits the wall for the 15<sup>th</sup> time. If any rebound requires the subject to take, more than one- step recovery, the tests will be repeated.

### Scoring

Time taken from the signal ‘go’ till the ball hits the wall for the 15<sup>th</sup> time it will be recorded.

Lesser the time greater the speed of passing.” Muhammad Irvan Eva Salaf et.al.

## 3. “SEATED MEDICINE BALL THROW TEST

- The seated medicine ball throw (SMBT) is a field test intended to assess upper-body muscular power by measuring the maximal distance an individual can throw a medicine ball from an isolated, seated position.
  - Participants engage in a two-minute warm-up.
1. Participants sit in a specified position (either at a 45° angle on a bench or at a 90° angle against a wall).
  2. Participants throw a 2kg medicine ball with a 19.5 cm diameter as far as they can from the seated position.
  3. The distance thrown is measured using a measuring tape in meters.
  4. The test is typically performed three times on a single testing day to ensure consistency.
  5. Participant data, including height, body mass, and BMI, is recorded for analysis.
  6. The test is conducted in a controlled environment, such as a gym, with safety measures in place (e.g., sanitizing equipment, wearing masks).” Cory Biggar

## FLOW CHART

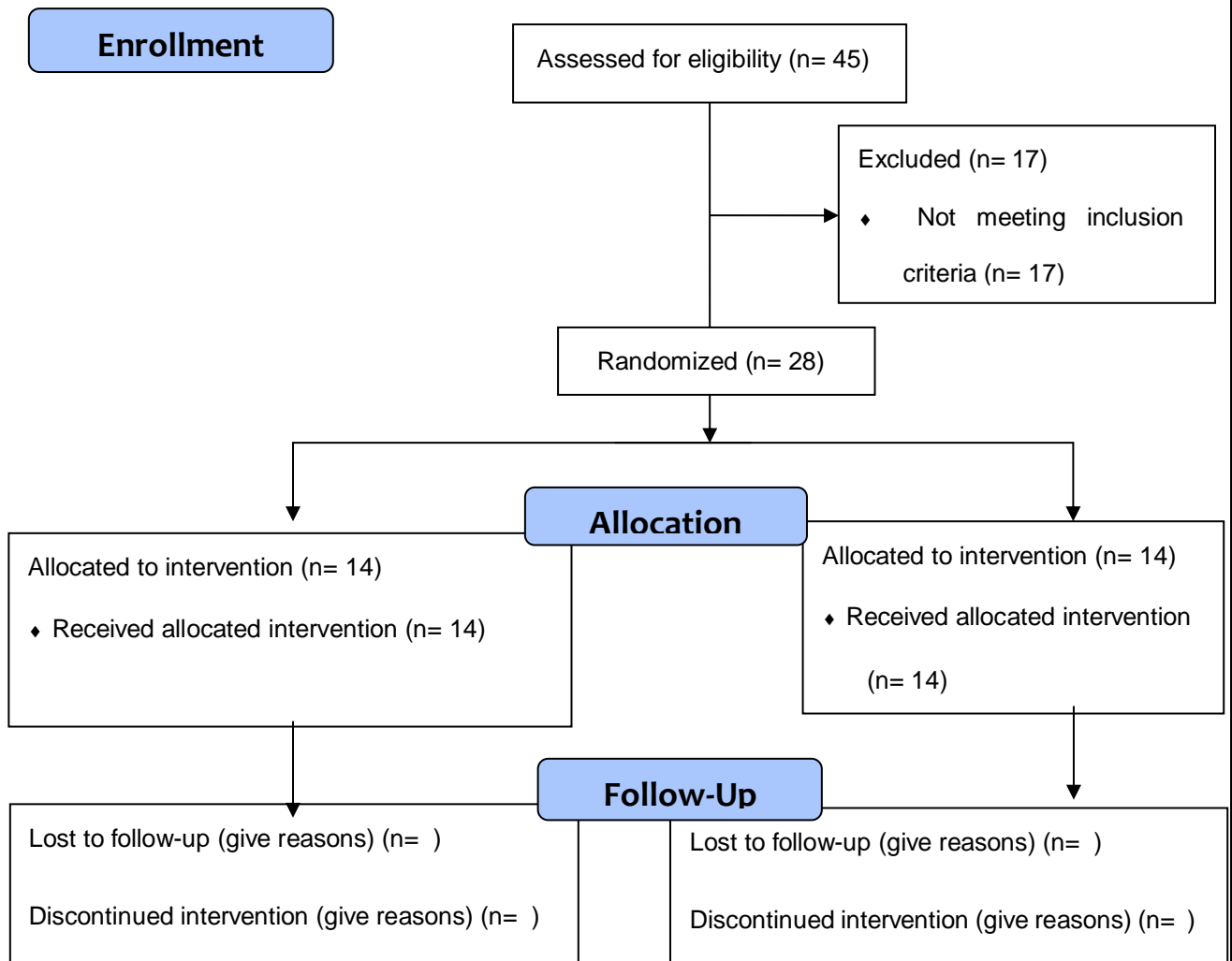


FIG 1: FLOW CHART FOR ALLOCATION OF PARTICIPANTS

## **PROCEDURE**

The present study was reviewed and approved by institutional ethical committee Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Pahala, Bhubaneswar.

A randomized trial was performed at GIH Sports Complex Bapuji Nagar Unit-1 Bhubaneswar.

The total 28 samples were selected using convenience sampling based on inclusion and exclusion criteria. They were included in the study with some criteria like Basketball players age between 15-19 years, both male and females, at least 6 months of basketball training and Developmental basketball players. The demographic data of the participants was taken like age, height and weight.

Then the study protocol was explained to all the participants and informed consent was obtained from all the participants.

The group allocation was done by using computer randomization.

All the participants were explained about the tests and exercises they would have to perform over a time period of 6 weeks.

Pre-test data for both the groups was first taken. (Group A) Control group had undergone Conventional basketball training (3 days per week for 6 weeks) which included Warm up = 8-10 min, Conventional training = 45 min, Cool-down = 5-8 min.

(Group B) Experimental group had undergone Ballistic-Six exercises (3 days per week for 6 weeks) (with progression after 3 weeks) which included Warm up = 8-10 min, Ballistic-Six exercises= 45 min, Cool down= 5-8 min.

All the exercises were performed under the therapist observation. After 6 weeks, all the participants were retested for Johnson Basketball test, Speed passing test and Seated medicine ball throw test. All the pre and post- test values were recorded and an excel sheet was maintained.

### **“BALLISTIC-SIX EXERCISES**

The Ballistic Six program includes 6 upper extremity plyometric exercises performed with quick, powerful movements requiring a pre-stretch of the involved shoulder musculature, thereby activating the stretch-shortening cycle. The stretch-shortening cycle is what makes a plyometric exercise unique, and it consists of 3 phases: the eccentric phase, the amortization phase, and the concentric phase. Peak performance and injury prevention for the overhead throwing athlete often depend on shoulder muscle activity, particularly the rotator cuff. Because of this, strengthening the muscles of the rotator cuff may be advantageous. This training offers recommendations for the implementation of a sport-specific upper extremity plyometric training program for overhead throwing athletes.

1. Elastic external rotation
2. Elastic 90-90 external rotation
3. Over-head soccer throw
4. 90-90 External rotation side throw
5. Deceleration baseball throw
6. Baseball throw

The Ballistic Six program consists of six upper-extremity plyometric exercises designed to engage the stretch-shortening cycle (SSC), a neuromuscular mechanism that enhances power output through a rapid sequence of muscle actions. This cycle includes three phases: eccentric, amortization, and concentric.

In the eccentric phase, a muscle is quickly stretched, triggering a stretch reflex through activation of muscle spindles—sensory receptors that respond to changes in muscle length and velocity. This reflexive response primes the muscle for a stronger contraction.

The amortization phase, the brief interval between the eccentric and concentric contractions, is critical for maximizing energy transfer. A quick amortization phase enables the body to convert stored elastic energy into forceful movement. If this transition is delayed, the energy dissipates and the performance benefit is lost. In ballistic training, minimizing this phase ensures an optimal force output in the subsequent movement.

Finally, the concentric phase—the execution of the movement—benefits directly from the potentiated muscle response initiated in the earlier phases. This phase, often called the “payoff phase,” results in an enhanced muscular contraction that mimics the explosive actions required in basketball.” Pretz et.al

Applying these principles, the Ballistic Six program targets upper-extremity muscles that are vital for basketball performance, including the pectorals, deltoids, triceps, and shoulder stabilizers. By conditioning these muscles through the SSC, athletes can improve their shooting accuracy, passing speed, and dribbling control. In developmental basketball players—whose neuromuscular systems are still adapting—such ballistic training may offer a critical advantage in enhancing skill performance and physical capacity in a sport-specific manner.



FIG 2: ELASTIC EXTERNAL ROTATION



FIG 3: ELASTIC 90-90 EXTERNAL ROTATION



FIG 4: OVER HEAD SOCCER THROW



FIG 5: 90-90 EXTERNAL ROTATION SIDE THROW



FIG 6: DECELERATION BASEBALL THROW



FIG 7: BASEBALL THROW

**Dosage and progression of the training**

Duration	Dosage	Female	Male
1-3 weeks	3 sets of 10 repetitions with 30 second between sets	1kg (one hand drill) 3 kg (two hand drill)	2kg (one hand drill) 4kg (two hand drill)
3-6 weeks	3 sets of 15 repetitions with 30 seconds between sets	2kg (one hand drill) 4kg (two hand drill)	3kg (one hand drill) 5kg (two hand drill)

Table 1 shows Dosage and progression of the training

# **STATISTICAL ANALYSIS**

## STATISTICAL ANALYSIS

### Descriptive Statistics

- **Normality test:** Shapiro-Wilk test was used to assess data normality (suitable since sample size  $< 50$ ).
- **Data representation:** As demographic data were not normally distributed, results were expressed as median.
- **Software:** IBM SPSS 26.0 (Windows 11) was used for data entry and analysis.
- **Researcher role:** The primary researcher collected the data.
- **Presentation:** Descriptive statistics were used to summarize participants' baseline characteristics.

### Inferential Statistics

- **Within-group analysis:**
  - Conducted using the Wilcoxon signed-rank test (non-parametric, suitable for small and non-normally distributed samples).
- **Between-group analysis:**
  - Conducted using the Independent t-test to compare outcomes across the two groups.
- **Significance level:** Set at  $p < 0.05$  for all statistical tests.

## **RESULTS**

## RESULTS

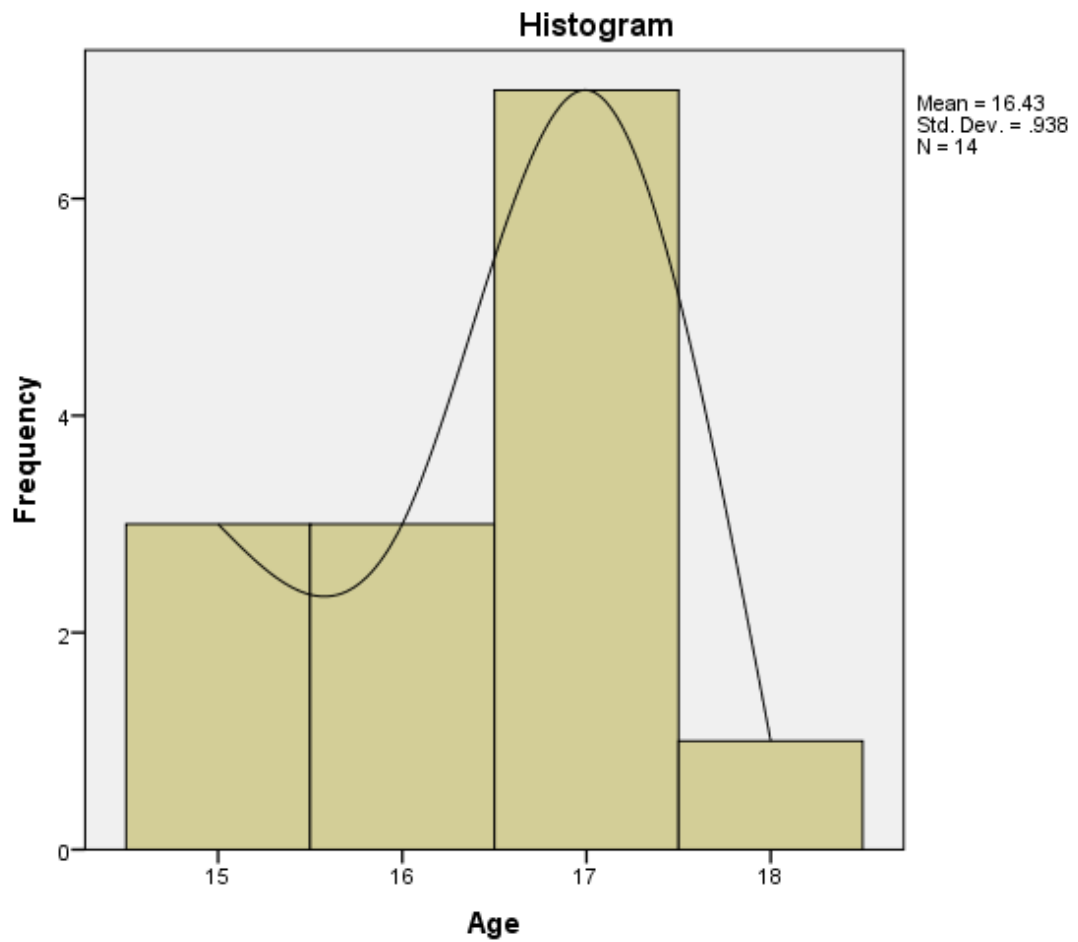
**Table Demographic characteristics of participants of the Experimental group for (n=14). (Shapiro-Wilk test)**

<b>SL. No.</b>	<b>Demographic Details</b>	<b>Mean</b>	<b>Median</b>	<b>SD</b>	<b>p-value</b>
<b>1.</b>	Age (year)	16.43	17	0.937	0.001
<b>2.</b>	Height (cm)	162.12	163.32	7.325	0.200
<b>3.</b>	Weight (kg)	57.41	56.13	6.493	0.200
<b>4.</b>	BMI (kg/m <sup>2</sup> )	21.13	21.34	0.671	0.200

**Abbreviation:** SD: Standard Deviation

\*p value > 0.05 indicates normal distribution of the data.

Table 2 shows Demographic values of Experimental group



Graph 1 Normality of Demographic values of Experimental group

- Mean age: 16.43 years; distribution not normal ( $p = 0.001$ ).
- Height, weight, and BMI were normally distributed ( $p = 0.200$ ).
- Group showed homogeneity in physical characteristics except for age.

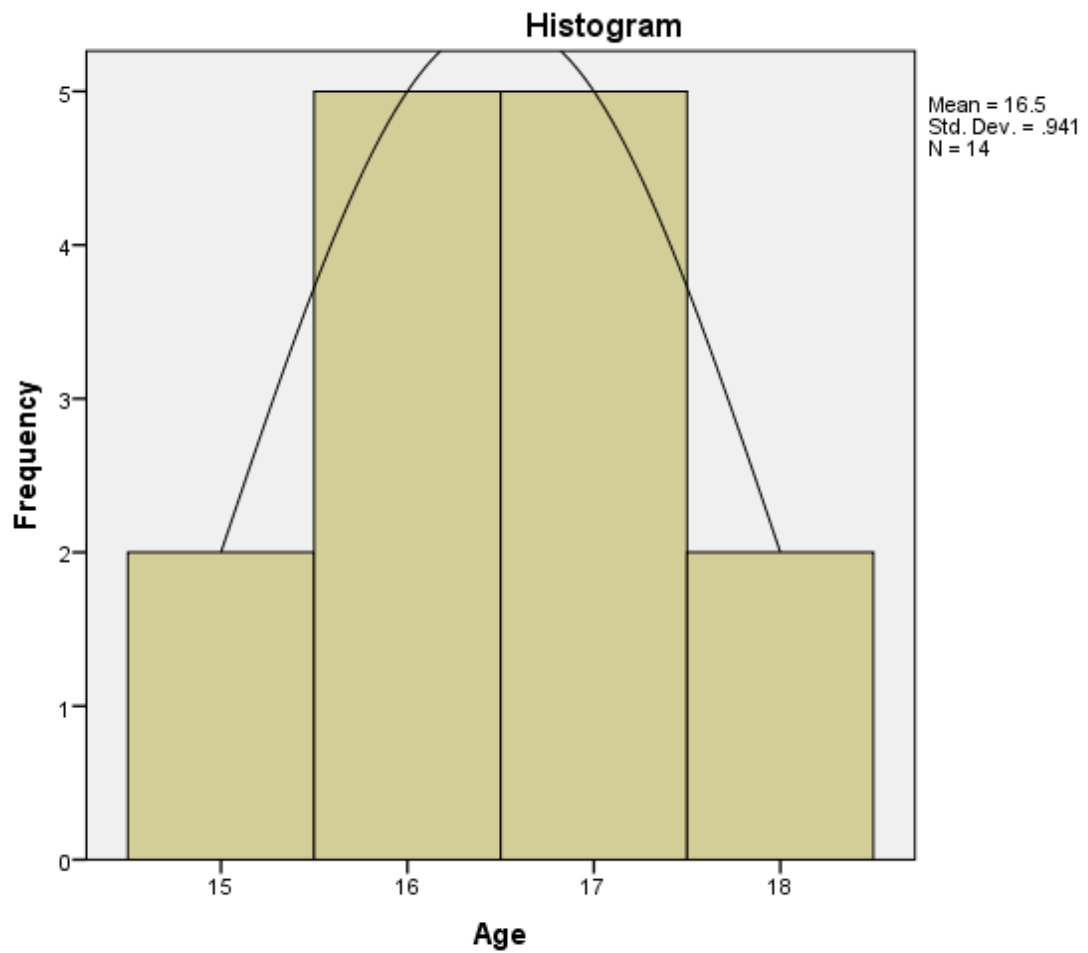
**Table Demographic characteristics of participants of the Control group for (n=14). (Shapiro-Wilk test)**

<b>SL. No.</b>	<b>Demographic Details</b>	<b>Mean</b>	<b>Median</b>	<b>SD</b>	<b>p-value</b>
<b>1.</b>	Age (year)	16.46	17	0.922	0.000
<b>2.</b>	Height (cm)	162.46	163.50	7.36	0.200
<b>3.</b>	Weight (kg)	57.03	56.50	6.50	0.200
<b>4.</b>	BMI (kg/m <sup>2</sup> )	21.41	21.40	0.672	0.200

**Abbreviation:** SD: Standard Deviation

\*p value > 0.05 indicates normal distribution of the data.

Table 3 shows Demographic values of Control group



Graph 2: Normality of Demographic values of Control group

- Mean age: 16.46 years; distribution not normal ( $p = 0.000$ ).
- Height, weight, and BMI were normally distributed ( $p = 0.200$ ).
- Demographics were consistent, with age as the only non-normal variable.

**Table of Pre-Outcome Measures Normality**

<b>SL.NO</b>	<b>Variable</b>	<b>Mean</b>	<b>Median</b>	<b>SD</b>	<b>P value</b>
<b>1</b>	Pre-Accuracy test	18.50	17.50	3.06	0.039
<b>2</b>	Pre-Field Goal Speed test	10.39	10.00	3.05	0.014
<b>3</b>	Pre-Dribbling test	18.42	15.00	5.88	0.001
<b>4</b>	Pre-Passing test	35.39	37.50	6.35	0.011
<b>5</b>	Pre-Seated Medicine ball throw test	4.89	4.63	0.58	0.000

Table 4 shows Data distribution of Pre-Outcome Measures

**Interpretation:** Table 4 outlines the normality test results of the pre-intervention outcome measures. All variables, including pre- shooting accuracy test, field goal speed, dribbling, passing, and seated medicine ball throw, demonstrated p-values less than 0.05 on the Shapiro–Wilk test. This indicates that none of the pre-outcome measures followed a normal distribution. Consequently, non-parametric tests were considered more appropriate for analyzing pre-intervention data.

**Table outcome measures characteristics (within group) of participants of the study**

SL. No.	Outcome Measure	Mean (Pre)	Mean (Post)	Median (Pre)	Median (Post)	SD (Pre)	SD (Post)	p-value (Pre)	p-value (Post)
1	Shooting accuracy	18.50	21.39	17.50	20.40	3.06	3.51	0.001	0.000
2	Field Goal Speed test	10.39	11.75	10	11.50	3.05	3.28	0.000	0.000
3	Dribbling test	18.42	21	15	17	5.88	6.19	0.000	0.000
4	Passing test (seconds)	35.39	32.8	37.50	35.50	6.34	6.68	0.000	0.000
5	SMBT test (meters)	4.89	5.02	4.63	4.70	0.58	0.63	0.013	0.001

Table 5 shows Data distribution of outcome measures characteristics (within group)

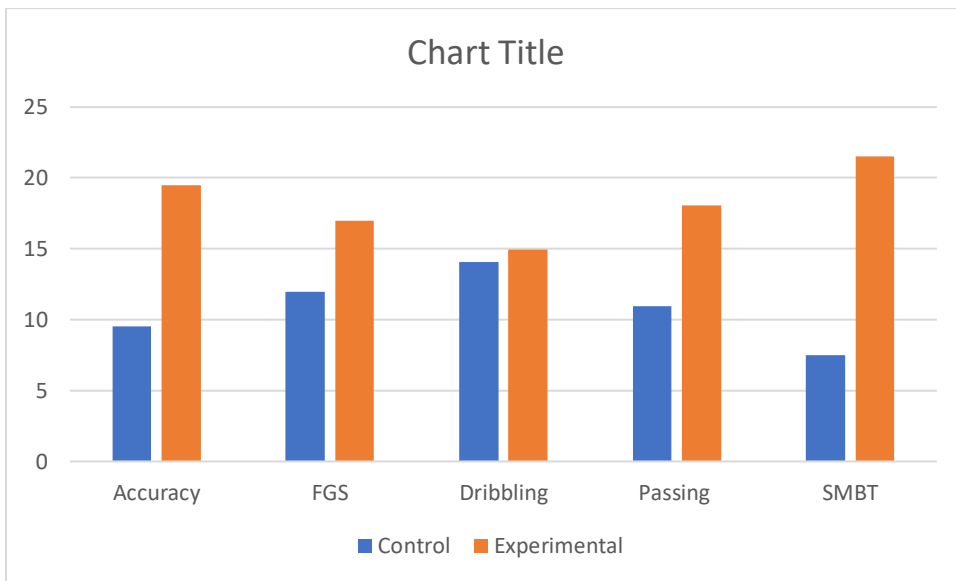
**Interpretation:** Within-group results showed significant improvements across all performance measures. Accuracy increased from  $18.50 \pm 3.06$  (median = 17.50,  $p = 0.001$ ) to  $21.39 \pm 3.51$  (median = 20.40,  $p = 0.000$ ). Field goal speed rose from  $10.39 \pm 3.05$  (median = 10.00,  $p = 0.000$ ) to  $11.75 \pm 3.28$  (median = 11.50,  $p = 0.000$ ). Dribbling scores improved from  $18.42 \pm 5.88$  (median = 15.00,  $p = 0.000$ ) to  $21.00 \pm 6.19$  (median = 17.00,  $p = 0.000$ ). Passing time reduced from  $35.39 \pm 6.34$  sec (median = 37.50,  $p = 0.000$ ) to  $32.80 \pm 6.68$  sec (median = 35.50,  $p = 0.000$ ). Medicine ball throw distance increased from  $4.89 \pm 0.58$  m (median = 4.63,  $p = 0.013$ ) to  $5.02 \pm 0.63$  m (median = 4.70,  $p = 0.001$ ). These results confirm significant post-intervention improvements.

**Table outcome measures characteristics (between group) of participants of the study**

SL.NO	Variable	Control group	Experimental group	P Value
		Mean Rank	Mean Rank	
1	Accuracy test	9.50	19.50	0.000
2	Field Goal Speed test	12.00	17.00	0.000
3	Dribbling test	14.04	14.96	0.000
4	Passing test	10.96	18.04	0.000
5	Seated Medicine ball throw test	7.50	21.50	0.001

Table 6 shows Data distribution between different groups with mean rank

**Interpretation:** Between-group analysis revealed that the experimental group outperformed the control group in all outcomes. Accuracy (mean rank = 19.50 vs. 9.50,  $p = 0.000$ ), field goal speed (17.00 vs. 12.00,  $p = 0.000$ ), dribbling (14.96 vs. 14.04,  $p = 0.000$ ), passing (18.04 vs. 10.96,  $p = 0.000$ ), and medicine ball throw (21.50 vs. 7.50,  $p = 0.001$ ) were all significantly better in the experimental group. This demonstrates the effectiveness of Ballistic-Six training across multiple performance parameters.



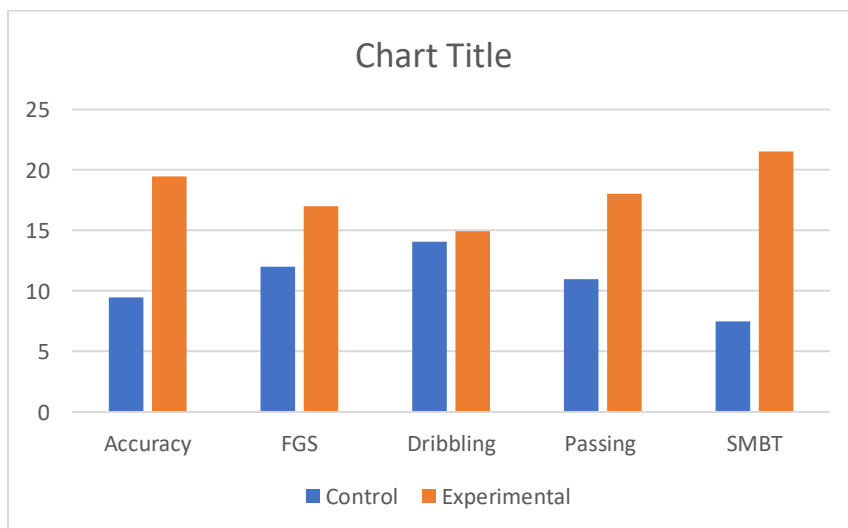
Graph 3: Between group comparison Bar Diagram

**Table outcome measures characteristics (within group) of participants of the study**

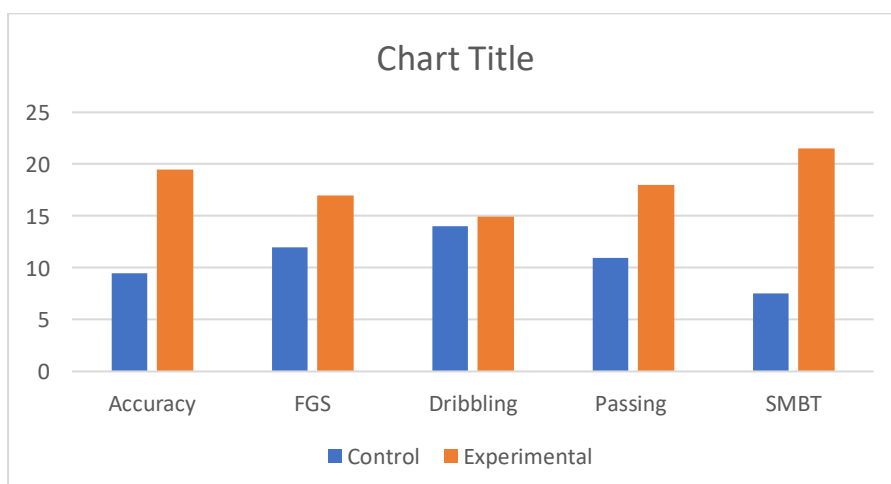
SL.NO	Variable	Control group		Experimental group		P Value
		Mean Rank		Mean Rank		
		Pre-test	Post-test	Pre-test	Post-test	
1	Accuracy test	9.32	7.86	19.68	21.14	0.000
2	Field Goal Speed test	8.11	7.68	20.89	21.32	0.000
3	Dribbling test	7.82	7.89	21.18	21.11	0.000
4	Passing test	20.64	21.50	8.36	7.50	0.000
5	Seated Medicine ball throw test	10.64	9.46	18.36	19.54	0.001

Table 7 shows Data distribution of within group with mean rank

**Interpretation:** Table 7 highlights the within-group mean rank changes across the control and experimental groups. In the experimental group, significant improvements were noted in all outcome measures, including accuracy, field goal speed, dribbling, passing, and seated medicine ball throw (all  $p < 0.05$ ). Conversely, the control group showed no meaningful changes between pre- and post-tests. This demonstrates that the observed improvements in performance can be attributed to the Ballistic-Six intervention rather than natural progression or practice effects.



Graph 4: Control group Pre and Post Bar diagram (within group)



Graph 5: Experimental group Pre-Post Bar diagram (within group)

## **DISCUSSION**

## **DISCUSSION**

The aim of the study was to assess whether Ballistic Six exercises could improve basketball skills and upper-limb power. The novelty of this study is that Ballistic-Six training has not yet been applied to basketball players. While it has been successfully implemented in other sports such as volleyball, cricket, baseball, and badminton, its potential benefits for basketball remain unexplored. Given the sport-specific demands of basketball, Ballistic-Six training may play a key role in enhancing shooting accuracy and dribbling skills, thereby contributing to improved overall performance. The result of within-group analysis showed significant improvements across all performance outcome measures following the intervention. Participants demonstrated better shooting accuracy, faster dribbling, improved passing efficiency, and greater upper limb power, while also showing enhanced field goal speed. When compared between groups, the experimental group consistently was better than control group across all outcome measures, with significant gains observed in shooting accuracy and seated medicine ball throw performance. These findings confirm the effectiveness of Ballistic-Six training in improving multiple skill and upper extremity power parameters relevant to basketball performance.

Simran Narang et al., 2021 has demonstrated moderate associations between medicine ball throw performance and strength measures such as bench-press throwing (Cronin & Owen, 2004). These findings suggest that training adaptations are task-specific, relying on the speed of movement and contraction characteristics of the involved muscles. Traditional resistance training, which emphasizes controlled lifting and deceleration phases, tends to favor hypertrophy over speed and power. Elif Turgut et al., 2019 stated

that ballistic training emphasizes rapid contraction of fast-twitch muscle fibers and minimizes deceleration, thereby optimizing neural and muscular adaptations necessary for explosive upper limb actions.

Plyometric exercises, including ballistic training, operate on the principle of the stretch–shortening cycle, enabling the development of muscular power through efficient energy storage and release. Evidence supports the effectiveness of upper limb plyometric training in improving throwing distance and velocity across different sports and age groups. For example, adolescent handball players demonstrated improved throwing distance following a six-week plyometric push-up program, while pediatric tennis players showed performance gains with neuromuscular training incorporating upper limb plyometrics. Similarly, Ballistic Six programs have previously enhanced throwing velocity in collegiate baseball players and improved performance in pediatric volleyball players.

These findings justify a gap in applying ballistic training specifically to basketball, where shooting and passing demand upper limb power and coordination. Investigating the effect of Ballistic Six training on upper extremity power addresses this gap by exploring whether such training can optimize fast-twitch muscle fiber recruitment and translate into improved sport-specific outcomes. Therefore, the current study is justified in assessing the influence of Ballistic Six training on upper extremity power, as it has the potential to enhance both performance capacity and functional transfer to basketball-specific skills.

Exal Garcia-Carrillo et.al 2023 Upper-body plyometric training (UBPT) has been shown through systematic reviews and meta-analyses to produce modest but

meaningful improvements in sport-specific throwing performance when compared to control groups. These performance gains are attributed to a range of neuromuscular adaptations, including enhanced motor unit firing, improved inter- and intra-muscular coordination, increased contraction velocity of muscle fibers, and superior force–power generating capacity. Importantly, UBPT predominantly trains the velocity end of the force–velocity spectrum, which is highly relevant for explosive sport-specific actions such as passing, rebounding, and shooting in basketball.

The Ballistic-Six exercise program, which incorporates medicine ball throws, plyometric push-ups, overhead passes, and other explosive upper-limb actions, closely mirrors these principles of UBPT. By emphasizing rapid stretch–shortening cycle utilization and high-velocity ballistic movements, the program has the potential to enhance upper-limb power, reaction speed, and force transmission—qualities essential for basketball performance. Furthermore, evidence has demonstrated that improvements in maximal strength and seated medicine ball throw (SMBT) performance translate into superior sport-specific outputs, with significant correlations reported between upper-body strength and ball velocity ( $r = 0.64–0.69$ ).

Given basketball's heavy reliance on explosive upper-body actions—such as overhead passing, three-point shooting, and dynamic rebounding—the physiological and neuromuscular adaptations induced by ballistic training are likely to confer direct performance benefits. Therefore, investigating the effects of the Ballistic-Six exercise program on basketball performance is justified, as it integrates evidence-based UBPT mechanisms with the specific physical demands of the sport.

In within-group analysis, field goal speed did not improve as expected, likely due to irregular session attendance. Missing sessions from the prescribed thrice weekly program may have reduced training exposure, thereby limiting neuromuscular adaptations and skill acquisition.

Ballistic-Six exercises focus on fast, explosive movements that train the body to use quick, powerful muscle contractions—similar to shooting, passing, and rebounding. Studies in sports like volleyball, baseball, and tennis have already proven that this type of training improves throwing power and performance. Since basketball also relies heavily on upper-body strength and speed, applying Ballistic-Six exercises could directly boost skills like shooting accuracy, passing efficiency, and overall game performance.

## **CONCLUSION**

## **CONCLUSION**

These findings indicate that Ballistic-Six training effectively improved accuracy, dribbling, passing, and upper limb strength, with the most pronounced gains in accuracy and throwing power.

**LIMITATIONS AND RECOMMENDATIONS FOR  
FUTURE STUDY**

## **LIMITATIONS**

A limitation of this study is the absence of long-term follow-up to evaluate whether the performance gains from the Ballistic-Six exercise program are sustained.

The potential influence of confounding factors, including player position, baseline skill and strength levels, prior training experience, physical fitness and injury history which may have affected the observed outcomes.

## **RECOMMENDATIONS FOR FUTURE STUDY**

Assessing players across different competitive levels such as novice, collegiate, and elite may help determine the generalizability of findings.

Future research can utilize advanced outcome measures, including force plate analysis and biomechanical laboratory assessments, to improve the precision reliability and validity of performance evaluation.

## **SUMMARY**

## **SUMMARY**

This study investigated the effects of a six-week Ballistic-Six plyometric training program on basketball-specific skills and upper limb power in developmental players aged 15–19 years. Twenty-eight participants were randomly allocated into an experimental group, which underwent Ballistic-Six training in addition to routine practice, and a control group, which continued conventional basketball training. Outcome measures included Johnson’s Basketball Test (shooting accuracy, field goal speed, dribbling), the Speed Passing Test, and the Seated Medicine Ball Throw Test (SMBT) for upper-limb power. Within-group analysis demonstrated significant improvements in shooting accuracy, dribbling, passing, and SMBT distance following the intervention, while field goal speed did not show significant change since some participants were not regular for training. Between-group comparisons revealed that the experimental group showed better performance than the control group in shooting accuracy, passing, and upper-limb power, confirming the efficacy of Ballistic-Six training. The results suggest that Ballistic-Six exercises are effective in enhancing accuracy, ball-handling efficiency, and upper extremity power, with the strongest impact observed on shooting accuracy and medicine ball throw performance. The study highlights the potential of sport-specific ballistic training to optimize neuromuscular adaptations in basketball players. However, limitations include the lack of long-term follow-up, and possible confounding effects of player position, baseline skill level, and attendance irregularities. Future studies should incorporate larger cohorts, elite-level players, and advanced biomechanical assessment tools such as force plates and motion analysis systems to improve reliability and generalizability.

## **STATEMENT OF FUNDING**

## **STATEMENT OF FUNDING**

No outside funding was reported associated with the work featured in this thesis.

## **BIBLIOGRAPHY**

## BIBLIOGRAPHY

1. Hussen E, Yirga B and Aychiluhim W. The Effects of Twelve Weeks Technical Training to Improve Basic Skills of Basketball. *Ann Yoga Phys Ther.* 2020; 4(1): 1042.
2. Mendhe, S., & Borkar, P. (2021). *Epidemiology of musculoskeletal injuries in basketball players: Systematic review.* *International Journal of Physical Education, Sports and Health*, 8(2), 90–93.
3. Lior Laver, Baris Kocaoglu Brian Cole, Annunziato Amendola. *Basketball Sports Medicine and Science.* 2020
4. Pretz, Ryan MPT, CSCS. “Ballistic Six” Plyometric Training for the Overhead Throwing Athlete. *Strength and Conditioning Journal* 26(6):p 62-66, December 2004.
5. Paudyal TR, Shukla A, Sherchan L. A study of basketball skills among the public and private secondary schools students of Rupandehi District, Nepal. *Journal of Sports Science and Nutrition.* 2023;4(1):86-9.
6. Biggar C, Larson A, DeBeliso M. Establishing normative reference values for the Utah seated medicine ball throw protocol in adolescents. *bioRxiv.* 2021 Dec 16:2021-12.
7. MONA E. Effect of ballistic six exercises on certain physical variables and flat serve performance in tennis for female beginners. *Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health.* 2022 Jan 1;22(1).

8. Turgut E, Cinar-Medeni O, Colakoglu FF, Baltaci G. “Ballistic Six” upper-extremity plyometric training for the pediatric volleyball players. *The Journal of Strength & Conditioning Research*. 2019 May 1;33(5):1305-10.
9. Salafi MIE, Suherman WS, Suhartini B, Antoni MS, Pratama KW, Nurfadhila R, Nugroho W, Miftachurohmah Y. Design, Validation, and Reliability of a Basketball Skill and Performance Test Instrument in Adolescent Players. *Teor. metod. fiz. vihov*. [Internet]. 2023 Oct. 30 [cited 2025 May 23];23(5):668-77. Available from: <https://tmfv.com.ua/journal/article/view/2188>
10. Narang S, Patil D. “Determination of ballistic six exercises and theraband exercises on physical performance in badminton players: a randomized controlled clinical trial.” (2021)  
[*Journal of Pharmaceutical Research International*]
11. Singh A, Gopal AR, Sandhu JS. The effect of ‘Ballistic Six’ plyometric training on performance of medium pace Asian Indian cricket bowlers. (2014)  
[*Saudi Journal of Sports Medicine*]
12. Sakshi Singh<sup>1</sup>, Dr. Akhil Mehlotra<sup>2</sup>, Prof. (Dr.) Abhimanyu Singh “Evaluating Kinesthetic Perception Among Female Basketball Players At The Sports Authority Of India, Dharamshala” (2024)
13. Exal Garcia-Carrillo, Ramírez-Campillo R, Thapa RK, Afonso J, Urs Granacher, Izquierdo M. Effects of Upper-Body Plyometric Training on Physical Fitness in Healthy Youth and Young Adult Participants: A Systematic Review with Meta-Analysis. *Sports Medicine - Open*. 2023 Oct 13;9(1).

## **ANNEXURES**

## ANNEXURES 1: IEC Certificate



# 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/2025/159

Date: 09/05/2025

**APPROVAL LETTER**  
**APPENDIX- VIII**

To,

**KARISHMA P ASHER**  
ABSMARI  
273, PAHAL, BHUBANEWAR-752101

**Protocol Title: Effect of Ballistic-Six exercises on basketball skills among Developmental Basketball Players - A randomized control trial**

**Protocol ID.: ABS-IEC-2025-PHY-048**

**Subject: Approval for the conduct of the above referenced study**

Dear Mr./Ms./Dr **KARISHMA P ASHER**

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
<b>Dr. Smaraki Mohanty</b> Clinician
<b>Dr. Satyajit Mohanty</b> Scientific Member
<b>Mr. Shib Shankar Mohanty</b> Legal Expert
<b>Ms. Annie Hans</b> Social Scientist
<b>Ms. Subhashree Samal</b> Lay Person
<b>Mr. Deepak Ku. Pradhan</b> Scientific Member
<b>IEC-SECRETARIAT</b>
<b>Mr. Gouranga Ku. Padhy</b> <b>Mr. Susant Ku. Raychudamani</b>

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





**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/2025/159

Date: 09/05/2025

MEMBERS	
<b>Dr. Smaraki Mohanty</b> Clinician	
<b>Dr. Satyajit Mohanty</b> Scientific Member	
<b>Mr. Shib Shankar Mohanty</b> Legal Expert	
<b>Ms. Annie Hans</b> Social Scientist	
<b>Ms. Subhashree Samal</b> Lay Person	
<b>Mr. Deepak Ku. Pradhan</b> Scientific Member	
IEC-SECRETARIAT	
<b>Mr. Gouranga Ku. Padhy</b> <b>Mr. Susant Ku. Raychudamani</b>	

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	Ret. 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 in the prescribed format attached, 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**  
**Member Secretary**  
**ABSMARI ETHICS COMMITTEE**



2

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

 **+91-63707-03654**

 **iec@absmari.com**

## **ANNEXURES 2: Informed Consent Form**

**TITLE OF THE STUDY:** Effect of Ballistic-Six exercises on basketball skills among Developmental Basketball Players - A randomized control trial

### **Introduction**

You are invited to participate in a research study. It is important that you read this description of the study and understand your role in it including the nature and risk of participation. Please give your consent to participate in this clinical study if you have completely understood the nature and course of this study and if you are aware of your rights as a participant.

**Purpose of research:** The purpose of this research is to improve basketball skills with Ballistic-Six exercises

**Expected duration of the study:** This is an intervention-based study for 6 weeks

**Study procedure to be followed:** I understand that I will be asked to follow an Exercise training program.

### **Possible benefits of study**

If proven to be effective, Ballistic-Six exercises can be included as a training program for basketball players

### **What happens when the research trial stops?**

It is a six-week study. Once the required data is collected, study will be stopped.

**Compensation for participation.**

Participation in this study will be at no cost to you. No compensation will be provided for your participation.

**Compensation for study related injuries.**

You will be provided medical care for any physical injury or illness that occurs as a result of your direct participation in this study. This medical care will be at no cost to you. You will not give up any legal rights by signing this form.

**Right to withdraw from the study.**

Participation in this study is entirely voluntary. You may choose not to take part or leave the study at any time.

I further understand that any information that becomes available during the course of the study that may affect my willingness to take part will be informed to me.

Institutional review board authorities may wish to examine records to verify the information collected. By signing this document, I give permission for this review of records.

I understand that my identity will not be revealed in any report or publication.

I agree to take part in above study.

Sign:

Date:

### **ANNEXURES 3: Case Record Form**

**Name of the participant:**

**Date:**

**Age:**

**Gender:**

**Dominance:**

**Height:**

**Weight:**

## ANNEXURES 4: MASTER CHART

SL.NO	AGE	Gender	Exp Accuracy Pre	Exp Accuracy Post	Exp Goal Seed Pre	Exp Goal speed Post	Exp Dribble Pre	Exp Dribble Post	Exp Passing Pre	Exp Passing Post	Exp SBT Pre	Exp SBT Post	Height	Weight	BMI
1	15	Male	19	23	8	11	14	16	32	28	4.46	4.92	162	54	20.6
2	17	Male	23	26	12	12	28	30	27	24	6.13	6.36	166	56	20.3
3	17	Male	20	23	15	18	29	32	28	25	4.93	5.23	156	52	21.4
4	17	Male	26	27	16	17	22	26	25	24	5.15	5.41	162	56	21.3
5	17	Male	18	25	11	12	22	28	32	32	4.73	4.8	166	57	20.7
6	16	Male	21	23	13	14	23	25	33	27	6	6.13	156	52	21.4
7	15	Male	16	19	10	13	20	24	43	35	4.25	4.45	168	64	22.7
8	18	Male	17	23	11	13	21	26	30	25	6.13	6.2	172	66	22.3
9	16	Male	22	27	15	16	26	27	31	27	4.25	4.46	159	51	20.2
10	17	Male	21	24	14	15	27	28	28	26	5.97	6.12	157	52	21.1
11	17	Male	22	24	10	13	26	27	29	27	5.44	5.9	163	59	22.2
12	16	Male	22	26	13	14	22	23	27	25	5.38	5.6	148	47	21.5
13	17	Male	16	22	17	18	23	30	26	22	5.65	5.882	174	66	21.8
14	15	Female	24	28	13	16	26	28	31	28	4.63	4.78	145	43	20.5
15	18	Male	16	18	7	8	13	15	39	37	4.58	4.62	168	62	22
16	17	Male	17	19	9	10	12	14	41	39	4.61	4.64	159	55	21.8
17	17	Male	14	16	8	8	14	16	44	41	4.55	4.59	155	52	21.6
18	16	Male	15	17	7	8	13	15	42	41	4.52	4.56	158	53	21.2
19	15	Male	16	18	7	9	12	15	38	36	4.63	4.67	168	61	21.6
20	18	Male	18	20	10	12	15	17	42	41	4.57	4.6	173	67	22.4
21	16	Male	17	19	9	10	12	14	41	39	4.67	4.69	162	56	21.3
22	17	Male	16	18	7	9	15	17	38	37	4.44	4.47	165	59	21.7
23	16	Male	18	20	8	9	13	16	44	41	4.63	4.65	167	58	20.8
24	17	Male	17	19	7	8	14	17	41	39	4.54	4.58	171	66	22.6
25	17	Male	19	21	8	9	15	17	39	37	4.68	4.72	164	57	21.2
26	15	Male	15	17	10	11	12	14	42	40	4.49	4.52	165	68	21.3
27	16	Male	17	19	7	7	14	16	41	38	4.71	4.74	169	61	21.4
28	16	Female	16	18	9	9	13	15	37	38	4.42	4.46	151	47	20.6

**Karishma P. Asher**

**EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS –**

- Quick Submit
- Quick Submit
- Odisha University of Health Sciences

**Document Details**

Submission ID trnoid::1:3345438303	48 Pages
Submission Date Sep 20, 2025, 2:50 PM GMT+5:30	6,174 Words
Download Date Sep 20, 2025, 4:13 PM GMT+5:30	36,220 Characters
File Name developmental_basketball_players_A_Randomized_control_trial.docx	
File Size 1.2 MB	

**\*% detected as AI**

AI detection includes the possibility of false positives. Although some text in this submission is likely AI generated, scores below the 20% threshold are not surfaced because they have a higher likelihood of false positives.

**Caution: Review required.**

It is essential to understand the limitations of AI detection before making decisions about a student's work. We encourage you to learn more about Turnitin's AI detection capabilities before using the tool.

**Disclaimer**

Our AI writing assessment is designed to help educators identify text that might be prepared by a generative AI tool. Our AI writing assessment may not always be accurate (i.e., our AI model may produce either false positive results or false negative results), so it should not be used as the sole basis for adverse actions against a student. It takes further scrutiny and human judgment in conjunction with an organization's application of its specific academic policies to determine whether any academic misconduct has occurred.

**Frequently Asked Questions**

**How should I interpret Turnitin's AI writing percentage and false positives?**

The percentage shown in the AI writing report is the amount of qualifying text within the submission that Turnitin's AI writing detection model determines was either likely AI-generated text from a large-language model or likely AI-generated text that was likely revised using an AI paraphrase tool or word spinner.

False positives (incorrectly flagging human-written text as AI-generated) are a possibility in AI models.

AI detection scores under 20%, which we do not surface in new reports, have a higher likelihood of false positives. To reduce the likelihood of misinterpretation, no score or highlights are attributed and are indicated with an asterisk in the report (\*%).

The AI writing percentage should not be the sole basis to determine whether misconduct has occurred. The reviewer/instructor should use the percentage as a means to start a formative conversation with their student and/or use it to examine the submitted assignment in accordance with their school's policies.

**What does 'qualifying text' mean?**

Our model only processes qualifying text in the form of long-form writing. Long-form writing means individual sentences contained in paragraphs that make up longer piece of written work, such as an essay, a dissertation, or an article, etc. Qualifying text that has been determined to be likely AI-generated will be highlighted in cyan in the submission, and likely AI-generated and then likely AI-paraphrased will be highlighted purple.

Non-qualifying text, such as bullet points, annotated bibliographies, etc., will not be processed and can create disparity between the submission highlights and the percentage shown.



# Karishma P. Asher

## EFFECT OF BALLISTIC-SIX EXERCISES ON BASKETBALL SKILLS AMONG DEVELOPMENTAL BASKETBALL PLAYERS - ...

- Quick Submit
- Quick Submit
- Odisha University of Health Sciences

### Document Details

Submission ID

trn:oid::1:3345438303

Submission Date

Sep 20, 2025, 2:50 PM GMT+5:30

Download Date

Sep 20, 2025, 4:12 PM GMT+5:30

File Name

developmental\_basketball\_players\_A\_Randomized\_control\_trial.docx

File Size

1.2 MB

48 Pages

6,174 Words

36,220 Characters



Page 1 of 54 - Cover Page

Submission ID trn:oid::1:3345438303



Page 2 of 54 - Integrity Overview

Submission ID trn:oid::1:3345438303

## 9% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

### Filtered from the Report

- Bibliography
- Quoted Text
- Cited Text
- Small Matches (less than 8 words)

### Match Groups

- 50 Not Cited or Quoted 9%**  
Matches with neither in-text citation nor quotation marks
- 0 Missing Quotations 0%**  
Matches that are still very similar to source material
- 0 Missing Citation 0%**  
Matches that have quotation marks, but no in-text citation
- 0 Cited and Quoted 0%**  
Matches with in-text citation present, but no quotation marks

### Top Sources

- 8% Internet sources
- 6% Publications
- 0% Submitted works (Student Papers)

### Integrity Flags

#### 0 Integrity Flags for Review

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.