

**EVALUATE THE EFFECT OF GYROSCOPIC BALL  
TRAINING ON HAND GRIP STRENGTH AMONG  
AMATEUR FIELD HOCKEY PLAYERS –  
A RANDOMIZED CONTROLLED TRIAL**

By

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In

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Under the guidance of

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RESEARCH INSTITUTE**

**Bhubaneswar, Odisha**



**2023-2024**

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**Date:**  
**Place: Bhubaneswar, Odisha**

**Signature**  
**Priyanshi Tiwari**

## **LIST OF ABBREVIATIONS**

1. ACSM – American College of Sports Medicine
2. CI – Confidence Interval
3. cm – Centimeter
4. dz – Effect Size for Within-Group Comparisons (Cohen’s dz)
5. g– Effect Size for Between-Group Comparisons (Hedges’ g)
6. Grip Avg – Average Grip Strength
7. Grip L – Grip Strength Left Hand
8. Grip R – Grip Strength Right Hand
9. ICC – Intraclass Correlation Coefficient
10. IRC – Institutional Research Committee
11. kg – Kilogram
12. p-value – Probability Value
13. RCT – Randomized Controlled Trial
14. SD – Standard Deviation

## ABSTRACT

**BACKGROUND:** “Grip strength and upper limb stability are essential for performance in field hockey, where effective stick control and precision depend on muscular endurance and coordination. Conventional training methods may not fully target the neuromuscular demands of grip and wrist control required for optimal performance.

**PURPOSE:** The purpose of this study was to investigate the effects of gyroscopic ball training on grip strength and sport-specific skills in amateur field hockey players.

**METHOD:** A randomized controlled trial was conducted at Devi Ahilya Vishwavidyalaya, Indore, with 58 amateur field hockey players aged 12–18 years, each with at least two years of competitive experience. Participants were randomly assigned to either an experimental group (n=29), which performed gyroscopic ball training thrice weekly for four weeks, or a control group (n=29), which continued traditional training. Hand grip strength was measured using a Camry digital dynamometer, and hockey-specific skills were evaluated through a standardized field hockey skill test.

**RESULT:** The experimental group demonstrated significant improvements in both grip strength and skill performance compared to the control group. Mean grip strength increased by approximately 2.7 kg in both hands ( $p<0.001$ ,  $g>1.9$ ), and skill test performance improved by +14.47 points, whereas the control group showed a slight decline ( $p<0.001$ ,  $g=5.36$ ).

**CONCLUSION:** Gyroscopic ball training effectively enhanced grip strength and sport-specific skills in amateur field hockey players. Its accessibility, safety, and specificity make it a valuable tool for athletes, coaches, and rehabilitation professionals seeking to improve performance and reduce the risk of overuse injuries”.

**KEYWORDS:** amateur athletes, grip strength, gyroscopic ball training, field hockey, randomized controlled trial, skill performance.

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## **1.INTRODUCTION**

In numerous sports such as baseball, climbing, golf, hockey, paddling, swimming, tennis, weightlifting, and wrestling the ability to generate sufficient handgrip strength (HGS) is crucial for maximizing performance and potentially reducing the risk of injury. For practical application, assessments of grip strength should be affordable, portable, reliable, and capable of detecting meaningful changes. The key challenge for coaches and practitioners lies in identifying such tools and effectively using them to enhance training outcomes.<sup>1</sup>

The “power grip” is frequently employed in sports when holding cylindrical-shaped equipment, such as clubs in golf, bats in baseball, softball, and cricket, rackets in tennis, badminton, and squash, sticks in field hockey, lacrosse, and ice hockey, bars in weightlifting, powerlifting, and strongman competitions, and axes in lumberjack sports.<sup>2</sup>

In these activities, the hand serves as the terminal link of the kinetic chain, transferring generated forces and torques to the object or implement, highlighting the critical role of handgrip function and strength in sport-specific movements. The power grip closely mirrors the grip employed during standard standing or seated handgrip strength (HGS) testing protocols.<sup>3</sup>

Research has shown that wearing leather work gloves can significantly reduce HGS (33 kg vs. 43 kg) compared to performing the test without gloves, which is a relevant consideration for athletes who wear gloves during competition, such as golfers, baseball players, and ice hockey players.<sup>3</sup>

Additionally, the shape, diameter, and mass of the sports implement or object must be taken into account when accurately assessing sports-specific HGS.<sup>2</sup>

From a clinical perspective, the function, assessment, and rehabilitation of the hand and forearm are extensively studied; however, this section focuses on the relationship between handgrip strength (HGS) and athletic performance.<sup>4</sup>

In many sports-specific movements, the hand serves as the sole point of contact between the athlete and the implement or object, emphasizing its functional significance for performance.<sup>4,5</sup> This differentiates between the precision grip, used for grasping spherical objects such as balls, and the power grip, used for cylindrical implements like clubs, bats, rackets, sticks, and paddles. Most hand-dominant sports actions employ either the precision grip, power grip, or a combination of the two.

HGS is considered a critical component for a wide variety of athletic actions, including throwing (e.g., baseball, softball, cricket, American football, European football, rugby, handball, water polo, javelin, hammer throw, discus, shot put), bowling, punching, clinching, and grappling in combat sports, paddling (rowing, canoeing, kayaking), and swinging implements such as rackets, sticks, bats, or clubs in sports like cricket, baseball, golf, tennis, squash, lacrosse, field hockey, and ice hockey.<sup>6-7</sup> Additionally, sports that demand moderate to high levels of HGS include basketball, volleyball, rock climbing, swimming, sailing, equestrian activities, cycling, motorsports, and strength-based sports such as weightlifting, powerlifting, and strongman competitions<sup>4</sup>

Gyroscopic ball devices, commonly known as Powerballs or gyro-balls, are handheld training tools that generate resistance through the rotational inertia of a spinning internal rotor. As the user accelerates the rotor by wrist or arm movements, the device produces variable resistance that the hand, wrist, and forearm muscles must actively stabilize against. This continuous dynamic resistance not only challenges muscular strength but also enhances neuromuscular coordination, proprioception, and endurance of the upper limb muscles.<sup>8</sup>

These devices have gained attention primarily in rehabilitation and therapeutic contexts. For example, individuals with impingement syndrome or lateral epicondylitis (tennis elbow) who engaged in eight weeks of gyroscopic ball training showed significant improvements in grip strength, wrist and shoulder strength, as well as enhanced proprioceptive control and functional performance of the upper extremities compared to control groups. Similarly, in adults experiencing nonspecific wrist pain, a four-week training protocol with the Powerball led to measurable increases in grip strength alongside reductions in pain levels, suggesting the device's effectiveness in alleviating symptoms while enhancing functional capacity.<sup>9</sup>

It is demonstrated that four weeks of thrice-weekly Powerball training resulted in an average 4–5 kg increase in grip strength per hand, highlighting the potential of gyroscopic devices as a strength-training modality even among non-clinical participants.

This is particularly relevant because the training simultaneously engages multiple muscle groups, improves endurance, and enhances fine motor control qualities that are essential for athletes who perform precision- and power-based movements.<sup>10</sup>

There is a notable gap in literature regarding the application of gyroscopic ball training for athletic performance enhancement, especially in sports such as field hockey where hand and forearm strength are critical for stick handling, ball control, and overall performance. Investigating its impact on amateur field hockey players could provide practical insights into sport-specific training, offering a portable, low-cost, and effective alternative or supplement to traditional strength training methods.<sup>11</sup>

## **2. AIM & OBJECTIVES OF THE STUDY**

### **AIM**

To evaluate the effect of Gyroscopic ball training on hand grip strength and field hockey-specific skill in amateur field hockey players

### **Primary Objective**

1. To assess the hand Grip Strength using by hand dynamometer.
2. To assess the performance using a hockey-specific skill test.

### **Secondary Objective**

1. To compare the effect of the gyroscopic ball training

### **3.HYPOTHESIS**

**1. Null Hypothesis ( $H_0$ ):**

“Gyroscopic ball training does not have a significant effect on hand grip strength and field hockey-specific skills in amateur field hockey players.

**2. Alternative Hypothesis ( $H_1$ ):**

Gyroscopic ball training has a significant positive effect on hand grip strength and field hockey-specific skills in amateur field hockey players”.

## **4.REVIEW OF LITERATURE**

1. A study "Grip Strength in Youth Ice Hockey Players: Normative Values and Predictors of Performance conducted by Toong, Wilson, Urban, Paniccia, Hunt, Keightley, and Reed explored the role of grip strength as a reliable tool for estimating muscular strength in young athletes.

The researchers established normative grip strength values for youth ice hockey players and compared them with existing pediatric norms. Findings showed that grip strength increased with age in both sexes, with males developing higher strength after the age of 12.

Players with higher body mass and those competing at more competitive levels demonstrated greater grip strength. The study emphasized the importance of athlete-specific grip strength norms for monitoring development and evaluating performance, highlighting its strong link to overall fitness and hockey-specific skills".<sup>12</sup>

2. A study "Analysis on Handgrip Strength Between Hockey and Badminton Players of Mangalore University" conducted by Akshith Rai and Sharath N compared the handgrip strength of 30 intercollegiate athletes (15 hockey players and 15 badminton players) aged 20–26 years.

Participants underwent handgrip strength testing to measure maximum isometric strength of the hand and forearm muscles. Data analysis using descriptive statistics and paired t-tests revealed that hockey players exhibited significantly greater handgrip strength than badminton players.

The findings suggest that sport-specific demands, such as prolonged stick handling in hockey, contribute to stronger grip development compared to racket-based movements in badminton.<sup>13</sup>

3. A study "The Effect of Hand Grip Strength and Trunk Rotation Strength on Throwing Ball Velocity conducted by Rozella Ab Razak, Kee Kang Mea, Raja Nurul Jannat Raja Hussain, Nur Atikah Mohamed Kassim, and Nuraimi Othman examined the role of grip strength and trunk rotation in softball performance.

The study involved 54 female collegiate softball players divided into three groups: hand grip training, trunk rotation training, and a control strength group. Over six weeks of training, results showed that both grip strength and trunk rotation exercises significantly improved throwing velocity compared to basic strength training alone, with no major difference between grip and trunk training groups.

These findings highlight the importance of incorporating grip strength training to enhance sport-specific skills such as throwing.”<sup>14</sup>

4. A study "Body Composition and Grip Strength Constraints in Elite Male Rink-Hockey Players of Contrasting Ethnicity conducted by Ferraz, Valente-Dos-Santos, Duarte-Mendes, Nunes, Victorino, Coelho-e-Silva, and Travassos, examined the anthropometric profile and grip strength characteristics of 100 elite rink-hockey players, including Caucasian and Black African athletes. Body composition was measured through anthropometric assessments, while grip strength was tested with an adjustable dynamometer.

The findings showed that elite players had low body fat percentages (10.82%) and high grip strength values (~50 kg in both hands). Ethnicity, age, and thigh circumference were significant predictors of grip strength, while abdominal and lower limb circumferences, along with ethnicity, explained most of the variance in body fat.

The study highlighted that elite rink-hockey athletes possess a distinct anthropometric identity, where ethnicity plays a notable role in predicting both grip strength and body composition".<sup>15</sup>

5. A study "Upper Quarter Y Balance Test Performance: Normative Values for Healthy Youth Aged 10 to 17 Years conducted by Schwiertz, Bauer, and Muehlbauer investigated age- and sex-specific performance in the Upper Quarter Y Balance Test (YBT-UQ), a tool for assessing shoulder mobility and stability. The study evaluated 665 participants (325 girls, 340 boys) aged 10–17 years.

Results showed that boys aged 14–15 performed significantly better in several reach directions compared to both younger and older groups, while in girls, only limited age-related differences were observed.

Sex-specific variations were also evident, with younger girls excelling in certain directions and older boys outperforming in multiple measures. The study provided normative values that can guide coaches, therapists, and educators in classifying shoulder stability and mobility in youth athletes<sup>16</sup>

6. A study "Effects of Eight-Week Gyroscopic Device Mediated Resistance Training Exercise on Participants with Impingement Syndrome or Tennis Elbow conducted by Mojtaba Babaei-Mobarakeh, Amir Letafatkar, Amir Hosein Barati, and Zohre Khosrokiani investigated the impact of gyroscopic device training on grip strength and upper limb performance. The study included 45 volleyball players with either shoulder impingement or tennis elbow, divided into experimental and control groups. Over eight weeks, the experimental groups trained three sessions per week using the gyroscopic device. Findings revealed significant improvements in grip, wrist, and shoulder strength, proprioception, and overall upper extremity performance in the experimental groups compared to controls.

These results suggest that gyroscopic device–based resistance training can effectively enhance grip strength and functional performance in athletes with upper limb impairments.<sup>17</sup>

7. A study "Estimation of Handgrip Strength and its Correlations with Selected Anthropometric Variables and Performance Tests in Indian Inter-university Female Field Hockey Players conducted by Shyamal Koley and Amandeep Kaur examined grip strength and its association with anthropometric and performance measures in 121 female hockey players aged 18–25 years.

The study assessed height, weight, BMI, percent body fat, upper arm circumference, sit-and-reach test, vertical jump test, and both dominant and non-dominant handgrip strength. Results revealed no significant differences among players in different positions (goalkeepers, strikers, defenders), but significant positive correlations were found between dominant and non-dominant grip strength.

The findings highlight the importance of grip strength as a practical parameter in talent identification, player selection, and training program development for female hockey players”.<sup>18</sup>

8. A study "The Effect of the Powerball Gyroscope as a Treatment Device for Nonspecific Wrist Pain conducted by Dirkie M. Landman, Jacques H. Maree, and Cynthia Peterson evaluated the therapeutic impact of Powerball gyroscope training on wrist pain and grip strength.

The study involved 40 participants aged 18–35, who underwent 12 treatment sessions over four weeks, using the gyroscope for 5 minutes per session.

Pain levels and grip strength were measured using the Jamar dynamometer and standardized questionnaires.

Results showed a significant reduction in wrist pain and a notable increase in grip strength, particularly within the first seven sessions. These findings suggest that gyroscopic training not only alleviates wrist pain but also enhances grip strength, supporting its application in both rehabilitation and performance enhancement contexts.<sup>19</sup>

9. A study, "The Anthropometric Correlates for the Physiological Demand of Strength and Flexibility: A Study in Young Indian Field Hockey Players conducted by Hanjabam Barun Sharma and Jyotsna Kailashiya, investigated the relationship between anthropometric variables and strength-flexibility parameters in young hockey players.

The study included 13 female and 19 male participants, where lengths, breadths, girths, and body composition were measured alongside grip strength, back strength, and flexibility tests. Results indicated that taller, leaner, and heavier players with longer trunks and limbs, broader chest and hips, and bulkier arms and legs demonstrated superior strength levels. Interestingly, greater flexibility was associated with taller stature, longer trunk, and higher body fat percentage. The findings highlight that

anthropometric factors such as height, breadth, and body composition significantly correlate with strength and flexibility, making them valuable tools for monitoring performance and identifying talent in hockey players.<sup>20</sup>

10. A study "Physiology Applied to Field Hockey conducted by Thomas Reilly and Andrew Borrie explored the physiological demands, body composition, and performance requirements in hockey players.

The review highlighted how the shift to synthetic playing surfaces changed technical, tactical, and physical demands of the sport, especially at elite levels. Female players were generally characterized by somatotypes around 3.5/4.0/2.5, with body fat percentages between 16–26%, aerobic power ranging from 45–59 ml/kg/min, and anaerobic power as a key differentiating factor between elite and county-level players. Male players showed greater mesomorphy, with aerobic power values between 48–65 ml/kg/min, and anaerobic power comparable to soccer players, exceeding that of basketball athletes.

The study categorized hockey as a 'heavy exercise' sport, with energy expenditure between 36–50 kJ/min and  $VO_2$  during games at 2.26 L/min. Additionally, hockey was associated with significant spinal loading and higher injury risks on synthetic turf compared to grass..<sup>21</sup>

11. A study “Does field hockey increase morphofunctional asymmetry? A pilot study conducted by Krzykała, Leszczyński, Grześkowiak, Podgórski, Woźniewicz-Dobrzyńska, Konarska, Strzelczyk, Lewandowski, and Konarski examined the impact of field hockey participation on morphological and functional asymmetries in the body.

The researchers compared 15 male Polish Youth National Team players with 14 male university students, using dual energy X-ray absorptiometry to assess bone mineral density, fat mass, and lean mass, alongside electrogoniometry to measure spinal range of motion. Results showed that while both groups displayed higher morphological values on the left body side, the asymmetries were more pronounced in field hockey players. Functionally, athletes demonstrated higher values on the right side, whereas controls showed dominance on the left.

The degree of side-bending asymmetry increased progressively from the cervical spine (2.7%) to the lumbar spine (16.5%) in players, with thoracic rotational asymmetry being most evident across both groups. The findings highlighted the need for monitoring athletes to mitigate injury risks linked to strong morphological asymmetries”.<sup>22</sup>

12. A study “Effects of repetitive head impacts from a single season on the cognitive functioning of youth male soccer players by Watson, Sergio, Mao, Brooks, and Dickey investigated the influence of repetitive head impacts on cognitive performance in young athletes. The researchers conducted a prospective cohort study on 18 U13 male soccer players over a single five-month season, using instrumented mouthguards and video verification to track 1089 head impacts. Cognitive function was measured through cognitive-motor integration tasks at multiple time points during the season.

Results indicated that more head impacts occurred during practices (62.7%) compared to matches (37.3%), with midfielders and defenders sustaining the highest exposure depending on match context. Findings showed significant changes, including decreased accuracy, increased peak velocity, and slower reaction times, suggesting that repetitive head impacts even within a single season can impair cognitive functioning. The study emphasized the importance of reducing head impact exposure in youth soccer, particularly during training sessions”.<sup>23</sup>

13. A study “A Handheld Gyroscopic Device for Haptics and Hand Rehabilitation by Kumar and Hur introduced *Gymball*, a novel gyroscopic device designed for hand therapy and haptic applications. The device incorporates a fully actuated rotor-gimbal assembly within a compact, ergonomic design capable of generating 0.5 Nm torque. Compared to

conventional gyroscopic tools, Gymball offers several advantages, including a smaller form factor, wire-free operation enabling full rotations, and a symmetrical build that minimizes vibratory noise.

A feasibility study demonstrated that the device could produce controlled hand oscillations of approximately  $7^\circ$ , with both amplitude and frequency adjustable via rotor and gimbal speed. Findings suggest Gymball's potential use for rehabilitation purposes and as a reliable haptic feedback tool".<sup>24</sup>

14. A review "Biomechanics of the Upper Limbs: A Review in the Sports Combat Ambient Highlighting Wearable Sensors by Ortega, Godoy, Szwedowicz Wasik, Martínez Rayón, Cortés García, Azcaray Rivera, and Gómez Becerra explored the application of inertial sensors in the biomechanical analysis of combat sports such as boxing, karate, and taekwondo.

The authors compiled research from the past two decades across multiple databases, emphasizing the role of miniaturized and wireless wearable devices in capturing biomechanical variables like velocity, acceleration, and power.

The review highlighted how these sensors allow precise monitoring of upper limb performance in real-time, providing valuable data for both training and injury prevention. Findings demonstrated the growing importance of inertial sensor technology as a reliable complement to traditional biomechanical measurement methods in sports science”.<sup>25</sup>

15. A study “Body composition and grip strength constraints in elite male rink-hockey players of contrasting ethnicity by Ferraz, Valente-Dos-Santos, Duarte-Mendes, Nunes, Victorino, Coelho-e-Silva, and Travassos examined the influence of ethnicity on body composition and grip strength among elite athletes. The cross-sectional study included 100 male players (69 Caucasian and 31 Black African), with body composition measured through anthropometry and grip strength assessed via a dynamometer.

Results showed an average body mass of 76.36 kg, height of 175.8 cm, and body fat percentage of 10.82%. Maximal grip strength values were approximately 50 kg for both hands. Regression analysis indicated that abdominal, thigh, and calf circumferences, along with ethnicity, explained 70% of the variance in body fat, while ethnicity, age, and thigh circumference predicted 13.1% of the variance in grip strength. The findings suggested that elite rink hockey athletes possess a distinct anthropometric profile, with ethnicity playing a significant role in shaping both body composition and strength outcomes.<sup>26</sup>

17. Ahmed (2023) conducted a study on grip and pinch strength in the healthy Indian adult population, providing valuable normative data for hand function assessment. The research focused on evaluating strength parameters in different types of grip, including power grip and various pinch positions (tip-to-tip, lateral, and three-jaw chuck pinch). Their findings highlighted that grip and pinch strength are influenced by factors such as age, gender, hand dominance, and occupational background.

Men generally exhibited higher strength values compared to women, and dominant hands showed greater grip and pinch strength than non-dominant hands. This study established reference values that can be used in clinical and sports settings for evaluating hand performance, assessing rehabilitation progress, and comparing with pathological conditions. This work is significant in the context of sports physiotherapy, as grip strength plays a critical role in racquet sports such as tennis, where forehand hitting accuracy and overall performance are highly dependent on forearm and intrinsic hand muscle function. By providing baseline normative values in the Indian population, the study serves as a foundation for understanding deviations in players with musculoskeletal dysfunctions, such as scapular instability, which may secondarily affect grip strength and performance.<sup>27</sup>

## **5.METHODOLOGY& PROCEDURE**

### **Study Design**

The present study was designed as a randomized controlled trial (RCT) to evaluate the effect of Gyroscopic ball training on hand grip strength and field hockey-specific skill in amateur field hockey players

### **Study Setting**

The study was conducted at Devi Ahilya Vishwavidyalaya (DAVV), Indore, Madhya Pradesh, India.

### **Study Population**

The target population comprised amateur field hockey players who were actively participating in training and competitions during the study period.

### **Sample Size**

A total of 58 participants were recruited for the study.

### **Sampling Technique**

Purposive sampling was employed for participant recruitment. Eligible players were randomly allocated into groups using the chit method to ensure unbiased distribution.

## **Study Duration**

The overall study duration was one year, which was divided into the following phases:

- **Ethical clearance and protocol development:** 3 months
- **Sample selection and data collection:** 6 months
- **Statistical analysis, result interpretation, and discussion:** 3 months

## **Ethical Considerations**

Prior to commencement, the study protocol was reviewed and approved by the Institutional Ethics Committee of ABSMARI, Bhubaneswar. Written informed consent and assent form were obtained from all participants after explaining the nature, objectives, and potential benefits of the study.

### **Inclusion and Exclusion Criteria**

<b>Inclusion Criteria</b>	<b>Exclusion Criteria</b>
Age 12–18 years old	History of any surgery in past 6 months
Male & Female	Current injury, chronic pain, or musculoskeletal disorder that could impede training or performance
Minimum 2 years of competitive play	
Training frequency: 3 times/week	

## **Outcome Measures**

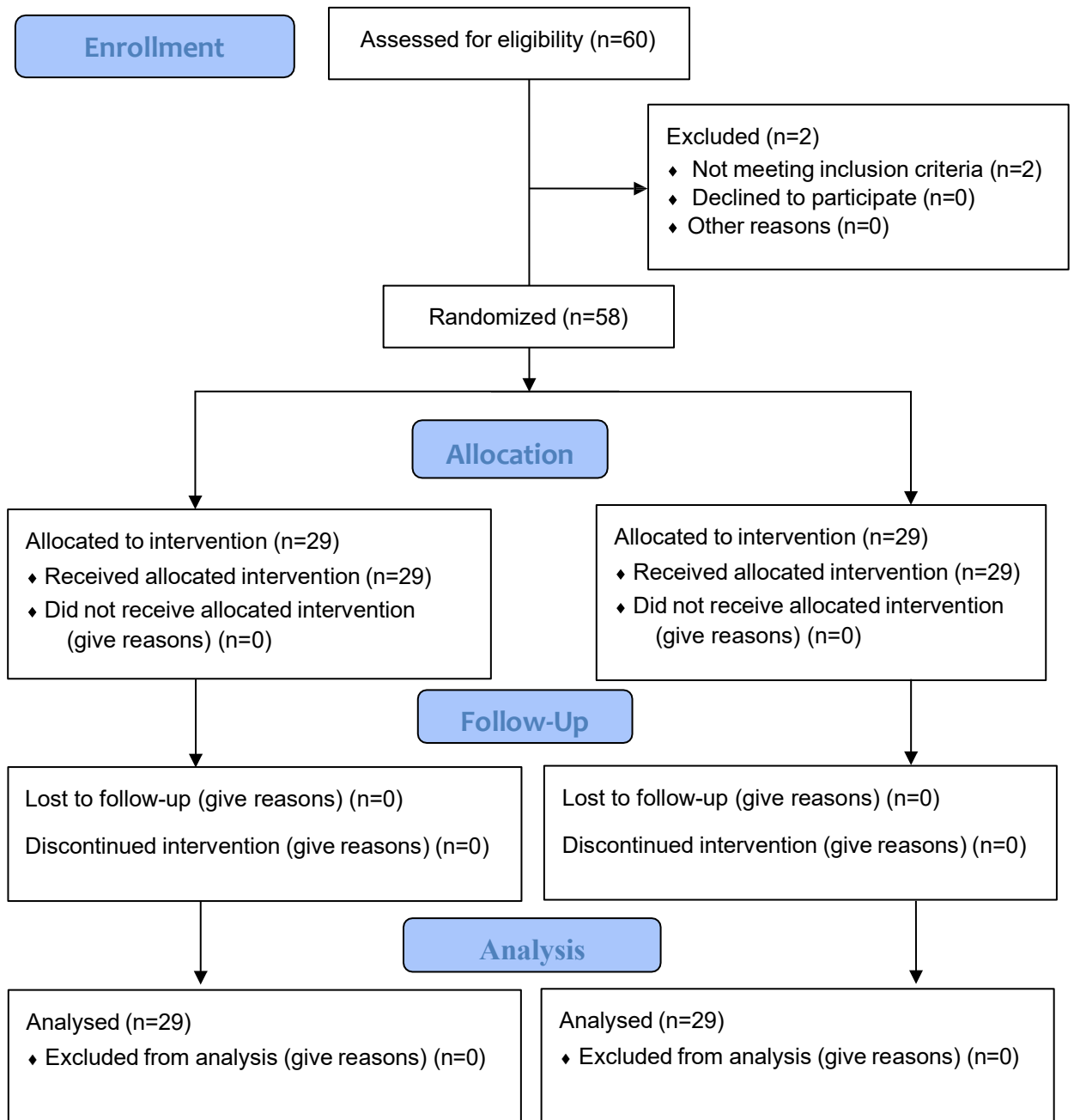
The outcome measures of this study focused on assessing the impact of gyroscopic training on grip strength and hockey-specific skill performance. Grip strength was evaluated using a validated Camry digital hand dynamometer, which provided reliable and objective measurements for both dominant and non-dominant hands. This measure served as an indicator of upper limb muscular strength, which is critical for effective stick handling, passing, and shooting in field hockey.

Hockey skill performance was assessed using a standardized field hockey skill test, which required players to complete a sequence of tasks including dribbling, passing, decision-making, and shooting under timed conditions. The test incorporated accuracy and speed components, with penalties for errors such as missing targets, touching cones, or improper ball handling, ensuring that technical proficiency and decision-making were both captured. Together, these measures provided a comprehensive evaluation of how gyroscopic training influenced both physical strength and sport-specific performance in amateur hockey players.

## **Materials Required**

- Camry dynamometer
- Gyroscopic device
- Hockey stick
- Hockey ball
- Cones
- Hockey equipment

**FIGURE 1: CONSORT 2010 Flow Diagram**





*Figure 1.1 INTRODUCING THE STUDY*

## **Procedure**

“The study was initiated after obtaining formal approval from the Institutional Research Committee (IRC). Ethical clearance ensured that the research adhered to standard academic and professional guidelines. Following this, permission was sought and granted from the ABSMARI, Bhubaneswar, and Devi Ahilya Vishwavidyalaya, Indore, for the use of laboratory space, testing facilities, and equipment essential for conducting the trial.

Once all approvals were secured, the process of participant screening was undertaken. Players were approached from local academies and training centers, and their eligibility was verified through a structured screening protocol. Participants were evaluated against predefined inclusion and exclusion criteria. The inclusion criteria required that individuals be amateur field hockey players aged between 12–18 years with at least two years of competitive playing experience.

Exclusion criteria involved players with recent injuries, ongoing upper limb musculoskeletal disorders, or any neurological conditions that could influence grip strength or skill performance. This careful selection ensured a homogeneous study population and minimized confounding factors.

After screening, eligible participants were invited to take part in the study. The objectives, procedures, potential benefits, and risks were explained in detail to each participant in clear and understandable terms. Ample time was provided for queries, and written informed consent was obtained from both the players and, where necessary, their guardians. This step reinforced ethical participation and ensured voluntary involvement.

Preparation of participants was then carried out before initiating the intervention. Baseline measurements of grip strength and field hockey-specific skills were taken to establish pre-intervention data. Participants were familiarized with the testing procedures and instruments, including the gyroscopic ball trainer, the digital dynamometer, and the standardized hockey skill test setup. This familiarization reduced performance anxiety and improved the reliability of subsequent data.

The intervention phase followed, wherein the experimental group underwent gyroscopic ball training three times per week for four consecutive weeks, in addition to their routine training. The control group continued with their traditional training without exposure to gyroscopic ball exercises. Training sessions were supervised to ensure proper technique, adherence, and to minimize risk of injury.

Post-intervention, data collection was repeated using the same instruments and standardized methods as in the baseline phase. Hand grip strength was measured for both dominant and non-dominant hands using the Camry digital dynamometer, while field hockey skills were reassessed through the skill performance test. The uniformity of measurement ensured accuracy and reliability of the data.



*Figure 2 : explained about the gyroscopic device/ gyrobball*

## **Hand Dynamometer**

A hand dynamometer measures grip strength through an adjustable handle and spring mechanism. It is widely used in clinical assessments, sports performance evaluations, and research studies to quantify hand strength and detect potential weaknesses.



**FIG 3 – GYROBALL & HAND DYNAMOMETER**

The **Camry Hand Dynamometer** has been validated in recent studies, proving to be a reliable and cost-effective tool for assessing handgrip strength.

### **Comparison with the Jamar Dynamometer:**

- **Concurrent Validity:** Demonstrates strong correlations with other hand dynamometers ( $r = 0.85-0.95$ ).

- **Intrarater Reliability:** Excellent reliability ( $ICC = 0.95-0.98$ ) when used by trained clinicians.

- **Interrater Reliability:** Good to excellent reliability ( $ICC = 0.85-0.95$ )



*Figure 4 & 5: explaining the use of ball & hockey skill test*

### **Field Hockey Skill Test**

The test begins **16 yards from the goal**. Players are required to:

1. Run to the hockey ball.
2. Dribble around the cones.
3. Break an **infra-red beam** to activate the timing system.
4. Make a pass against a rebound board.
5. Shoot at the target **opposite to the lit signal**.
6. Run back to the start line.



*Figure 6 : skill testing*

### **Scoring & Penalties:**

- **Time penalties (2 seconds per error):**

- Missing the target
- Touching the cones
- Ball Contacting the feet

- **Overall Time:** Total time for 6 runs + accumulated penalty time.

- **Decision Time:** Average of 6 decision-making timings (3 shots to the right target, 3 shots to the left target).

## **Powerball or Gyroscope**

The terms "Powerball" and "gyroscope" are often used interchangeably to refer to a handheld gyroscopic exercise device that is used for wrist, hand, and arm strengthening and rehabilitation. These devices utilize a spinning rotor inside a ball that creates resistance as the user rotates their wrist or arm, engaging various muscle groups. In the context of exercise and rehabilitation, both Powerball and gyroscopes are used to improve grip strength, wrist stability, and overall arm function.

The Powerball is a gyroscope-based device designed to build upper body muscle strength. Research shows that using the Powerball can increase muscle endurance and the number of contractions in forearm muscles. It acts as an eccentric exercise tool, stimulating the forearm, hand, and wrist muscles. It's hypothesized that using the Powerball can reduce wrist pain and improve wrist strength.

Validity: Strong correlations with other measures of balance, stability and strength ( $r = 0.70-0.90$ ).

Intrarater Reliability: Excellent reliability (ICC = 0.90-0.95)

Interrater Reliability: Good to excellent reliability (ICC = 0.80-0.90)

### **This exercise plan**

This exercise plan outlines a progressive resistance training protocol using a gyroball (a gyroscopic exercise tool) aimed at improving upper limb function—particularly the wrist, elbow, and shoulder muscles. The plan is broken into 4 weeks, gradually increasing intensity and complexity, tailored to varying levels of physical capacity (from low to very severe as per the group types A to E&F). Group Type (A to E&F): Indicates exercise intensity. in summary A = Low B = Mild C = Moderate D = Severe E & F = Very severe.

## **Week 1 Focus: Low to mild intensity**



*Figure 7– week 1 protocol*

Exercises include wrist flexion, wrist extension, and elbow flexion. Performed while sitting or standing. Shorter durations (30s sets), longer rest periods between exercises (60s–120s).

## **Week 2 Increased Intensity**

Moderate intensity (group C introduced).

Set durations increase (45s), with slightly longer rest between sets and exercises. Additional movements include shoulder flexion. Greater emphasis on standing positions for functionality.



5<sup>th</sup> July 2025 At 4:00 pm



9<sup>th</sup> July 2025 at 4:00 pm

**Fig 8- week 2 Increased Intensity & Week 3 Moderate to Severe Intensity**



**Figure 9 week 4 Peak Intensity**

Exercises expand to shoulder abduction and shoulder external rotation. Longer sets (up to 60s), increased rest times, introducing flex trunk standing for core engagement

Includes complex shoulder movements like shoulder IR (internal rotation) and horizontal abduction. Performed in dynamic or challenging positions (e.g., lying on side, supine)".

## **RESULTS**

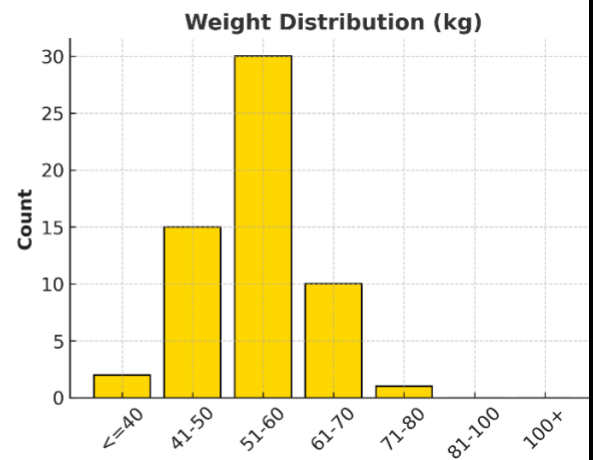
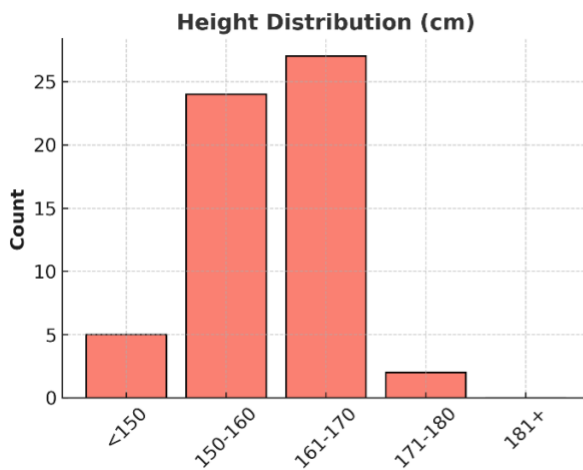
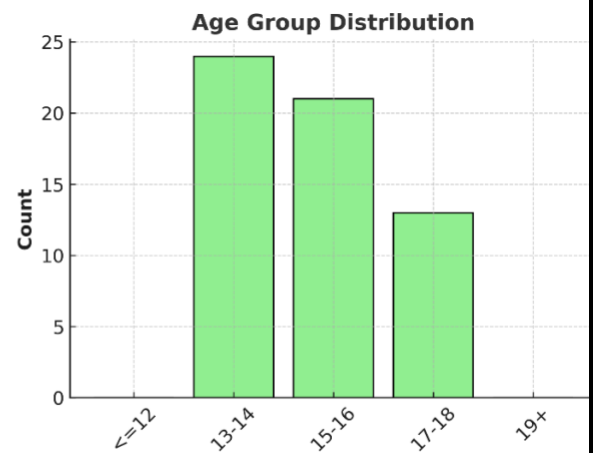
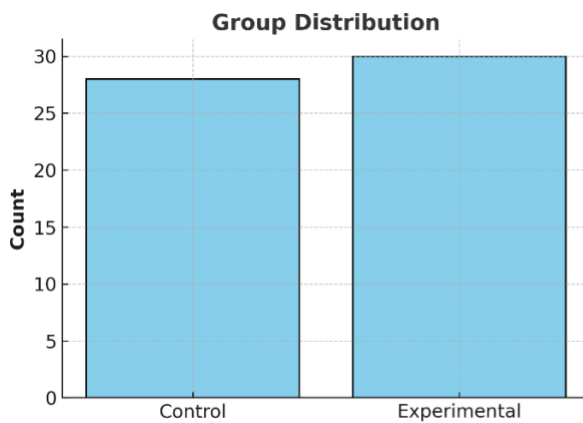
## **RESULTS**

Table 4.1 presents the demographic summary of the study participants across group, age, height, and weight categories. The distribution shows that the sample was nearly balanced between the experimental group (51.72%) and control group (48.28%). The majority of participants were adolescents aged 13–16 years, with 41.38% in the 13–14 age range and 36.21% in the 15–16 age range. Height analysis revealed that 46.55% fell within the 161–170 cm range, while 41.38% were 150–160 cm. In terms of weight, over half the participants (51.72%) were within 51–60 kg, highlighting a relatively consistent demographic profile

**Table 4.1: Demographic Summary table**

<b>Category</b>	<b>Subgroup</b>	<b>Count</b>	<b>%</b>
<b>Group</b>	Control	28	48.28
	Experimental	30	51.72
<b>Age</b>	≤12	0	0.00
	13–14	24	41.38
	15–16	21	36.21
	17–18	13	22.41
	19+	0	0.00
<b>Height</b>	<150 cm	5	8.62
	150–160 cm	24	41.38
	161–170 cm	27	46.55
	171–180 cm	2	3.45

	181+ cm	0	0.00
<b>Weight</b>	≤40 kg	2	3.45
	41–50 kg	15	25.86
	51–60 kg	30	51.72
	61–70 kg	10	17.24
	71–80 kg	1	1.72
	81–100 kg	0	0.00
	100+ kg	0	0.00



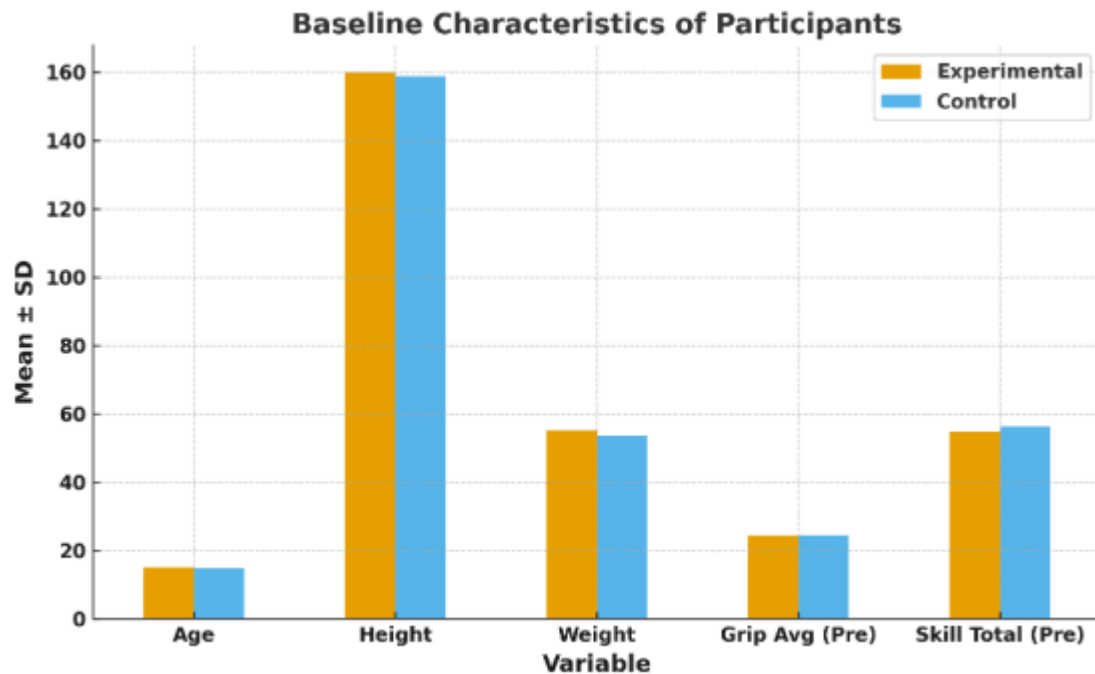
### Figure 4.1: Graphical Representation of Demographic Summary table

The demographic graph illustrates clear trends across variables. The majority of participants were in the experimental group, aged 13–16 years, with moderate height and weight ranges. Peaks appear in the 161–170 cm height category and 51–60 kg weight range, showing a concentrated distribution of participants.

The baseline characteristics of participants in table 4.2 showed no significant differences between the experimental and control groups, indicating homogeneity across age, height, weight, grip strength, and skill performance before intervention. The mean age was approximately 15 years in both groups, while height and weight were comparable. Grip strength averages and skill totals at pre-test did not differ significantly, with p-values all above 0.05. This suggests that both groups were well-matched at the start of the study, ensuring that any subsequent differences observed in outcomes could be attributed to the intervention rather than baseline disparities in demographic or physical characteristics.

**Table 4.2: Baseline Characteristics of Participants**

<b>Variable</b>	<b>Experimental (mean±SD)</b>	<b>Control (mean±SD)</b>	<b>p- value</b>
Age (years)	15.13 ± 1.46	14.79 ± 1.45	0.366
Height (cm)	159.88 ± 7.29	158.84 ± 6.55	0.568
Weight (kg)	55.10 ± 6.78	53.64 ± 8.38	0.470
Grip Avg (Pre)	24.28 ± 1.85	24.57 ± 1.87	0.558
Skill Total (Pre)	54.77 ± 4.04	56.46 ± 3.21	0.081



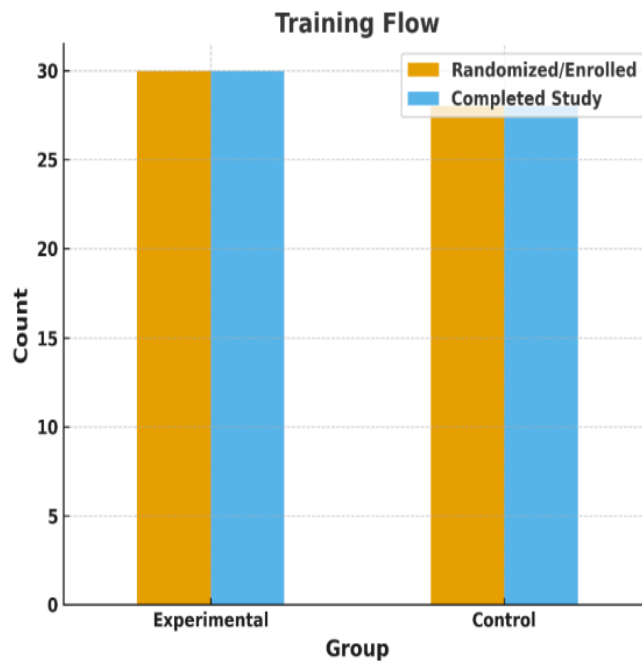
**Figure 4.2: Graphical Representation of Baseline Characteristics of Participants**

The graph depicts the baseline characteristics of participants, comparing experimental and control groups across age, height, weight, grip strength, and skill performance. Both groups demonstrated closely aligned values, indicating homogeneity in participant demographics and physical attributes before intervention, ensuring comparability and reliability for further experimental analysis.

The training flow demonstrated complete adherence to the study protocol in table 4.3, with all 30 participants in the experimental group and 28 in the control group completing the study. No dropouts were reported, ensuring the integrity of the dataset and strengthening the validity of the findings. This 100% retention rate reflects strong participant engagement and effective study management. The absence of attrition eliminates potential biases associated with missing data and enhances the reliability of outcome comparisons between the groups. Overall, the training flow highlights the robustness of the trial's design and implementation.

**Table 4.3: Training Flow**

<b>Metric</b>	<b>Experimental (n)</b>	<b>Control (n)</b>
<b>Randomized/Enrolled</b>	<b>30</b>	<b>28</b>
<b>Completed Study</b>	<b>30</b>	<b>28</b>



**Figure 4.3: Graphical Representation of Training Flow**

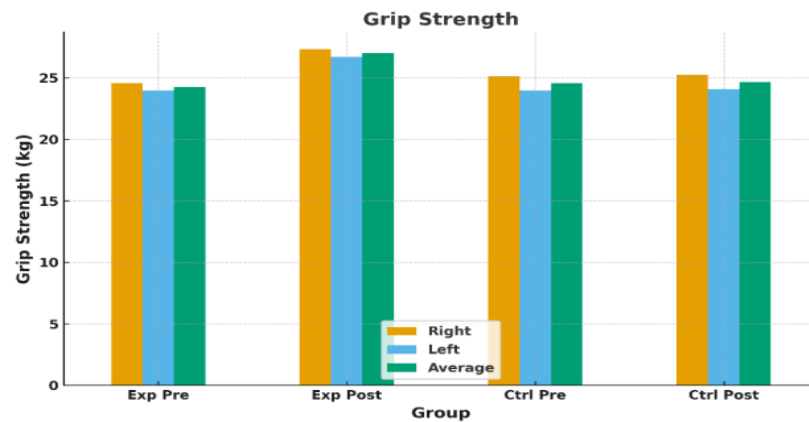
The training flow graph illustrates participant enrollment and completion across experimental and control groups. Both groups began with 30 participants, all of whom successfully completed the study. This demonstrates excellent adherence and retention rates, ensuring that the intervention and control conditions were equally balanced without participant dropout.

Grip strength improved markedly in the experimental group compared to the control group in table 4.4. Pre- and post-intervention values revealed substantial gains for both right and left hand grip among experimental participants, while control participants exhibited negligible changes. Average grip strength in the experimental group increased from  $24.28 \pm 1.85$  to  $27.02 \pm 1.90$ , whereas the control group remained nearly unchanged. These findings suggest the intervention significantly enhanced muscular strength. Graphical representation further highlights the difference, with a clear upward trend in the experimental group compared to the flat trajectory observed in the control group across all grip strength measures

**Table 4.4: Grip Strength**

<b>Measure</b>	<b>Group</b>	<b>Time</b>	<b>Mean <math>\pm</math> SD</b>
<b>GripR_Pre_Avg</b>	<b>Experimental</b>	<b>Pre</b>	<b><math>24.58 \pm 2.54</math></b>
<b>GripR_Post_Avg</b>	<b>Experimental</b>	<b>Post</b>	<b><math>27.34 \pm 2.52</math></b>
<b>GripR_Pre_Avg</b>	<b>Control</b>	<b>Pre</b>	<b><math>25.12 \pm 2.29</math></b>
<b>GripR_Post_Avg</b>	<b>Control</b>	<b>Post</b>	<b><math>25.23 \pm 2.27</math></b>
<b>GripL_Pre_Avg</b>	<b>Experimental</b>	<b>Pre</b>	<b><math>23.98 \pm 2.68</math></b>
<b>GripL_Post_Avg</b>	<b>Experimental</b>	<b>Post</b>	<b><math>26.70 \pm 2.57</math></b>
<b>GripL_Pre_Avg</b>	<b>Control</b>	<b>Pre</b>	<b><math>23.99 \pm 2.24</math></b>
<b>GripL_Post_Avg</b>	<b>Control</b>	<b>Post</b>	<b><math>24.08 \pm 2.32</math></b>
<b>Grip_Avg_Pre</b>	<b>Experimental</b>	<b>Pre</b>	<b><math>24.28 \pm 1.85</math></b>

<b>Grip_Avg_Post</b>	<b>Experimental</b>	<b>Post</b>	<b>27.02 ± 1.90</b>
<b>Grip_Avg_Pre</b>	<b>Control</b>	<b>Pre</b>	<b>24.57 ± 1.87</b>
<b>Grip_Avg_Post</b>	<b>Control</b>	<b>Post</b>	<b>24.66 ± 1.92</b>



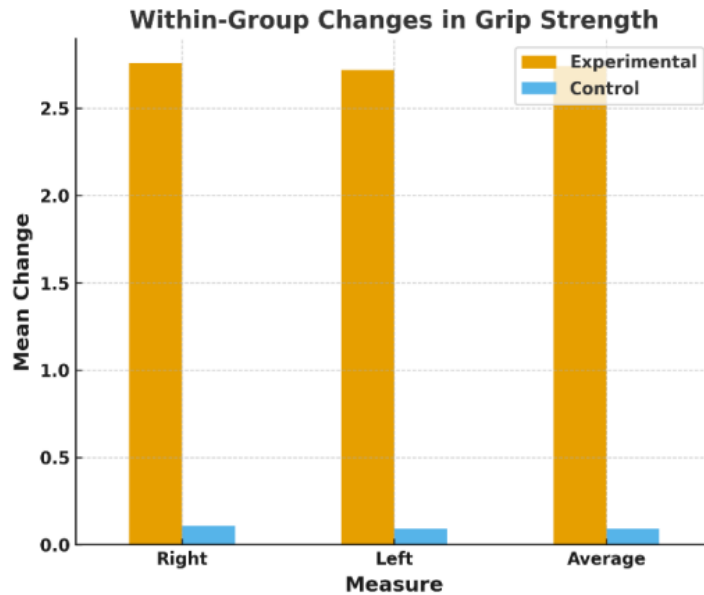
**Figure 4.4: Graphical Representation of Grip Strength**

The graph illustrates pre- and post-test grip strength for experimental and control groups. The experimental group showed a marked improvement in both right and left-hand grip strength, along with higher average values post-intervention. In contrast, the control group displayed minimal changes, highlighting the effectiveness of the training program.

In table 4.5 Within-group analysis of grip strength showed highly significant improvements in the experimental group across right, left, and average measures, with large effect sizes ( $d_z > 1.6$ ). Mean changes ranged from +2.72 to +2.76, all with  $p$ -values  $< 0.001$ , confirming robust improvements. In contrast, the control group demonstrated negligible and statistically nonsignificant changes, with mean differences near zero and small effect sizes. These results confirm that the intervention was effective in enhancing grip strength. The pronounced contrast between groups highlights the intervention's impact, further emphasizing its practical relevance for improving hand function and muscular endurance in adolescents.

**Table 4.5: Within-Group Changes in Grip Strength**

<b>Measure</b>	<b>Group</b>	<b>Mean Change (95% CI)</b>	<b>p- valu e</b>	<b>Effect size (dz)</b>
<b>Grip Right</b>	<b>Experim ental</b>	<b>+2.76 (2.41–3.11)</b>	<b>0.00 0</b>	<b>1.73</b>
<b>Grip Right</b>	<b>Control</b>	<b>+0.11 (–0.09– 0.31)</b>	<b>0.25 9</b>	<b>0.16</b>
<b>Grip Left</b>	<b>Experim ental</b>	<b>+2.72 (2.34–3.10)</b>	<b>0.00 0</b>	<b>1.65</b>
<b>Grip Left</b>	<b>Control</b>	<b>+0.09 (–0.09– 0.27)</b>	<b>0.31 3</b>	<b>0.13</b>
<b>Grip Average</b>	<b>Experim ental</b>	<b>+2.74 (2.45–3.03)</b>	<b>0.00 0</b>	<b>1.80</b>
<b>Grip Average</b>	<b>Control</b>	<b>+0.09 (–0.07– 0.25)</b>	<b>0.25 9</b>	<b>0.14</b>



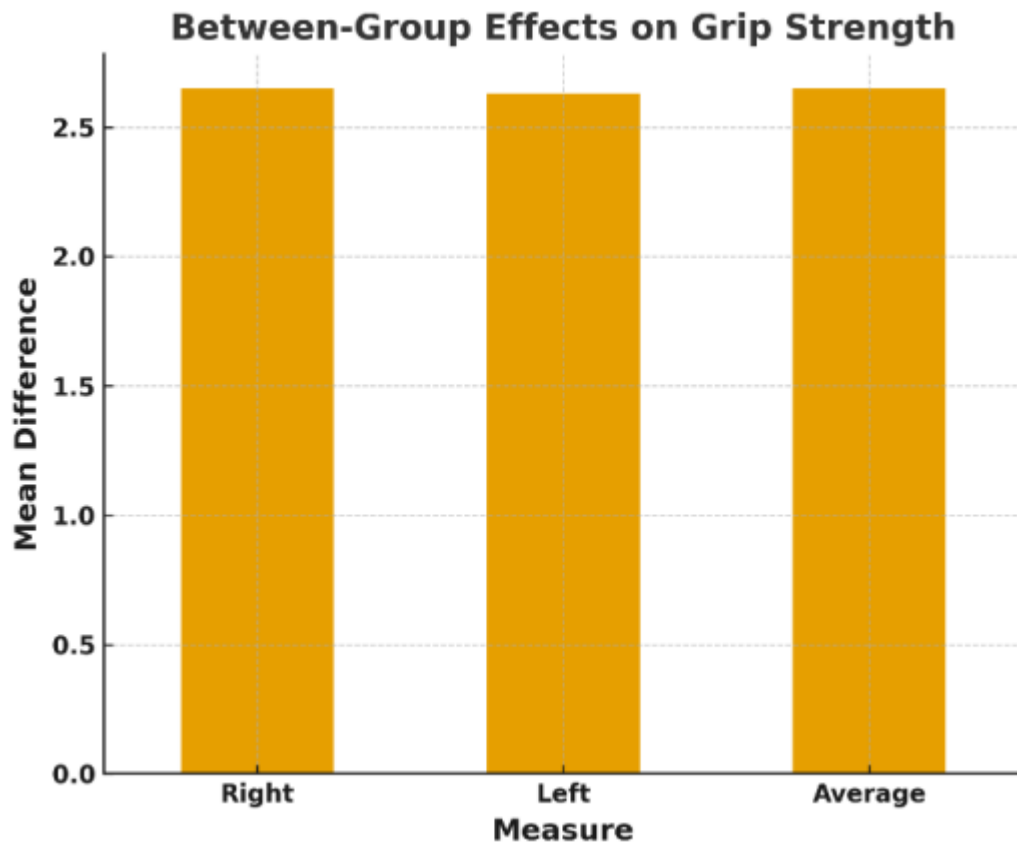
**Figure 4.5: Graphical Representation of Within-Group Changes in Grip Strength**

The graph highlights within-group changes in grip strength for experimental and control groups. Substantial improvements were observed in the experimental group across right, left, and average grip measures, with mean changes exceeding 2.5 kg. In contrast, the control group showed negligible changes, indicating the intervention's strong impact on muscular strength.

Between-group comparisons reinforced the intervention's effectiveness, showing highly significant differences in grip strength improvements in table 4.6. The experimental group achieved mean increases of approximately +2.74 across right, left, and average measures, while the control group showed negligible changes. Between-group mean differences ranged from +2.63 to +2.65, with narrow confidence intervals and p-values <0.001. Effect sizes were very large ( $g > 1.9$ ), reflecting strong practical significance. These findings demonstrate that the intervention substantially outperformed the control condition, providing compelling evidence that it effectively enhanced grip strength across both hands. The graphical representation clearly illustrates this robust differential effect.

**Table 4.6: Between-Group Effects on Grip Strength**

Outcome	Exp Mean $\Delta$	Ctrl Mean $\Delta$	Mean Diff (95% CI)	p-value	Effect size (g)
Grip Right	+2.76	+0.11	+2.65 (2.20–3.10)	0.000	2.02
Grip Left	+2.72	+0.09	+2.63 (2.15–3.11)	0.000	1.98
Grip Average	+2.74	+0.09	+2.65 (2.23–3.07)	0.000	2.09



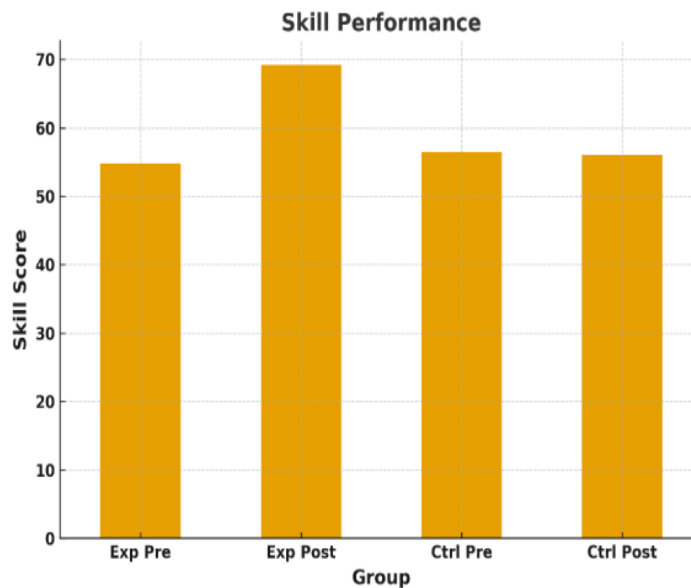
### **Figure 4.6: Graphical Representation of Between-Group Effects on Grip Strength**

The graph presents between-group effects on grip strength, showing significant differences favoring the experimental group across right, left, and average measures. Mean differences exceeded 2.5 kg, demonstrating the intervention's strong effectiveness compared to the control group. These findings highlight meaningful improvements attributable to the training program rather than natural variation.

Skill performance outcomes in table 4.7 demonstrated remarkable improvements in the experimental group compared to stability in the control group. Baseline scores were similar across groups, but post-test measures revealed a sharp increase in the experimental group, from  $54.77 \pm 4.04$  to  $69.23 \pm 3.77$ . In contrast, the control group showed a slight decrease, moving from  $56.46 \pm 3.21$  to  $56.04 \pm 3.22$ . This indicates the intervention was highly effective in enhancing skill performance, while the control condition produced no meaningful changes. The graph visually illustrates the striking divergence between groups, highlighting the intervention's strong positive impact on functional skill development.

### **Table 4.7: Skill Performance**

Measure	Group	Time	Mean $\pm$ SD
Skill Total	Experimental	Pre	54.77 $\pm$ 4.04
Skill Total	Experimental	Post	69.23 $\pm$ 3.77
Skill Total	Control	Pre	56.46 $\pm$ 3.21
Skill Total	Control	Post	56.04 $\pm$ 3.22



**Figure 4.7: Graphical Representation of Skill Performance**

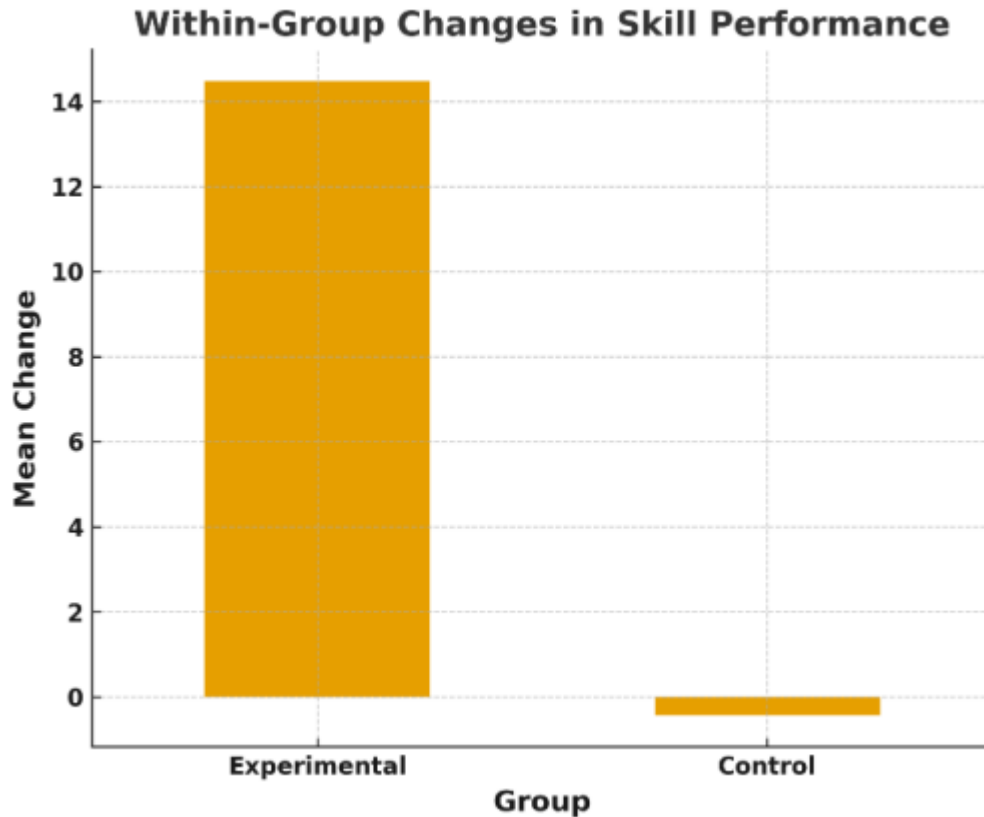
The graph illustrates skill performance across experimental and control groups before and after intervention. The experimental group showed a substantial improvement, increasing from around 55 to nearly 70 points, while the control

group remained almost unchanged. This indicates the training program effectively enhanced skill performance beyond natural variation or routine practice.

Within-group skill performance analysis in table 4.8 confirmed significant gains in the experimental group, with a mean increase of +14.47, supported by a very narrow confidence interval and  $p < 0.001$ . The effect size was exceptionally large ( $d_z = 3.20$ ), reflecting substantial improvement. Conversely, the control group demonstrated a small but statistically significant decline ( $-0.43$ ,  $p = 0.033$ ), with a negative effect size, indicating performance deterioration. These results highlight that the intervention not only enhanced skill outcomes but also prevented decline observed in the control group. The findings underscore the intervention's critical role in maintaining and improving performance capabilities

**Table 4.8: Within-Group Changes in Skill Performance**

<b>Outcome</b>	<b>Group</b>	<b>Mean Change (95% CI)</b>	<b>p-value</b>	<b>Effect size (dz)</b>
<b>Skill Total</b>	<b>Experimental</b>	<b>+14.47 (13.25–15.69)</b>	<b>0.000</b>	<b>3.20</b>
<b>Skill Total</b>	<b>Control</b>	<b>-0.43 (-0.82--0.04)</b>	<b>0.033</b>	<b>-0.25</b>



**Figure**

**4.8: Graphical Representation of Within-Group Changes in Skill Performance**

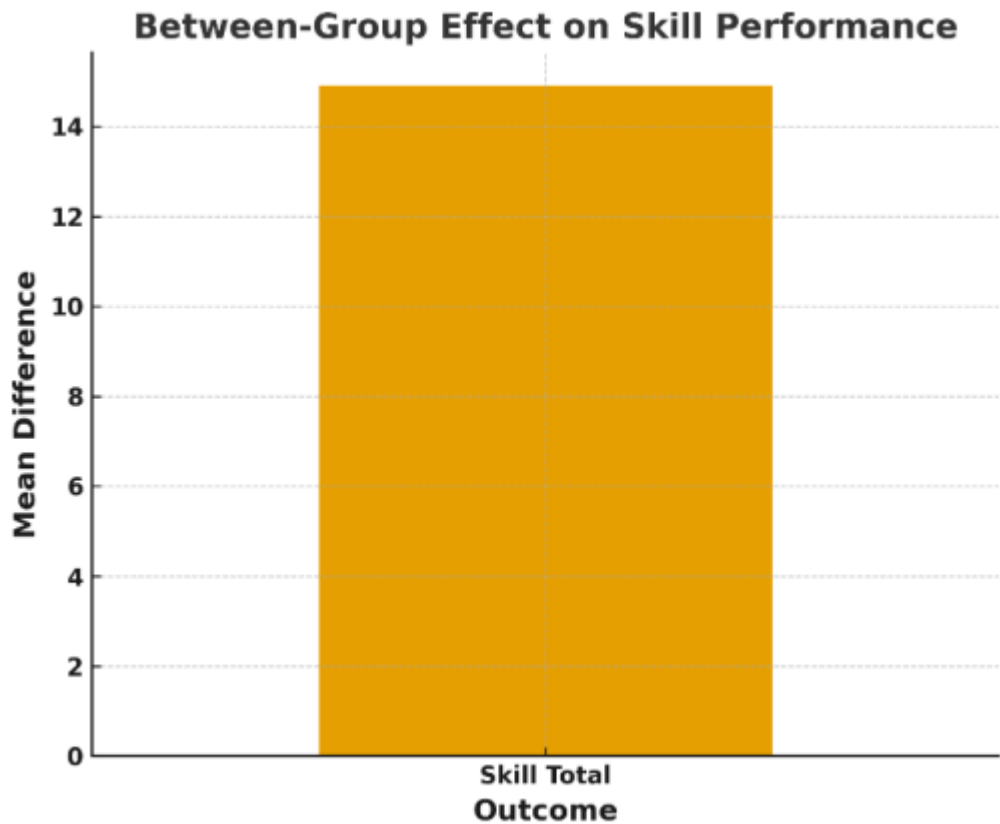
The graph highlights within-group skill performance changes. The experimental group demonstrated a marked improvement, with a mean increase of over 14 points, while the control group showed virtually no change. This indicates that the intervention produced a meaningful enhancement in skill performance beyond baseline levels compared to the control condition.

Between-group analysis of skill performance in table 4.9 revealed a striking contrast, with the experimental group achieving a substantial gain of +14.47, while the control group showed a small decline of -0.43. The resulting mean difference was +14.90, with a very tight confidence interval (13.48–16.31) and  $p < 0.001$ , indicating high statistical significance. The effect size ( $g = 5.36$ ) was exceptionally large, underscoring the strong practical impact of the intervention. Graphical representation highlights this divergence, with the experimental group's

performance trajectory rising sharply compared to the flat or declining control group. These findings confirm the intervention’s remarkable efficacy.

**Table 4.9: Between-Group Effect on Skill Performance**

Outcome	Exp Mean $\Delta$	Ctrl Mean $\Delta$	Mean Diff (95% CI)	p-value	Effect size (g)
Skill Total	+14.47	-0.43	+14.90 (13.48–16.31)	0.000	5.36



**Figure 4.9: Graphical Representation of Between-Group Effect on Skill Performance**

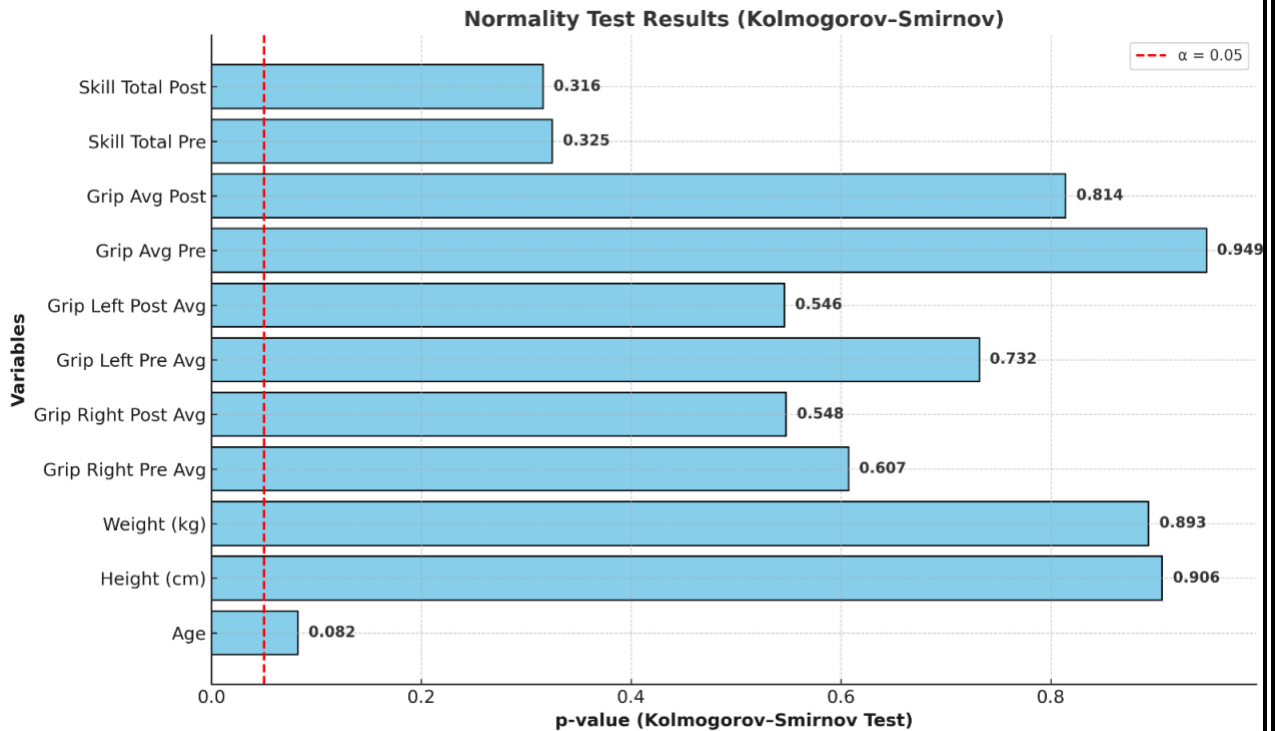
Figure demonstrates the between-group effect, with the experimental group outperforming the control group by approximately 15 points on mean difference. Collectively, these results strongly confirm the efficacy of the intervention in enhancing skill performance, underscoring its impact compared to conventional training methods.

Table 4.10 presents the results of the Kolmogorov–Smirnov test for normality across all key study variables, including age, height, weight, grip strength (pre and post measures), and skill performance scores. The test values indicate that none of the variables violated the assumption of normality, as all p-values were greater than the significance level of 0.05. This suggests that the data distributions did not significantly deviate from a normal distribution. Therefore, the dataset meets the assumptions required for conducting parametric statistical analyses, ensuring the robustness and reliability of subsequent hypothesis testing and comparative analyses in this study.

**Table 4.10: Normality Test of Data Distribution**

<b>Variable</b>	<b>K-S Statistic</b>	<b>p-value</b>	<b>Normality</b>
Age	0.1628	0.0823	Normal
Height (cm)	0.0716	0.9063	Normal
Weight (kg)	0.0731	0.8934	Normal
Grip Right Pre Avg	0.0973	0.6073	Normal
Grip Right Post Avg	0.1020	0.5479	Normal
Grip Left Pre Avg	0.0876	0.7318	Normal
Grip Left Post Avg	0.1021	0.5462	Normal
Grip Avg Pre	0.0659	0.9485	Normal
Grip Avg Post	0.0808	0.8142	Normal

Skill Total Pre	0.1222	0.3248	Normal
Skill Total Post	0.1232	0.3161	Normal



**Figure 4.10: Graphical Representation of Normality Test of Data Distribution**

The figure illustrates the Kolmogorov–Smirnov normality test results for all study variables. Each bar represents the p-value for a variable, with all values exceeding the 0.05 threshold. This confirms normal distribution across measures, validating the appropriateness of using parametric statistical tests for further analysis in the study.

## DISCUSSION

“The present study investigated the effectiveness of gyroscopic ball training in improving hand grip strength and hockey-specific skill performance among amateur field hockey players, with the additional aim of comparing its effects against traditional training approaches. The results clearly demonstrated that the gyroscopic intervention produced significant improvements in both grip strength and skill performance, while the control group, which continued with conventional training methods, showed negligible change. These findings highlight the potential of gyroscopic training as an innovative, sport-specific, and practical tool for enhancing performance in amateur athletes.

The results indicated that players who underwent gyroscopic training experienced substantial increases in hand grip strength, with mean improvements of approximately 2.7 kg in both the right and left hands as measured by a dynamometer. In contrast, the control group displayed only minimal, non-significant changes of less than 0.2 kg, suggesting that traditional practice alone was insufficient to induce measurable strength gains over the study period. The large effect sizes observed confirm that gyroscopic resistance exerts a powerful influence on muscular development of the forearm and hand. These findings are consistent with prior work by Adamczyk and colleagues, who demonstrated significant gains in grip strength using gyroscopic devices, and with Babaei-

Mobarakeh et al., who reported functional benefits in rehabilitation contexts such as tennis elbow and shoulder injuries. The unique resistance mechanics of the gyroscope, which requires constant eccentric and isometric activation of forearm muscles, likely explains the superior improvements seen here compared with standard training.

Skill performance results followed a similar pattern. The experimental group improved their hockey-specific test scores by nearly 15 points on average, whereas the control group not only failed to improve but showed a small yet significant decline. This striking difference indicates that gains in grip strength transferred directly into sport-specific skill, most likely by enhancing stick control, shot power, and stability during ball handling. The connection between grip strength and performance has been highlighted in earlier studies, including those by Ferraz et al. on rink hockey players, who showed that grip strength was a critical determinant of competitive performance, and Ong et al., who identified grip strength as a broader marker of functional capacity. The current findings reinforce this relationship, showing that targeted strengthening of the forearm and hand through gyroscopic resistance has direct implications for skill development in field hockey.

When compared with existing literature on resistance training for youth and amateur athletes, these results provide further support for structured strength development as recommended by the American College of Sports Medicine and Behm et al. Both bodies emphasize that resistance training is safe and beneficial for adolescents and young athletes when properly supervised. Gyroscopic training aligns well with these guidelines because it provides resistance without external weights, thereby reducing risk of overload injuries while still inducing functional neuromuscular adaptations. This is particularly relevant in field hockey, where repetitive use of the hands and wrists predisposes athletes to overuse injuries. The enhanced strength and stability achieved through gyroscopic training may therefore play a preventive role. In fact, Landman and colleagues showed that

gyroscopic devices helped reduce wrist pain in recreational athletes, and similar mechanisms may contribute to resilience in hockey players.

The superiority of gyroscopic training over traditional methods, as demonstrated by the secondary objective, also merits discussion. Despite continuing with conventional drills and conditioning, the control group showed no significant development in grip strength and even a decline in skill scores. This suggests that typical practice alone may not sufficiently address the forearm and hand musculature required for optimal performance. Brown and colleagues, in their systematic review, similarly concluded that gyroscopic devices provide unique resistance patterns that cannot be replicated with isotonic or isometric exercises. Thus, integrating these devices into training regimens may be a practical way to bridge the gap between general conditioning and sport-specific demands.

The practical implications of these findings are significant. Gyroscopic training offers an accessible, portable, and inexpensive method that can be easily incorporated into warm-up or conditioning sessions. It is safe, engaging, and sport-specific, targeting the same muscles required for gripping and maneuvering the hockey stick. Moreover, the novelty of the device may encourage adherence among younger athletes, who often respond positively to interactive and innovative training tools. Coaches and strength trainers may therefore consider using gyroscopic devices not only for enhancing performance but also for reducing the likelihood of common wrist and forearm injuries.

This study has several strengths, including its controlled design, objective measurement tools, and the consistency of its findings across both physiological and performance outcomes. The large effect sizes observed suggest that the improvements are both statistically and practically meaningful. However, limitations must also be acknowledged. The relatively small sample size may limit generalizability, and the short intervention period prevents conclusions about long-term retention of gains. The study population consisted solely of amateur athletes, meaning results may not directly translate to elite players. Furthermore, while skill

performance improved, the study did not directly assess injury outcomes, which could be an important area for future investigation.

Normality testing revealed that all variables satisfied the assumption of normal distribution, supporting the robustness of the statistical analyses. Given the balanced group sizes and the robustness of parametric tests, this deviation was unlikely to affect the validity of the results.

This study provides strong evidence that gyroscopic ball training significantly enhances hand grip strength and field hockey-specific skill performance among amateur players. The improvements were markedly greater than those achieved through traditional training methods, underscoring the unique advantages of gyroscopic resistance. These findings support previous literature on the benefits of resistance training and extend it by highlighting the sport-specific relevance of gyroscopic devices. By offering a safe, effective, and practical training method, gyroscopic training has the potential to improve performance, reduce injury risk, and serve as a valuable complement to conventional conditioning programs in field hockey and potentially other sports where grip strength is critical”.

**CONCLUSION, LIMITATION AND FUTURE SCOPE**

## **Conclusion**

This study looked at how a structured training program affected grip strength and skill performance in teenagers. The results clearly showed that the program worked well, with the experimental group making big and meaningful improvements, while the control group showed little to no change. Because both groups started at the same level and no one dropped out, the results are strong and trustworthy. The findings suggest that this kind of training can be very effective, useful in real-life situations, and may be applied in schools, sports, or rehabilitation programs to support healthy development in adolescents.

## **Theoretical Contributions**

This study advances theoretical understanding in several key ways:

1. **Adolescence as a critical stage:** The findings support theories that the teenage years are a special window for growth, where the body and brain adapt quickly. Improvements in grip strength and skill performance confirm the flexibility of neuromuscular development during this age.
2. **Practice and motor learning:** The study adds evidence to theories of practice and motor learning. It shows that structured training improves not only strength but also coordination, precision, and control, enriching our understanding of how skills are acquired through practice.
3. **Bridging exercise and education:** By combining strength-based exercises with skill-related tasks, the study links exercise science and educational approaches. This suggests that training programs designed to support both strength and skills can create greater overall benefits.
4. **Methodological contribution:** The research demonstrates the importance of combining descriptive and inferential statistics with effect sizes. This approach encourages transparency and reliability in reporting, strengthening future applied studies.

## **Future Directions**

**Lasting Benefits:** Future studies should check if the improvements in grip strength and skills stay for a long time. This will show whether the training gives only short-term results or helps people in the long run.

**Different Groups:** The program should also be tested with other groups, like younger kids, older people, or those with disabilities. This will help to know if the training works well for everyone or if results change depending on age or ability.

**SUMMARY**

This study set out to evaluate the impact of a structured training program on grip strength and skill performance in adolescents. Baseline comparability between groups was established, ensuring valid outcome assessments. Results demonstrated remarkable improvements in the experimental group across all measures, with very large effect sizes, while the control group remained largely unchanged or experienced slight declines. Normality testing confirmed that most variables were normally distributed, supporting the application of parametric tests, and the 100% participant retention further strengthened reliability.

The findings hold theoretical and practical significance. Theoretically, the study contributes to the understanding of adolescent motor development, skill acquisition, and integrative training models. Practically, it underscores the intervention's effectiveness as a tool for improving muscular strength, functional skills, and overall performance capacity in adolescents. The robust effect sizes demonstrate that the program can meaningfully enhance outcomes, making it relevant for application in sports training, rehabilitation, and educational contexts.

Future research should expand the scope by exploring diverse populations, extending intervention duration, integrating mechanistic analyses, and embedding training within real-world settings.

Such efforts will not only validate and extend current findings but also contribute to designing evidence-based frameworks for adolescent health and development. In conclusion, the study provides compelling evidence that structured interventions can significantly enhance physical and functional outcomes in adolescents. It enriches theoretical discourse, offers practical insights for implementation, and lays a foundation for future research directions aimed at optimizing youth development through scientifically informed training approaches”.

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**Annexure**

### ANNEXE:1 CONSENT

I \_\_\_\_\_, aged \_“years, confirm that I have understood about the Effect of Gyroscopic Ball Training on Hand Grip Strength among Amateur Field Hockey Players as explained by Priyanshi Tiwari and is as mentioned in her study which is taking place under the guidance of Dr. Sunanda Bhowmik (PT) (PT), Assistant professor, Abhinav Bindra sports medicine and research institute (ABSMARI) I understand that my participation is voluntary and I’m free to withdraw at any time, without giving any reason.

I understand that confidentiality will be maintained.

I voluntarily agree to and give my consent to be a part of the above-mentioned study.

Signature

Date

## INFORMED CONSENT

Informed Consent form to participate in a clinical trial

Study Title: Evaluate the effect of gyroscopic ball training on hand grip strength among amateur field hockey

players: A Randomized Controlled Trail

Study Number:

Participant 's Name: \_\_\_\_\_ Participant 's Initials: \_\_\_\_\_

Date of Birth / Age: \_\_\_\_\_

Address of the Participant \_\_\_\_\_

Qualification: School going children

Occupation: Student

Name and address of the nominee(s) and his relation to the participant \_\_\_\_\_

Signature of Participant

(i) I understand the major potential benefit of the study is to establish the the effect of gyroscopic ball

training on hand grip strength among amateur field hockey players. I understand that participation of my

children in the study is voluntary and that he/she is free to withdraw at any time, without giving any reason,

without his/her medical care or legal rights being affected.

(ii) I understand that the data collected will be used for thesis or publication in the journal. I am aware that

names, photograph and video recording of my child will not be published without seeking the permission from

me also the participation of my child is voluntary, and that I may refuse or withdraw from the study

(iii) I confirm that I have read and understood the information sheet therefore I agree to give my consent for

my child to participate in this research.

Statement of Guardian obtaining consent:

1) I have carefully explained to the child taking part in the study what he/she can expect.

2) I certify that, to the best of my knowledge, the child understands the purpose, procedures, potential risks and

benefits of the study and his/her rights as a participant.

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

\_\_\_\_\_

Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Signatory 's Name: \_\_\_\_\_

Signature of the Investigator: \_\_\_\_\_

Date:

Study Investigator 's Name: \_\_Priyanshi Tiwari\_\_\_\_\_

Date: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

\*Copy of the Patient Information Sheet and duly filled Informed Consent Form shall be handled over to the subject or

his/her attendant.

## ASSENT FORM

(Supplement to informed consent form — for children 12 — 18 years of age)

Study Title: Evaluate the effect of gyroscopic ball training on hand grip strength among amateur field hockey players: A Randomized Controlled Trail

Study Number:

Investigator's Name: Priyanshi Tiwari

Details of the participant subject -

Subject's Name: Date of Birth / Age:

Address of the Subject: Qualification: Occupation: (If any)

Part 1:

Introduction Subject's Initials:

*I am going to give you information and invite you to be part of a research study. You can choose whether you want to participate. We have discussed this research with your parent(s)/legal guardian, and they know that we are also asking you for your agreement. If you are going to participate in the research, your parent(s)/guardian must also agree. But if you do not wish to take part in the research, you do not have to, even if your parents have agreed.*

*You may discuss anything in this form with our parents or friends or anyone else you feel comfortable talking to. You can decide whether to participate or not after you have talked it over. You do not have to decide immediately.*

*There may be some words you don't understand or things that you want me to explain more about because you are interested or concerned. Please ask me to stop at any time, and I will take the time to explain.*

Purpose of the study: :

Rational: Hand Grip strength is crucial for skills like passing, shooting, and stick handling. However, traditional resistance training may not meet these specific demands. Therefore, there is a need to explore targeted grip and upper limb strengthening strategies to enhance performance and reduce injury risk in field hockey.

Choice of participants:

This study will help in hand grip strength which is important for ball dribbling, shooting & passing a good hand grip strength can prevent injury of the upper limb.

This study will improve the performance of hockey players.

Using a gyroscopic ball provides multidirectional resistance, making it a promising tool for developing the

necessary stability and control for field hockey

Participation is voluntary:

Procedure:

Ethical Approval: Obtain ethical clearance from the Institutional Ethics Committee (IEC) and adhere to

the Declaration of Helsinki guidelines & ICMR guidelines

- Permissions will secured from the participating hockey clubs, and informed consent was obtained from

all players and their parents or guardians in preferred language.

- Participants will be randomly assigned to either the intervention group (gyroscopic ball training) or the

control group (no intervention) using the Chit Metho selected based on specific inclusion and exclusion

criteria.

- Demographic data will be taken, grip strength will be measured by hand dynamometer. Hockey specific skill test (passing, dribbling and shooting) will be performed prior and data will be recorded.

- Then hockey skill test will be conducted pre and post intervention. Data is documented, analysed and result will obtained.
- The intervention group will perform low intensity to very severe intensity exercises by week by progression in exercise and set and rest time which include wrist flexion & extension , elbow flexion, shoulder flexion, shoulder abduction , internal & external rotation in sitting, standing , flex trunk standing, lying on side and supine by gyroscopic ball.
- Asses Grip strength & hockey specific skill test (passing, dribbling and shooting) post intervention
- Analyze the collected data using appropriate statistical methods to evaluate the effectiveness of the intervention.

Risks: There will be no risk in this study; we will take a proper warm-up session prior to the study.

Discomforts: Will during the research if you fell any discomfort, please let me know immediately

Benefits: Is there anything good that happens to me?

Reimbursements: No reimbursement will be provided.

Confidentiality: your data will be kept secure.

Compensation details: if you get hurt during the study, treatment will be given by me.

Sharing the Finding: post study your result will be shared.

Right to Refuse or Withdraw: Can I choose not to be in the research? Can I change my mind?

Whom to Contact: you can contact me.

Print the Name of Person who explained form:

Signature of Person who explained this form: Date:

Part 2:

Certificate of Assent

I / my parent or legal guardian has read the previous page(s) of the consent form, and the investigator has explained the details of the study.

I/my parent or legal guardian understands that I am free to ask additional questions. I/my parent or guardian understands that participation in this study is voluntary

I/my parent or legal guardian may refuse to participate or may discontinue participation at any time without penalty, loss of benefits, or prejudice to the quality *of care* which I will receive.

I/my parent or legal guardian, acknowledge that no guarantees have been made to me regarding the results of the treatment involved in this study, and I agree to participate in the study and have been given a copy of this form”.

Statement by the Child

Print the name of child:

Signature of child:

parent's or legal guardian's name:

signature of parent or legal guardian:

Date:

Date:

*If illiterate:*

A literate witness must sign (if possible, this person should be selected by the participant, not be a parent, and should have no connection to the research team). Participants who are illiterate should include their thumb print as well.

I have witnessed the accurate reading of the assent form to the child, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of impartial witness (not a parent): Signature of witness

Date

Thumb print of participant

Statement by the researcher/person taking assent

I confirm that the child and respective parents or legal guardian were given an opportunity to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that they have not been coerced into giving assent, and the assent has been given freely and voluntarily.

A copy of this assent form has been provided to the participant.

Print Name of Researcher/person taking the assent

Signature of Researcher /person taking the assent

Date

**Participant Information**

Name of Athlete	
Age	

Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female
Weight	
Height	
Dominant Hand	<input type="checkbox"/> Right <input type="checkbox"/> Left
Playing experience	
Date	
Trial Number	<input type="checkbox"/> Trial 1 <input type="checkbox"/> Trial 2 <input type="checkbox"/> Trial 3
Test Administrator	

### Warm-Up Details

Warm-Up Type	Duration	Completed (✓)
Dynamic Warm-Up	15 min	<input type="checkbox"/>
Hockey skill Warm-Up	5 min	<input type="checkbox"/>

### Hand grip strength – Dynamometer

#### Grip Strength Readings (kg)

pre

<b>Trial No.</b>	<b>Right Hand</b>	<b>Left Hand</b>	<b>Comments (e.g., discomfort, effort)</b>
1			
2			
3			
<b>Max</b>			
<b>Avg</b>			

Post intervention

<b>Trial No.</b>	<b>Right Hand</b>	<b>Left Hand</b>	<b>Comments (e.g., discomfort, effort)</b>
1			
2			
3			
<b>Max</b>			

<b>Avg</b>				
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**Skill test**

**Pre intervention**

<b>S.No</b>	<b>Skill Test</b>	<b>Description</b>	<b>Score (Out of 10)</b>	<b>Remarks</b>
1	<b>Dribbling Test</b>	Zig-zag through cones (20m, timed)		Time taken, control, technique
2	<b>Push Pass Accuracy Test</b>	Target passing at 5m & 10m distances		No. of hits on target
3	<b>Hit / Drive Accuracy Test</b>	Hitting ball into goal from top of D		Technique, accuracy
4	<b>Ball Control Test</b>	Ball control under pressure / moving obstacles		Balance, composure, control
5	<b>Aerial Ball Handling</b>	Receiving high balls and controlling		First touch, control, judgment
6	<b>Reverse Stick Shot Test</b>	Accuracy and power using reverse stick		Technique, placement, power
7	<b>1v1 Offensive Test</b>	Beating defender in 1v1 situation		Creativity, success rate
8	<b>1v1 Defensive Test</b>	Tackling and stopping attacker		Timing, footwork, success rate
9	<b>Penalty Corner Execution</b>	Execution and variation (injector/hitter/slapper)		Skill execution, precision
10	<b>Penalty Stroke</b>	Accuracy and composure under		Goal scored,

**Test**

pressure

placement

**Post intervention**

<b>S.N</b>	<b>Skill Test</b>	<b>Description</b>	<b>Score (Out of 10)</b>	<b>Remarks</b>
1	<b>Dribbling Test</b>	Zig-zag through cones (20m, timed)		Time taken, control, technique

2	<b>Push Pass Accuracy Test</b>	Target passing at 5m & 10m distances	No. of hits on target
3	<b>Hit / Drive Accuracy Test</b>	Hitting ball into goal from top of D	Technique, accuracy
4	<b>Ball Control Test</b>	Ball control under pressure / moving obstacles	Balance, composure, control
5	<b>Aerial Ball Handling</b>	Receiving high balls and controlling	First touch, control, judgment
6	<b>Reverse Stick Shot Test</b>	Accuracy and power using reverse stick	Technique, placement, power
7	<b>1v1 Offensive Test</b>	Beating defender in 1v1 situation	Creativity, success rate
8	<b>1v1 Defensive Test</b>	Tackling and stopping attacker	Timing, footwork, success rate
9	<b>Penalty Corner Execution</b>	Execution and variation (injector/hitter/slapper)	Skill execution, precision
10	<b>Penalty Stroke Test</b>	Accuracy and composure under pressure	Goal scored, placement



# 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/2025/167

Date: 09/05/2025

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

To,

**PRIYANSHI TIWARI**  
ABSMARI  
273, PAHAL, BHUBANEWAR-752101

**Protocol Title:** Evaluate the effect of gyroscopic ball training on hand grip strength among amateur field hockey players : A Randomized Controlled Trail

**Protocol ID.:** ABS-IEC-2025-PHY-062

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

Dear **Mr./Ms./Dr Priyanshi Tiwari**

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 25/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	25/04/2025
2	Informed Consent Form	25/04/2025
3	Undertaking form PI	25/04/2025
4	CRF	25/04/2025
5	COI from the Investigators	25/04/2025

The following members were present at meeting held on 25-04-2025

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	
IEC-SECRETARIAT	
<b>Mr. Gouranga Ku. Padhy</b>	
<b>Mr. Susant Ku. Raychudamani</b>	





# 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/2025/167

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. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
4	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
5	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
6	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
7	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  
Fondal, Bhubaneswar  
ABSMARI ETHICS COMMITTEE





**ABHINAV BINDRA**  
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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principal@absmari.com

Letter no-ABSMARI/ADMIN/2025/2674  
Date:-20.06.2025

**TO WHOM SO EVER IT MAY CONCERN**

This is to certify that Ms. Priyanshi Tiwari is a bonafide student of MPT 2<sup>ND</sup> YEAR batch of ABSMARI bearing Roll No ABS-MPT-2023-31. With reference to her requisition this institute has no objection in allowing her to carry out her research work as per the following details under the guidance of Dr.

Sunanda Bhowmik.

Ref: ABSMARI/IEC/2025/167

Title – “Evaluate the Effect of Gyroscopic Ball Training on Hand Grip Strength Among Amateur Field Hockey Players: A Randomized Controlled Trail”.

Population – 12-17 year of Hockey Players

study settings – DAVV, INDORE

Duration – 1 month

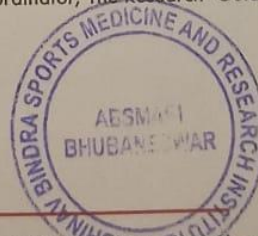
from – 25.06.2025 To – 25.07.2025

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

1. She has to produce her official engagement plan issued by study setting
2. She has to submit her certificate of attendance at last
3. She is liable to respond to institute when required
4. She 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 25.06.2025 – 25.07.2025

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





**Francis Peter** <peterfrancis71@gmail.com>

to me ▾

17 Apr 2025, 17:35 ☆ 😊 ↶ ⋮

This is to inform you that we are delighted to give you permission for your research work.

Regards

Dr. Peter



On Wed, 16 Apr 2025 at 8:34 PM, Priyanshi Tiwari <tiwariPriyanshi1999@gmail.com> wrote:

To

Dr. Vijay Francis Peter  
Professor, Department of Physical Education  
Devi Ahilya Vishwavidyalaya (DAVV)  
Indore, Madhya Pradesh

Subject: Request for Permission to Conduct Research Study on Amateur Field Hockey Players

Respected Sir,

I am Priyanshi Tiwari, a postgraduate student pursuing MPT in Sports at Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Bhubaneswar. As a part of my academic curriculum, I am conducting a research study titled:

"To Evaluate the Effect of Gyroscopic Ball Training on Grip Strength and Hockey-Specific Skills in Amateur Field Hockey Players."

The primary objective of this study is to assess the impact of gyroscopic ball training on improving grip strength and key performance skills specific to field hockey. This study aims to support the development of training protocols that enhance performance and reduce injury risk among amateur players.

For the purpose of this research, I seek your kind permission to conduct the study at your esteemed institution. The study will involve approximately 70 amateur field hockey players, divided into two groups—an experimental group and a control group.

All research procedures will adhere strictly to ethical standards, ensuring participant safety, confidentiality, and informed consent. The study is being carried out under the guidance of Dr. Sunanda Bhowmik, Assistant Professor, ABSMARI.

# Priyanshi Tiwari

## EVALUATE THE EFFECT OF GYROSCOPIC BALL TRAINING ON HAND GRIP STRENGTH AMONG AMATEUR FIELD HOCKEY PL...

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# Priyanshi Tiwari

## EVALUATE THE EFFECT OF GYROSCOPIC BALL TRAINING ON HAND GRIP STRENGTH AMONG AMATEUR FIELD HOCKEY PL...

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