

“The Effect of Post Rehabilitation on Fitness Parameters in Injured Versus Non-Injured Field Hockey Players Across Different Playing Positions: A Cross Sectional Observational Study”

By

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LIST OF ABBREVIATION

<u>Abbreviation</u>	<u>Full Form</u>
<u>YYIRT1</u>	<u>Yo-Yo Intermittent Recovery Test Level 1</u>
<u>YYIR L1</u>	<u>Yo-Yo Intermittent Recovery Test Level 1</u>
<u>RSA</u>	<u>Repeated Sprint Ability</u>
<u>RHIET</u>	<u>Repeated High Intensity Endurance Test</u>
<u>SMBT</u>	<u>Seated Medicine Ball Throw</u>
<u>ASLR</u>	<u>Active Straight Leg Raise</u>
<u>KTW</u>	<u>Knee to Wall (test)</u>
<u>SD</u>	<u>Standard Deviation</u>
<u>SPSS</u>	<u>Statistical Package for the Social Sciences</u>
<u>BMI</u>	<u>Body Mass Index</u>
<u>ANOVA</u>	<u>Analysis of Variance</u>
<u>NS</u>	<u>Not Significant</u>
<u>p-value</u>	<u>Probability Value</u>
<u>ICF</u>	<u>International Classification of Functioning, Disability and Health</u>
<u>CI</u>	<u>Confidence Interval</u>
<u>VO₂max</u>	<u>Maximal Oxygen Uptake</u>
<u>GPS</u>	<u>Global Positioning System</u>
<u>NLSC</u>	<u>National Level Sports Centre</u>
<u>t-test</u>	<u>Student's Unpaired t-test</u>

ABSTRACT

BACKGROUND: Field hockey is a dynamic team sport that demands superior physical fitness across various domains such as speed, power, endurance, and agility, with player injuries posing significant challenges to performance and career longevity. Persistent deficits in fitness parameters often remain following clinical rehabilitation, affecting return-to-play outcomes and elevating reinjury risk.

PURPOSE: To compare post-rehabilitation fitness parameters in injured versus non-injured field hockey players across different playing positions, thereby identifying residual deficits and informing position-specific rehabilitation and injury prevention strategies.

METHOD: A cross-sectional observational study included 46 injured and 46 non-injured male and female field hockey players aged 18–30 years, recruited through convenience sampling from clubs across India. Participants underwent validated fitness tests assessing speed (30m sprint), lower and upper body power (vertical jump, seated medicine ball throw), aerobic and anaerobic capacity (Yo-Yo Intermittent Recovery Test Level 1, Repeated Sprint Ability), agility (5-10-5 shuttle), tissue capacity (Copenhagen hold), flexibility (sit and reach), balance (single leg hop), and mobility (knee-to-wall, active SLR). Data were analyzed using descriptive statistics and Student's t-test (SPSS 27), with significance set at $p < 0.05$

RESULT: Injured players exhibited significantly poorer scores in speed (30m sprint: $5.01 \pm 0.41s$ vs. $2.81 \pm 0.30s$), lower body power (vertical jump: $38.13 \pm 7.37cm$ vs. $42.13 \pm 8.35cm$), upper body power (medicine ball throw: $5.45 \pm 1.25m$ vs. $6.21 \pm 0.74m$), aerobic capacity (Yo-Yo IRT L1: $1350.43 \pm 464.19m$ vs. $1868.69 \pm 274.77m$), agility (5-10-5 shuttle: $4.87 \pm 0.38s$ vs. $4.65 \pm 0.26s$), and anaerobic performance (RSA total sprint time: $30.05 \pm 2.49s$ vs. $28.80 \pm 1.55s$) compared to non-injured controls ($p < 0.05$ for all). Flexibility, balance, mobility, and other parameters showed variable differences, with some nonsignificant trends

CONCLUSION: Post-rehabilitation, injured field hockey players display persistent impairments in critical fitness domains necessary for high-level performance, even after medical clearance. These results highlight the need for comprehensive, individualized, and position-specific rehabilitation protocols that target restoration of speed, power, endurance, and agility, alongside effective monitoring using objective, sport-relevant tests. Tailored strategies enhance athlete health, minimize reinjury risk, and optimize competitive success in field hockey.

KEYWORDS: Field hockey; sports injury; rehabilitation; fitness parameters; speed; power; endurance; agility; position-specific training; return-to-play; tissue capacity; performance assessment

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INTRODUCTION

- Field Hockey, a dynamic team sport, demands a unique blend of physical fitness attributes to excel. Players' fitness levels significantly impact their performance, injury susceptibility, and overall well-being. Understanding these relationships is crucial for injury prevention and optimizing player health (1).
- It is a fast-paced team sport that combines skill, strategy, and athleticism. Played on grass or artificial turf, it captivates players and spectators alike with its intensity and precision (1).
- Over the past two decades, field hockey has undergone remarkable transformations. Previously, games lasted 70 minutes, with a five-minute halftime break after 35 minutes of play. However, in the modern era, hockey has evolved into a fast-paced, highly skilled team sport (1).
- The game now comprises four 15-minute quarters, alternating between explosive bursts of speed and strategic slower movements for rest intervals. A 15-minute halftime break and a 2-minute break between the first and final quarters allow players to recharge. During play, athletes must remain attentive and fully engaged (1).
- Beyond sheer speed, strategic movement plays a pivotal role. Players execute dodges and sprint straightaways at remarkable speeds, adapting to the game's demands. Positional play, a hallmark of both football and hockey, assigns players specific roles. The rapid ball movement necessitates players to be agile, nimble, and well-coordinated, with robust neuromuscular control and postural reflexes (1).
- Positional play assumes paramount importance in team sports like hockey. These sports thrive on a blend of physical fitness factors, granting distinct advantages to players in specific positions, especially at the highest levels of performance where specialization is pronounced (3,10).
- Speed, endurance, and strength are essential on the synthetic hockey surface. To harness each player's unique abilities, exceptional physical conditioning is imperative. In modern hockey, quick attacks involve swift crosses through the midfield, while players without the ball engage in

continuous free running. Positional switches during attacks and emphasis on specific fitness traits—such as speed, endurance, upper body power, flexibility, and agility—define contemporary hockey (1,3).

- Hockey, being a physically demanding sport, exerts unique stresses on players' bodies. Examining the differences in fitness parameters between injured and non-injured players, especially with respect to specific field positions, offers valuable insights for injury prevention, training strategies, and performance enhancement (5,6,12).
- The positional demands within field hockey add a further layer of complexity. Each playing position—forward, midfielder, defender, and goalkeeper—has distinct physical and physiological requirements. Forwards are often involved in repeated accelerations and maximal sprints, requiring explosive power and anaerobic capacity. Midfielders typically cover the greatest distances during a game, necessitating superior aerobic fitness and endurance. Defenders require strength, muscular endurance, and the ability to maintain positional discipline over prolonged periods. Goalkeepers demand exceptional reflexes, flexibility, and strength adapted to explosive, short-duration actions. Modern sports science evidence underlines significant disparities in match activity profiles and physiological loads based on these positions, which in turn necessitates position-specific fitness assessments and tailored training programs.
- Recognizing and addressing these positional differences is essential for optimizing individual and team performance, as well as for designing effective injury prevention strategies (3,10).
- Injury remains a pervasive challenge in competitive field hockey, impacting player availability, performance, and career trajectories. The high-intensity and contact elements inherent in play predispose athletes to a range of musculoskeletal injuries, particularly in the lower limbs, but also including upper limb and trunk pathologies. Epidemiological studies report high incidences of strains, sprains, contusions, and ligamentous injuries in elite field hockey populations. Injuries not only result in acute downtime but also have longer-term implications for athletic fitness and performance outcomes. Recovery from injury, therefore, encapsulates not only symptom resolution but also the restoration of comprehensive fitness parameters to pre-injury or superior levels (4,5,11,13).

- Rehabilitation programs in sports utilize a multimodal approach aiming to reinstate strength, endurance, balance, proprioception, and neuromuscular control. Despite the technological and methodological advances in sports physiotherapy and conditioning, evidence suggests that athletes frequently do not achieve complete restoration of fitness parameters by the time of clinical clearance for return to play. Deficits in speed, strength, and agility have been documented post-rehabilitation, which can compromise injury resilience and elevate the risk of recurrent injury. Furthermore, the path to recovery is often complicated by the positional demands on athletes; for example, a midfielder may experience persistent endurance deficits, whereas a forward may face challenges in regaining explosive sprint capability. These discrepancies highlight the need to analyse rehabilitation success through the lens of positional specificity (6,7,13,14).
- Research into functional and individualized training interventions post-injury has yielded promising results. Studies have demonstrated that complex contrast training and functional rehabilitation protocols can enhance critical fitness components—such as muscular power, aerobic capacity, and flexibility—post-injury. These interventions support not only physical recovery but also biochemical and biomechanical adaptations that are crucial for sustainable athletic performance. Additionally, wearable technologies and sports performance analytics now enable practitioners to monitor workload, fatigue, and fitness progression with unprecedented precision, facilitating position-specific adjustments in rehabilitation and conditioning regimens (8,9,15,16).
- From a clinical and practical perspective, understanding the variation in fitness parameters between injured and non-injured players post-rehabilitation is essential. Such knowledge aids clinicians, coaches, and sports scientists in identifying residual deficits, refining return-to-play criteria, and customizing training programs to player needs. Injury prevention strategies are also improved as modifiable risk factors particular to positions and injury history become clearer¹. Tailored management of training loads and recovery interventions ultimately contribute to enhanced player safety, improved performance metrics, and longer athletic careers (5,7,11,14).
- Despite the growing body of research on injury patterns and rehabilitation methodologies in field hockey, there is a notable gap in the explicit comparison of fitness outcomes post-rehabilitation between injured and non-injured players across different playing positions. This gap is critical

because injury recovery success and performance readiness cannot be generalized across positions given the biomechanical and physiological demands unique to each role (13,18). The present investigation, therefore, seeks to address this research gap by quantifying and comparing fitness parameters in injured field hockey players following rehabilitation with their non-injured peers, stratified by playing position.

- This study will assess key fitness parameters including aerobic endurance, muscular strength, anaerobic power, speed, and agility known to influence performance and susceptibility to injury in field hockey. By analysing differences across forwards, midfielders, defenders, and goalkeepers, it aims to contribute nuanced insights into position-specific recovery patterns and residual deficits post-injury. The findings are anticipated to inform the development of more precise rehabilitation protocols, training modifications, and individualized player monitoring systems that align with the tactical and physical realities of high-level field hockey.
- In summary, field hockey's demanding physical nature, coupled with the distinct positional roles and high injury incidence, underscores the importance of understanding fitness outcomes post-rehabilitation. This study intends to provide a comprehensive analysis to inform sports health professionals and performance staff on optimizing recovery, injury prevention, and performance enhancement in injured versus non-injured athletes across playing positions. This aligns with broader objectives of advancing sports physiotherapy science and elevating athlete care standards in competitive field hockey contexts.

NEED FOR STUDY

Understanding How Fitness Parameters Vary Between Injured And Non-injured Players, Particularly Considering Specific Field Positions, Can Provide Valuable Insights For Injury Prevention, Training, And Performance Optimization.

AIM & OBJECTIVES OF THE STUDY

The study aims to address the significant differences in fitness parameters between field hockey players who have sustained injuries and those who have not, particularly across various field positions. Understanding these differences is crucial for developing targeted training and rehabilitation programs that can enhance player performance and reduce the risk of future injuries

OBJECTIVES OF THE STUDY

1. Identify Relevant Fitness Parameters: Determine the key fitness parameters relevant to hockey performance, such as cardiovascular endurance, strength, agility, and flexibility.
2. Differentiate by Field Position: Investigate how these fitness parameters differ across various field positions (e.g., forwards, midfielders, defenders, goalkeepers).
3. Comparative analysis : between injured Vs. Non- injured field hockey players

REVIEW OF LITERATURE

1. Daljit Kaur and Dr. Amandeep Singh et al. (2023) explored how playing positions influence physical fitness attributes such as shoulder strength, abdominal strength, speed, agility, and endurance in female field hockey players. The research compared forwards, midfielders, defenders, and goalkeepers on these parameters, revealing that only speed significantly varied among positions based on one-way ANOVA results.
2. A study by Vikki Leslie et al. (2012) examined physiological and match-related characteristics of field hockey players considering age, sex, and playing level. Findings indicated that although high maximal oxygen uptake is crucial for elite players at junior and senior levels, it does not distinctly separate playing standards. Instead, short-distance speed and technical skills are key performance differentiators. The physical demands during matches were notably consistent between elite juniors and seniors, explaining the necessity of aerobic power even at younger levels. Differences in high-intensity match performance were evident between elite and sub-elite players, supporting the use of both laboratory and field assessments to predict match performance.
3. Jaganjyoti Das et al. (2023) conducted an epidemiological investigation into injury patterns among field hockey players, analyzing variables such as anatomical injury sites, gender, playing positions, injury circumstances, severity, and associated downtime. Using data from 179 participants collected through structured interviews, the study found an injury prevalence of 17.9%, with a higher two-year cumulative prevalence (34.6%) and an incidence rate of 8.38%. Lower limb injuries predominated (65.6%), particularly affecting the anterior leg and knee. Practice-related and non-contact injuries were more frequent than match and contact injuries. Previous injury history was significantly correlated with current injury prevalence. The study highlights the importance of early injury reporting, thorough recovery, and consistent physiotherapy and injury prevention interventions.
4. Barboza et al. (2018) studied injury prevalence and characteristics in elite field hockey players during the 2015-2016 Dutch season. Out of 74 analyzed players, 70% reported injuries totaling 112 cases, with 78% requiring medical care and 50% resulting in training or competition absences. Non-contact mechanisms accounted for the majority of injuries. Overall injury prevalence was 29%, with acute injuries constituting 9% and overuse injuries 14%. Players sustained 3.5 new acute injuries per 1,000 training

hours and 12.3 per 1,000 competitive hours. Median severity scores suggested moderate injury impact.

The authors stressed the critical need for injury prevention to protect players' performance and health.

5. Leelavathy MJ and Madhu GR (2021) provided an overview of common injuries encountered by female field hockey athletes. A sport with deep historical roots and global reach, field hockey is second in team sport popularity only to soccer. Injuries can have serious, sometimes lifelong consequences, including chronic conditions such as osteoarthritis particularly related to knee and ankle damage. Although complete injury eradication is challenging, reducing injury rates through competent coaching and preventive measures is vital. Most injuries reported were classified as less severe, with sprains, strains, dislocations, and lower back pain being the most prevalent types.
6. Raquel Silva Lemos, Gabriel Andrade Paz, and colleagues (2017) investigated relationships between body composition, explosive power (Sargent jump test), core endurance, agility (shuttle run), and sport-specific repeated sprint tests with and without the ball in professional female Brazilian field hockey players. Moderate correlations emerged between shuttle run and repeated sprint tests, as well as between body fat percentage and sprint ability. Other assessed variables showed weak or no significant associations. The authors suggested including shuttle run tests in training protocols and emphasized maintaining optimal body fat for peak hockey performance.
7. Research by Noblett et al. (2023) studied the physical and physiological demands placed on national-level male hockey players using GPS and heart rate monitoring. Over an average 52-minute playtime, players covered nearly 6 kilometers, with attackers accruing the most distance and defenders the least. High-intensity activity measurements averaged 21.4 meters per minute. The study observed decreased total relative distance and moderate-intensity exercise in the match's final quarter, with heart rate metrics fluctuating throughout periods, underscoring the importance of factoring positional demands into athlete conditioning programs.
8. Marrium Bashir and colleagues (2024) performed a cluster randomized controlled trial assessing a twelve-week functional training regimen's effects versus standard training on elite young male field hockey athletes in Pakistan. The intervention group exhibited significantly larger improvements in flexibility, agility (T-agility and Illinois agility tests), and upper-body endurance compared to controls, although no significant speed changes were noted. The results advocate integrating functional training

into hockey-specific conditioning.

9. Ibnu Noufal Kambitta Valappil et al. (2025) explored the impact of twelve weeks of complex and contrast training on physiological and biochemical markers in Indian male field hockey players. In a randomized design including complex training, contrast training, and control groups, vital capacity and VO₂max improved significantly in both intervention groups, with the complex training group showing the most pronounced enhancement. Resting heart rate and lipid profile components (HDL, LDL) remained unchanged. The study supports tailored complex training to boost respiratory and aerobic function in hockey athletes and calls for longer-term and broader research.
10. Colin Powell, Martinique Sparks, and Cindy Pienaar (2023) investigated positional and temporal variations in physical demands among elite female field hockey players across multiple international matches. Using GPS tracking for 23 athletes, they measured relative distance, player load, and movement intensity within match quarters. Defenders exhibited the lowest player load and predominately low-intensity activity; midfielders and forwards engaged in more high-intensity running. Across all positions, activity generally decreased from the first to the final quarter, though high-intensity efforts were maintained. Peak performance tended to occur in the second quarter, highlighting fatigue effects mid-game and the potential benefit of re-warming and strategic substitutions to optimize running performance.
11. Chris Bishop, Jon Brazier, Jon Cree, and Anthony Turner conducted a needs analysis for field hockey which identified repeated sprint ability (RSA) and aerobic capacity as pivotal for player performance. They emphasized sport-specific physical characteristics including speed, agility, strength, and power. The authors proposed several field tests such as interval shuttle runs for aerobic fitness, repeated sprint tests for RSA, and sprint and dribble assessments for acceleration and agility. They also stressed the importance of strength and power development to improve performance and mitigate injury risk. The study concluded that multi-faceted conditioning programs focusing on RSA and aerobic fitness are essential for elite field hockey competition.
12. Mayuri A. Khatavkar, Shradha Pawar, and Sayali Kedare (2025) conducted a cross-sectional survey involving 363 field hockey players in Maharashtra, India, spanning elite and recreational levels and multiple positions. Using the Nordic musculoskeletal pain questionnaire, they found the highest pain

prevalence in the lower back, affecting 34% overall, with males predominantly reporting lower back pain and females reporting significant neck pain. Pain distribution varied by position with goalkeepers reporting high knee pain (47%) and defenders more frequently experiencing lower back pain (47%). Elite players exhibited higher lower back pain rates than recreational counterparts. The study highlighted biomechanical and postural stresses—in particular the crouched posture typical in field hockey—as contributors to spine strain and overuse injuries, recommending targeted injury prevention focused on posture, strength, and flexibility tailored to positional needs.

13. Minkyung Choi and Kihyuk Lee (2025) analyzed injury patterns related to training among elite middle and high school field hockey players in Korea. Surveying 374 athletes aged 13-18, they reported no significant gender-based differences in injury prevalence but noted a lower injury rate in high school level compared to middle school athletes. The ankle and knee were most commonly injured, with males more affected by muscle injuries and females more by ligament injuries. Warm-up and cool-down exercises were commonly cited preventive measures. The findings underscore the vulnerability of younger athletes to injuries and the importance of targeted prevention programs emphasizing strength, balance, and proprioception.
14. Violeta Sánchez-Migallón et al. (2024) conducted a four-month in-season cohort study of fourteen semi-professional female field hockey players competing in Spain's 2nd Division. Monthly monitoring included maximal isometric strength of knee flexion and hip adduction/abduction, range of motion for hip flexion and ankle dorsiflexion, neuromuscular performance via countermovement jump height, and perceived fatigue. Results showed progressive strength gains in knee flexors and hip muscles, enhanced hip flexion mobility, but reduced ankle dorsiflexion over the period. Neuromuscular performance fluctuated, with a dip during congested match weeks, while fatigue and wellbeing measures remained stable. This highlights dynamic neuromuscular adaptation during the season and provides insight for optimizing recovery and injury prevention strategies.
15. The NL Sports Centre High Performance Program Staff designed a physical fitness testing battery for hockey players, including assessments of lower body power (vertical jump), upper body power (medicine ball throw), speed (30m sprint), and aerobic fitness (beep test). The battery supports critical coaching functions such as athlete selection, monitoring development, and guiding individualized

training programs. The document includes standardized test protocols and normative data to benchmark athlete performance in Atlantic Canada.

16. Ivan Baptista and colleagues examined position-specific physical demands in professional football players using time-motion and accelerometer data from 23 matches spanning two seasons. They analyzed sprinting, acceleration, deceleration, and turning actions across five positions: central backs, full-backs, central midfielders, wide midfielders, and central forwards. Central backs and midfielders displayed lower work-rates for high-intensity efforts compared to wide midfielders, full-backs, and forwards. Full-backs and wide midfielders performed more sharp directional changes over 90 degrees. High-intensity runs for central players were typically short-distance (1-5 meters), while full-backs covered longer distances (6-10 meters) at high speeds. These findings emphasize the necessity of position-tailored training focusing on sprinting, turning, and acceleration to optimize performance and reduce injury risk.
17. Fernando Dominguez-Navarro et al. studied 90 elite young female basketball players aged 13-17 to investigate the influence of explosive strength, dynamic balance, and anthropometric factors on single-leg hop test performance. Using countermovement jumps (CMJ), Y Balance Test, and hop tests, they found moderate correlations between CMJ outcomes and hop distances, highlighting explosive strength as a key predictor. Dynamic balance showed smaller but significant relationships with hop test results, while anthropometric variables and age were not significant predictors. Regression analysis confirmed that CMJ and balance scores together account for a significant proportion of hop test performance. These results advocate for incorporating plyometric and balance training in injury prevention for youth female athletes.
18. Farjana Akter Bobby and Manisha Badhan assessed aerobic endurance in 60 female cricket players (30 bowlers, 30 batters) using the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1). Bowlers significantly outperformed batters in total distance covered, attained levels, and estimated VO₂ max, suggesting superior aerobic capacity likely reflecting training demands. The YYIR1 demonstrated validity and reliability in distinguishing endurance fitness among female cricket players.
19. Erkal Arslanoglu et al. evaluated acceleration (10m) and sprint (30m) performances among 50 young soccer players of varying positions: goalkeepers, defenders, midfielders, and forwards. Forwards and defenders showed the best acceleration and sprint times, with goalkeepers scoring the lowest. However,

- differences were not statistically significant, probably due to comparable training backgrounds. The study implies that positional differences in sprint and acceleration might be minimal in amateur levels.
20. The International Hockey Federation (FIH) and Australian Hockey Authorities published guidelines detailing the minimum standards for the Yo-Yo Intermittent Recovery Test and sprint times required across various umpire panels internationally and nationally. The protocols specify testing procedures, reporting schedules, and licensing requirements, including injury reporting and medical clearance criteria needed for tournament eligibility.
 21. Field Hockey BC published a protocol for conducting the Yo-Yo Intermittent Recovery Test Level 1, outlining the test's rationale, step-by-step procedures, and pre-test preparations including hydration, rest, and nutrition. The protocol is intended to assess aerobic fitness progression among field hockey athletes at regional to national competitive levels, emphasizing standardized application for consistent results.
 22. National Testing Authorities (Canada) released comprehensive physical fitness testing protocols for male athletes aged U17 to U20. Tests include lower body power (squat jump, countermovement jump, drop jump), horizontal jump, upper body power (seated medicine ball throw), speed (40m sprint), agility (5-10-5 shuttle), aerobic capacity (Leger Boucher 20m shuttle), anaerobic endurance (Repeated High Intensity Endurance Test, Wingate test), and anthropometric measurements. Detailed guidelines ensure reliable athlete profiling and individualized training programming.
 23. Dragan Mijatovic et al. conducted a prospective study involving 129 professional male football players, investigating how change of direction speed (CODS) and reactive agility (RAG) predict injury risk. Findings showed that greater playing time and poorer reactive agility on the non-dominant side significantly increased injury susceptibility, while CODS was not a significant predictor. This underlines the importance of developing reactive agility, especially on the non-dominant limb, for injury prevention in football.
 24. Movement For Life Physiotherapy for Hockey Northern Territory provided guidelines for elite hockey physiotherapists outlining roles in athlete fitness screening before tournaments, daily treatment scheduling, travel and accommodation logistics, game-day responsibilities, postgame recovery, and injury documentation. The guidelines emphasize systematic athlete monitoring, communication with coaching staff, and preventive strategies to maintain player health and optimize on-field performance.

25. Dhruv Bhalla conducted a comparative study investigating motor fitness variables including abdominal strength, speed, and agility between state and national level hockey players aged 17 to 25 years. Standard test procedures such as shuttle runs for agility, 50-meter sprints for speed, and bent-leg sit-ups for abdominal strength demonstrated that national-level athletes had significantly superior motor fitness scores than state-level players. These differences are likely attributable to variations in training intensity, playing conditions, and strategic approaches at different competitive levels.

METHODOLOGY

Participants: A cross-sectional observational study was conducted on 92 field hockey players recruited from the Hockey Academy, Nagpur, Maharashtra, and other recognized hockey clubs in India[1]. Ethical clearance for the present study was obtained from the Institutional Ethics Committee of Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Bhubaneswar, prior to the commencement of the study (Protocol ID: ABS-MPT-2023-28)[1]. The participants included male and female hockey players aged 18–30 years, all of whom had active participation in competitive field hockey and represented various playing positions including forwards, midfielders, defenders, and goalkeepers[1]. Players were selected using the convenience sampling method and included both right- and left-dominant athletes[1]. Players with a recent musculoskeletal injury (within the last 6 months) were included in the injured group, while those with no recent injury history formed the non-injured group[1]. Exclusion criteria comprised refusal to provide informed consent, presence of pre-existing medical conditions or severe injuries affecting fitness assessment participation. The sample was equally divided into two groups: 46 injured and 46 non-injured field hockey

Sample size calculation:

The literature was not available to get the values of mean and standard deviation of injured and non injured hockey players. So pilot study of 30 injured and 30 non injured hockey players was conducted to find the Mean and Standard deviation of RSA (Total sprint time). Sample size is calculated by using

following parameters obtained from the pilot study.

Mean of the RSA (Total sprint time) in Non injured group = $\bar{x}_1 = 28.84$ seconds

Mean of the RSA (Total sprint time) in injured group

$$= \bar{x}_2 = 30.06 \text{ seconds}$$

Standard deviation of the RSA (Total sprint time) in Non injured group = $s_1 = 1.54$ seconds

Standard deviation of the RSA (Total sprint time) in injured group = $s_2 = 2.50$ seconds

Value of normal deviate at 95% level of confidence for two sided test = $Z_1 = 1.96$

Value of normal deviate at 80% power of the study = $Z_2 = 0.842$

$$\text{Formula : } n = \frac{(s_1^2 + s_2^2)(z_1 + z_2)^2}{(\bar{x}_1 - \bar{x}_2)^2}$$
$$= 45.47 \approx 46$$

Minimum sample size is 46.

Hence 46 non injured hockey players and 46 injured hockey players were included in the study.

MATERIALS USED

1. Marked Track
2. Stopwatch
3. Timing Gates
4. Jump Mat
5. Medicine Ball
6. Marking Cones.
7. Measuring Tape (>30m)
8. YYIRT L1 Test Audio With Loudspeaker (Volume Of Speaker Is Particularly Important)
9. Performance Recording Sheet.

PROCEDURE

7.1 Speed Assessment: 30-meter Sprint

The 30-meter sprint test is performed to measure an athlete's acceleration and speed over a short distance. To conduct the test, a flat and clear surface is first marked with two cones or markers to designate the start and finish lines, exactly 30 meters apart. The athlete begins in a stationary position with one foot placed on or just behind the starting line and remains still for about two seconds before the sprint begins, avoiding any movements such as rocking. On a start command like "Ready, set, go," the athlete sprints forward as fast as possible, driving the arms and legs to maximize speed and maintain proper sprinting form. A stopwatch is used to time the sprint, starting at the initial movement or at the starting signal and stopping as soon as the athlete's torso crosses the finish line. Typically, two or three trials are conducted with adequate rest between attempts, and the fastest time recorded is used for performance evaluation. Proper warm-up including dynamic stretches and practice starts is essential before the test to reduce injury risk and ensure the athlete is prepared for maximal effort. Accurate timing and consistent testing conditions are vital for reliable results that can inform training and monitoring of speed development.

7.2 Lower Limb Power: Vertical Jump Test

To determine lower body power, participants performed a vertical jump using a Just Jump mat. They were instructed to utilize maximal arm swing and explosive force. Successful completion required participants to land stably without stepping backward or altering foot placement. Each athlete was offered two trials, with only the superior score considered. This ensured data reliability by prioritizing optimal performance.

7.3 Upper Body Strength & Power: Seated Medicine Ball Throw/Pass

Upper Extremity strength and power were determined using the seated medicine ball throw protocol. Subjects sit on ground with extended legs, maintaining full back contact against a wall. After holding the medicine ball at chest level for two seconds and receiving an auditory start signal, they executed the throw. One practice session was allowed for technique familiarization, followed by two measured attempts. The greatest distance, measured to the nearest 0.1m, was documented. Measurement tape was aligned adjacent to the athlete, and a hard rubber-coated medicine ball was used to maintain consistent force transfer. Multiple

assistants recorded, marked, and retrieved the ball for procedural efficiency.

7.4 Aerobic Capacity: Yo-Yo Intermittent Recovery Test Level 1

Aerobic fitness is evaluated using the Yo-Yo Intermittent Recovery Test (YYIRT Level 1), a standardized protocol designed for intermittent exercise capacity assessment. Participants performed sequential 20-meter shuttle runs at increasing speeds, paced by audio cues. The test began with slower bouts, progressing to intensified speed increments every 320 meters. Intervals between sprints included brief 10-second active recovery jogs. Testing continued until volitional exhaustion or two consecutive failures to reach the designated line, with total distance covered serving as the endurance score.

7.5 Change-of-Direction Speed: 5-10-5 Agility Shuttle

Agility assessment involved the 5-10-5 shuttle, a test requiring rapid directional changes. Athletes started in a balanced stance with forward hand contact on the central cone. Following a brief hold, they sprinted to the lateral line (5 yards), touched the line, reversed direction to the opposite end (10 yards), and finished by crossing the start/finish line. Timing gates and cone markers ensured consistent measurement of completion time, with flat, unobstructed surfaces used for accuracy.

7.6 Anaerobic Capacity: Repeated High Intensity Endurance Test-Repeated Sprint Ability (RHIET)/REPEATED SPRINT ABILITY(RSA)

The RHIET measured anaerobic output and fatigue resistance via repeated 40-meter sprints, performed at preset intervals over a marked course. Athletes sprinted from start to endpoint, turned, and returned, with timing lights documenting each phase. Six maximal effort repetitions were completed, each starting at 30-second increments. The decrement in speed between the first and final sprints provided insights into the maintenance of high-intensity performance, pivotal for field hockey-specific demands.

7.7 Adductor Strength: Copenhagen Holds

Adductor muscle endurance was assessed using modified Copenhagen holds. Participants began side-lying, with the elevated leg positioned on a stable surface and supporting themselves via the forearm. After lifting the hips to establish a straight body alignment and maintaining contraction for 15–30 seconds, time held was recorded. Both sides were tested to evaluate bilateral strength and symmetry critical for injury prevention.

7.8 Flexibility Assessment: Sit and Reach

Flexibility was examined through the Sit and Reach test following an appropriate dynamic warm-up. Subjects, shoeless, placed feet at the base of a standardized box with knees straight, and reached forward smoothly, maintaining position for at least 2 seconds. Trials were repeated three times, with the highest or mean score documented for analysis. Proper demonstration and instruction preceded the test to ensure valid and reliable results.

7.9 Balance Testing: Single Leg Hop

Balance and functional stability were assessed using the single-leg hop test. Athletes stood on one leg at the start line, performed a maximal forward hop, landed, and maintained balance for two seconds. Distance from start to landing heel was measured precisely; three trials were conducted per limb, separated by short rests. The best performance from each side provided comparative function between limbs, useful for monitoring recovery and risk of reinjury.

7.10 Mobility Screening: Knee-to-Wall and Active SLR

Mobility was evaluated using two protocols. The knee-to-wall test assessed ankle dorsiflexion: athletes bent the knee toward the wall, inching the foot backward until heel lift occurred, and the largest achievable toe-to-wall distance was measured. The active straight leg raise (SLR) gauged hip and hamstring flexibility—with the athlete supine, raising one leg maximally while keeping the contralateral limb and pelvis stable, and hip flexion angle recorded via goniometry or inclinometry.

STATISTICAL ANALYSIS

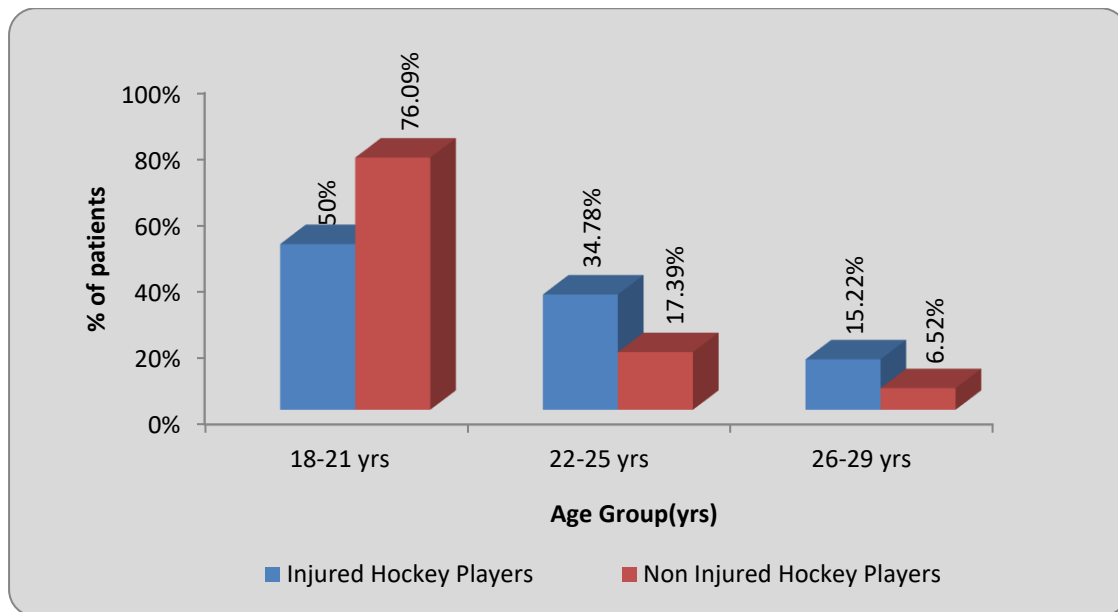
Statistical analysis was done by using descriptive and inferential statistics using Chi-square test and Student's unpaired t- test and software used in the analysis were SPSS 27.0 version and GraphPad Prism 7.0 version and $p < 0.05$ is considered as level of significance.

RESULTS

Table 1: Age wise distribution of patients in two groups

Age Group(yrs)	Injured Hockey Players	Non Injured Hockey Players	χ^2 -value
18-21 yrs	23(50%)	35(76.09%)	6.74 P=0.034,S
22-25 yrs	16(34.78%)	8(17.39%)	
26-29 yrs	7(15.22%)	3(6.52%)	
Total	46(100%)	46(100%)	
Mean \pm SD	21.63 \pm 2.97	20.30 \pm 2.43	
Range	18-28 yrs	18-27 yrs	

Graph 1: Age wise distribution of patients in two groups

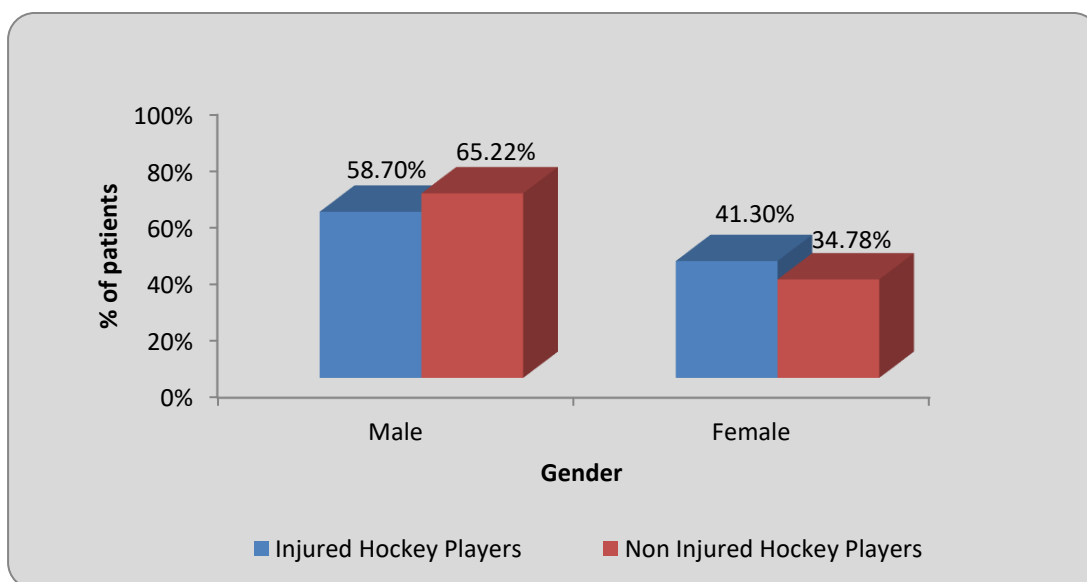


76.09% of the patients in non injured hockey players and 50% in injured hockey players were in the age group of 18-21 years, 34.78% in injured hockey players and 17.39% in non injured hockey players were in the age group of 22-25 years and 15.22% of injured hockey players and 6.52% in non injured hockey players were in the age group of 26-29 years. By using Chisquare test statistically significant difference was found in the ages of the patients of two groups(χ^2 -value =6.74,p-value=0.034).

Table 2: Gender wise distribution of patients in two groups

Gender	Injured Hockey Players	Non-Injured Hockey Players	χ^2 -value
Male	27(58.70%)	30(65.22%)	0.41 P=0.51,NS
Female	19(41.30%)	16(34.78%)	
Total	46(100%)	46(100%)	

Graph 2: Gender wise distribution of patients in two groups

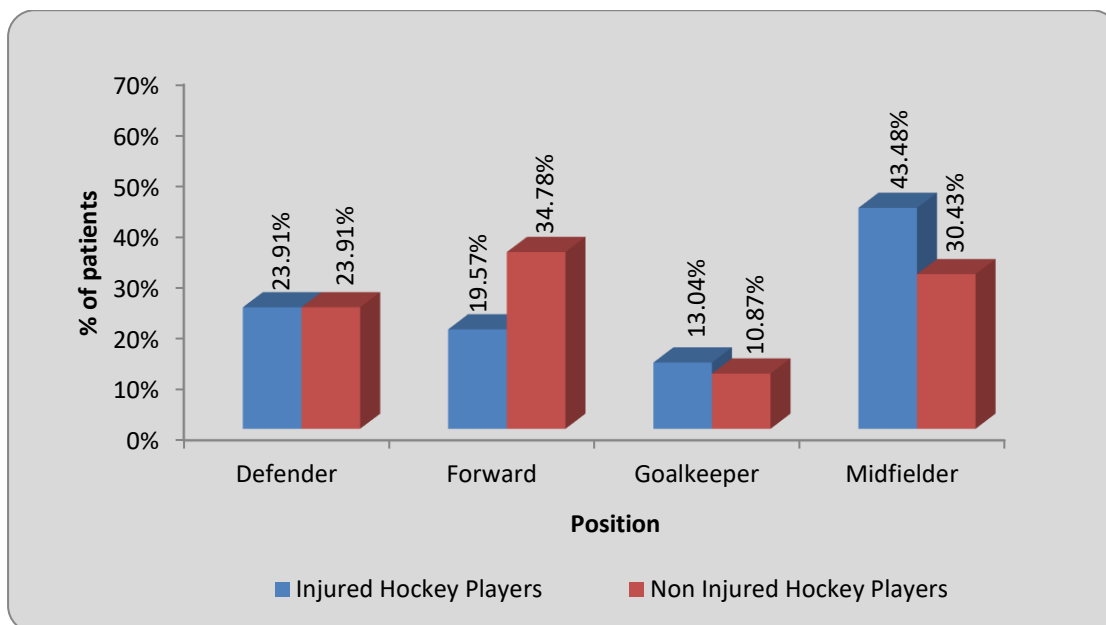


In examining gender distribution, the study demonstrates no statistically significant difference between injured and non-injured groups ($\chi^2 = 0.41$, $p = 0.51$). Males constitute the majority in both cohorts (58.70% injured vs. 65.22% non-injured), while females account for 41.30% in the injured and 34.78% in the non-injured groups. This finding suggests that the risk of injury in field hockey, within this age and skill group, is distributed similarly between male and female athletes. This aligns with existing research indicating comparable injury patterns across genders in field hockey when training intensity and match exposure are similar

Table 3: Position wise distribution of patients in two groups

Position	Injured Hockey Players	Non-Injured Hockey Players	χ^2 -value
Defender	11(23.91%)	11(23.91%)	3.11 P=0.37,NS
Forward	9(19.57%)	16(34.78%)	
Goalkeeper	6(13.04%)	5(10.87%)	
Midfielder	20(43.48%)	14(30.43%)	
Total	46(100%)	46(100%)	

Graph 3: Position wise distribution of patients in two groups

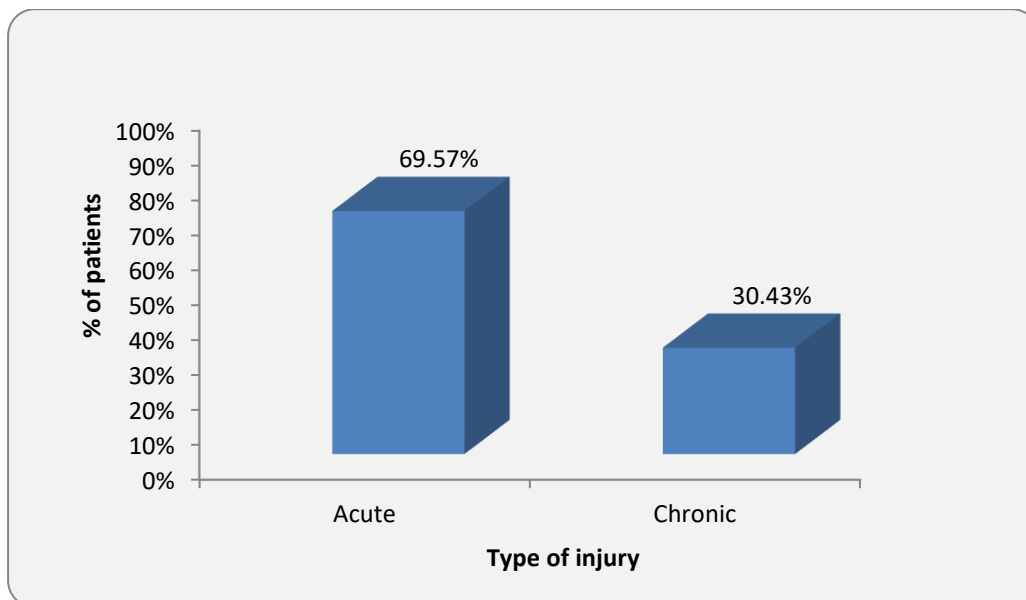


Regarding playing positions, the data indicate no significant association between position and injury occurrence ($\chi^2 = 3.11$, $p = 0.37$). Among the injured players, the highest proportion are midfielders (43.48%), followed by defenders (23.91%), forwards (19.57%), and goalkeepers (13.04%). In the non-injured group, forwards make up a larger share (34.78%) compared to their representation in the injured group, while midfielders, defenders, and goalkeepers are 30.43%, 23.91%, and 10.87% respectively.

Table 4: Comparison of type of injury in injured hockey players

Type of injury	No of patients	Percentage
Acute	32	69.57
Chronic	14	30.43
Total	46	100

Graph 4: Comparison of type of injury in injured hockey players



Within the injured cohort, acute injuries are predominant, making up 69.57% of cases, while chronic injuries account for 30.43%. This finding is consistent with field hockey's intensive, high-speed, and contact nature, leading to more traumatic injuries such as sprains, strains, and contusions. The lower proportion of chronic injuries might reflect seasonal or recent injury surveillance, as well as effective rehabilitation strategies reducing chronicity.

Table 5: Comparison of injury in injured hockey players

Injury	No of patients	Percentage
Achilles tendinopathy	3	6.52
ACL Injury	4	8.70
Acromioclavicular joint sprain	2	4.35
Adductor strain	3	6.52
Ankle sprains	3	6.52
Chronic regional pain syndrome	2	4.35
Chronic Shoulder Instability	1	2.17
Distal femoral fracture	1	2.17
Ear laceration/abrasion	2	4.35
Eyebrow laceration	1	2.17
Groin injury	1	2.17
Hamstring strain	4	8.70
Lumbar disc prolapsed	2	4.35
Lumbar pain	2	4.35
MCL injury knee	3	6.52
Medial and lateral meniscal tears	1	2.17
Patellar dislocation	1	2.17
Proximal biceps tendon injury	2	4.35
Quadriceps strain	4	8.70
Rectus abdominus tendinopathy	1	2.17
Shin splints	1	2.17
Stress fracture tibia at ankle	1	2.17
Thigh muscle hematoma	1	2.17

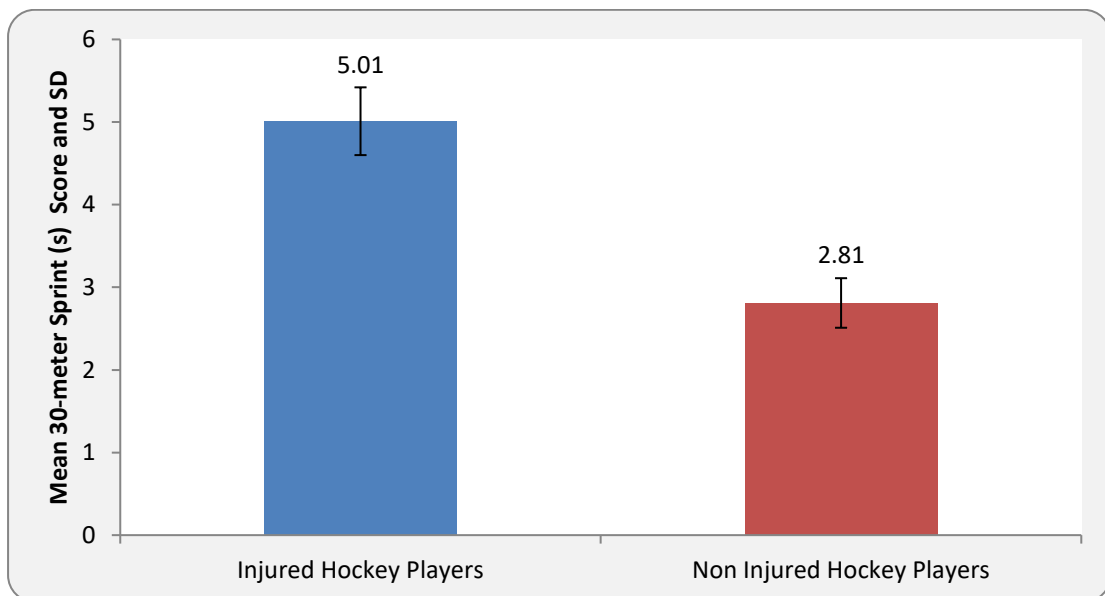
The spectrum of injuries demonstrates that lower limb injuries are most common in this cohort, with ACL injuries (8.70%), quadriceps strains (8.70%), hamstring strains (8.70%), and MCL knee injuries (6.52%)

being among the most prevalent. Other reported injuries include Achilles tendinopathy, ankle sprains, adductor strains, and meniscal tears. This pattern reflects the dynamic and physically demanding actions of field hockey—sprinting, rapid direction changes, and frequent tackles—placing high stress on the lower extremities

Table 6: Comparison of 30-meter Sprint (s) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	5.01	0.41	0.06	28.80 P=0.0001,S
Non-Injured Hockey Players	46	2.81	0.30	0.04	

Graph 6: Comparison of 30-meter Sprint (s) in injured hockey players and non-injured hockey players (Student's unpaired t test)

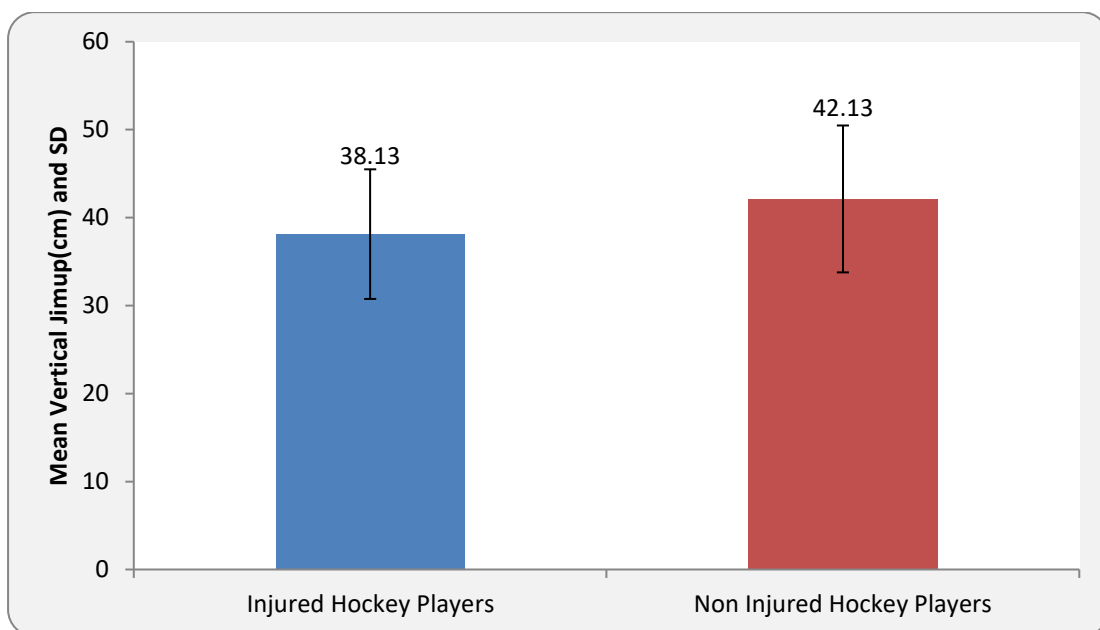


Mean 30-meter sprint(s) score in injured hockey players was 5.01 ± 0.41 and in non-injured hockey players it was 2.81 ± 0.30 . By using Student's unpaired t test statistically significant difference was found in 30-meter sprint(s) score among patients of two groups ($t=28.80$, $p\text{-value}= 0.0001$).

Table 7: Comparison of Vertical Jump(cm) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	38.13	7.37	1.08	2.43 P=0.017,S
Non-Injured Hockey Players	46	42.13	8.35	1.23	

Graph 7: Comparison of Vertical Jump(cm) in injured hockey players and non-injured hockey players (Student's unpaired t test)

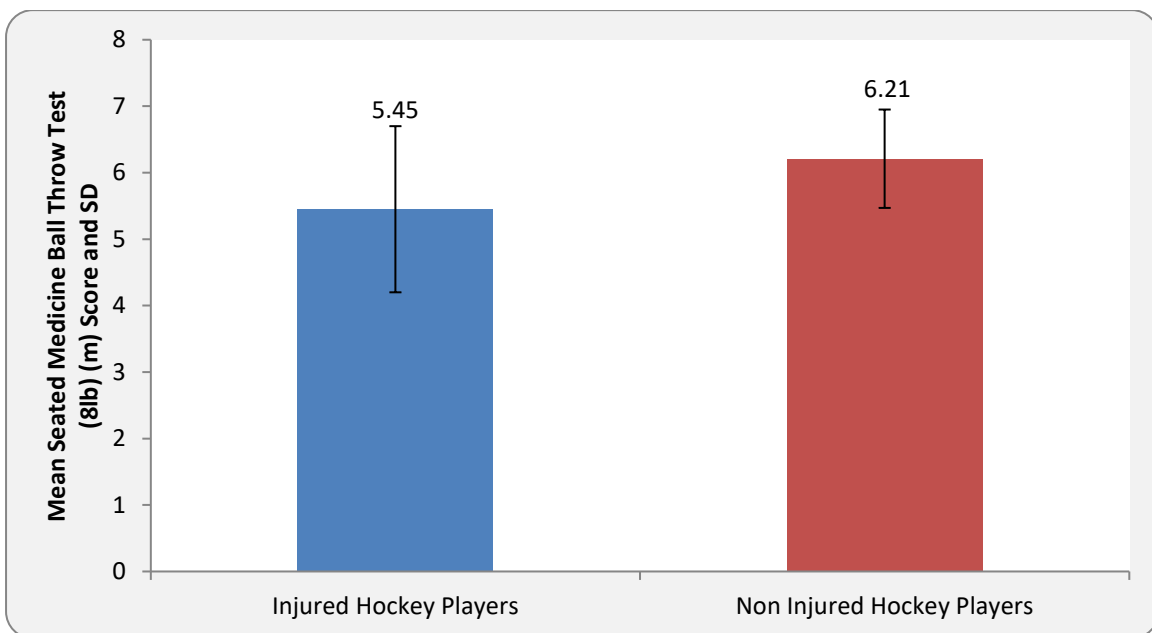


For lower body explosive power, non-injured players achieve higher vertical jumps (42.13 ± 8.35 cm) than injured players (38.13 ± 7.37 cm), with the difference reaching statistical significance ($t = 2.43, p = 0.017$).

Table 8: Comparison of Seated Medicine Ball Throw Test (8lb) (m) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	5.45	1.25	0.18	3.53 P=0.001,S
Non-Injured Hockey Players	46	6.21	0.74	0.10	

Graph 8: Comparison of Seated Medicine Ball Throw Test (8lb) (m) in injured hockey players and non-injured hockey players

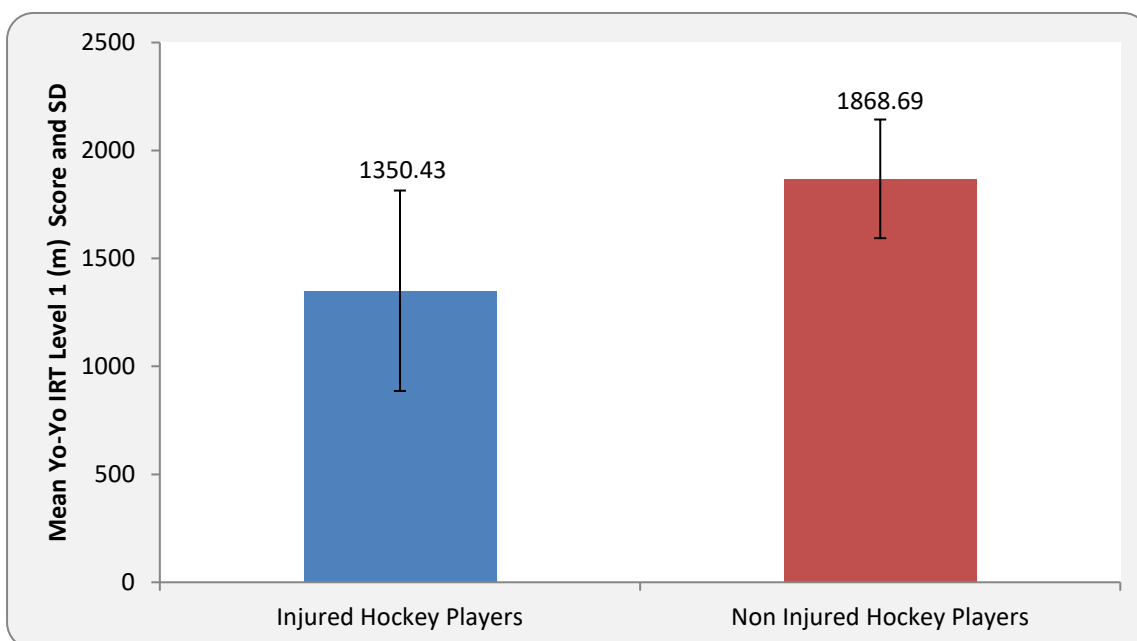


Upper body strength and power, as assessed by the seated medicine ball throw, show a statistically significant difference between groups ($t = 3.53$, $p = 0.001$). Non-injured players have a mean throw distance of 6.21 ± 0.74 meters, whereas injured players reach only 5.45 ± 1.25 meters.

Table 9: Comparison of Yo-Yo IRT Level 1 (m) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	1350.43	464.19	68.44	6.51 P=0.0001,S
Non-Injured Hockey Players	46	1868.69	274.77	40.51	

Graph 9: Comparison of Yo-Yo IRT Level 1 (m) in injured hockey players and non-injured hockey players

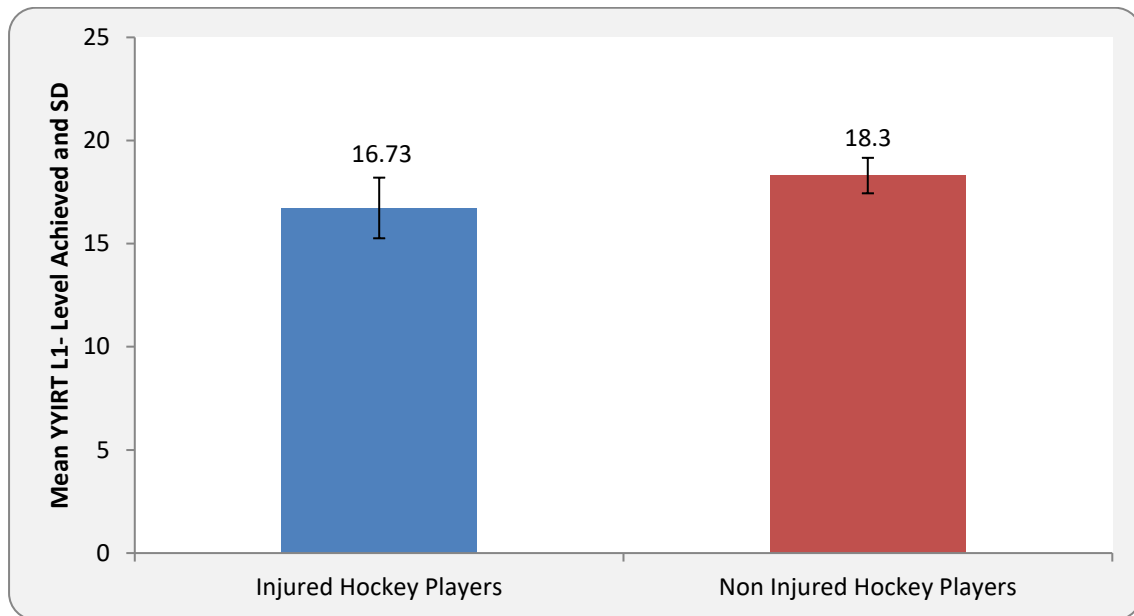


Aerobic capacity, a cornerstone of field hockey performance, is notably impaired in injured players, who achieve a mean distance of 1350.43 ± 464.19 meters on the Yo-Yo IRT L1 test, in contrast to 1868.69 ± 274.77 meters for non-injured players ($t = 6.51, p = 0.0001$)

Table 10: Comparison of YYIRT L1- Level Achieved in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	16.73	1.47	0.21	6.24 P=0.0001,S
Non-Injured Hockey Players	46	18.30	0.86	0.12	

Graph 10: Comparison of YYIRT L1- Level Achieved in injured hockey players and non-injured hockey players

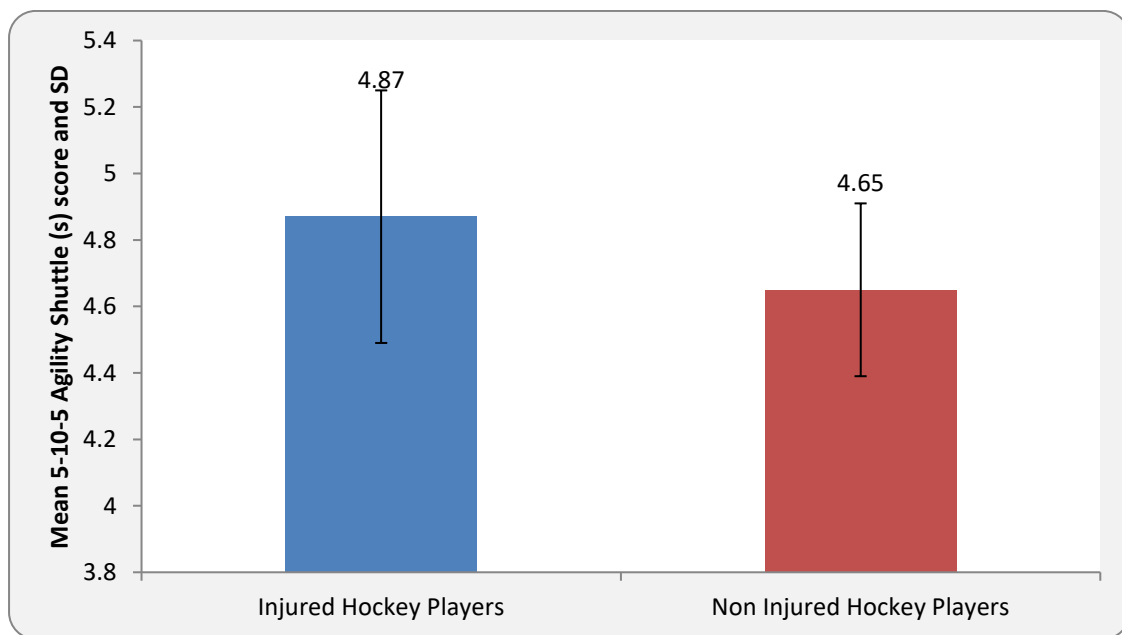


Supporting the previous finding, non-injured players attain a higher mean test level (18.30 ± 0.86) compared to injured players (16.73 ± 1.47), with a significant difference ($t = 6.24, p = 0.0001$). These findings reinforce the argument that aerobic fitness is compromised following injury, affecting the athlete's capacity for prolonged high-intensity efforts during matches

Table 11: Comparison of 5-10-5 Agility Shuttle (s) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	4.87	0.38	0.05	3.28 P=0.001,S
Non-Injured Hockey Players	46	4.65	0.26	0.03	

Graph 11: Comparison of 5-10-5 Agility Shuttle (s) in injured hockey players and non-injured hockey players

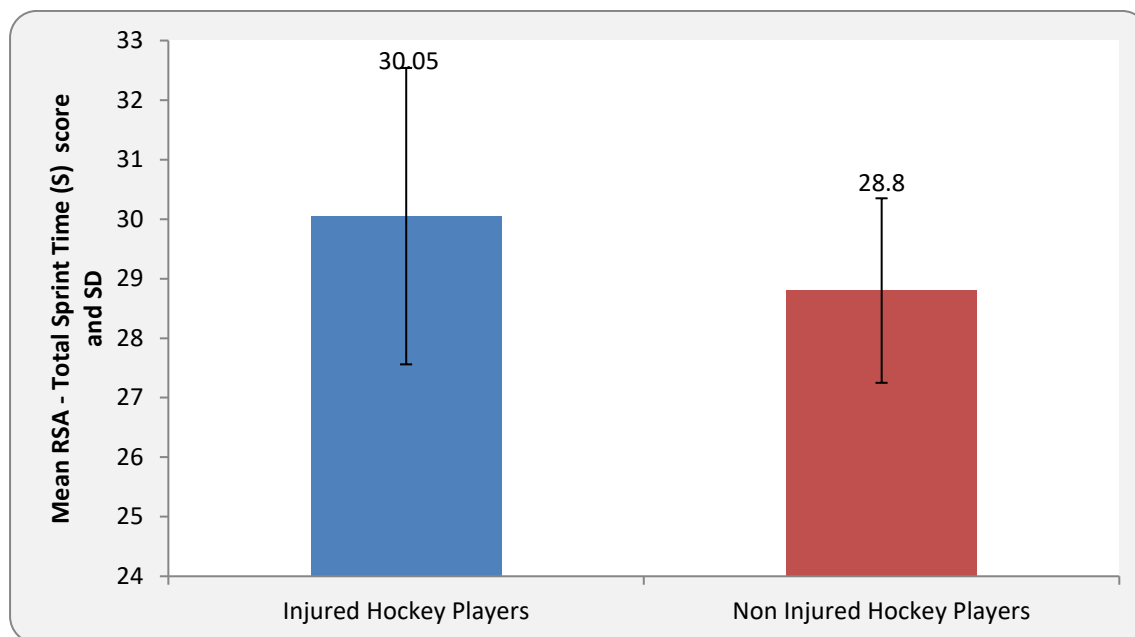


Agility performance, measured by the 5-10-5 shuttle test, is significantly better in non-injured players (4.65 ± 0.26 s) than in those recovering from injury (4.87 ± 0.38 s; $t = 3.28$, $p = 0.001$). The difference, though modest in absolute value, is critical in a high-speed, reactive sport like field hockey, where milliseconds can determine possession and scoring opportunities.

Table 12: Comparison of RSA - Total Sprint Time (S) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	30.05	2.49	0.36	2.89 P=0.005,S
Non-Injured Hockey Players	46	28.80	1.55	0.22	

Graph 12: Comparison of RSA - Total Sprint Time (S) in injured hockey players and non-injured hockey players

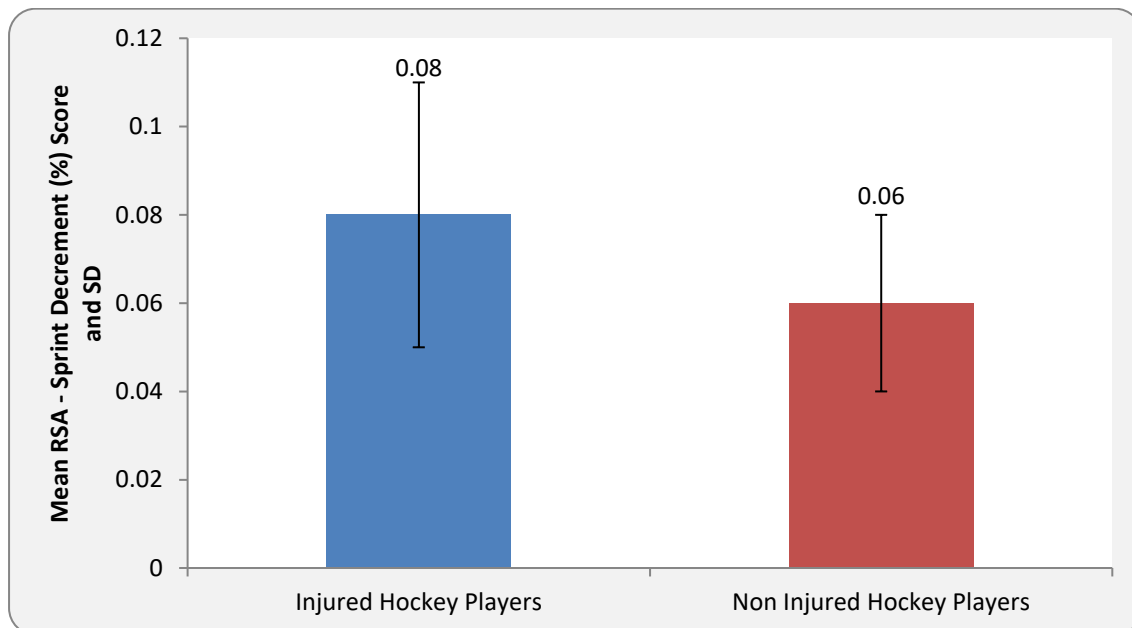


Anaerobic performance, as quantified by total sprint time in the Repeated Sprint Ability (RSA) test, is better in non-injured players (28.80 ± 1.55 s) than injured players (30.05 ± 2.49 s)—a significant difference ($t = 2.89$, $p = 0.005$).

Table 13: Comparison of RSA - Sprint Decrement (%) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	0.08	0.03	0.004	2.35 P=0.025,S
Non-Injured Hockey Players	46	0.06	0.02	0.003	

Graph 13: Comparison of RSA - Sprint Decrement (%) in injured hockey players and non-injured hockey players

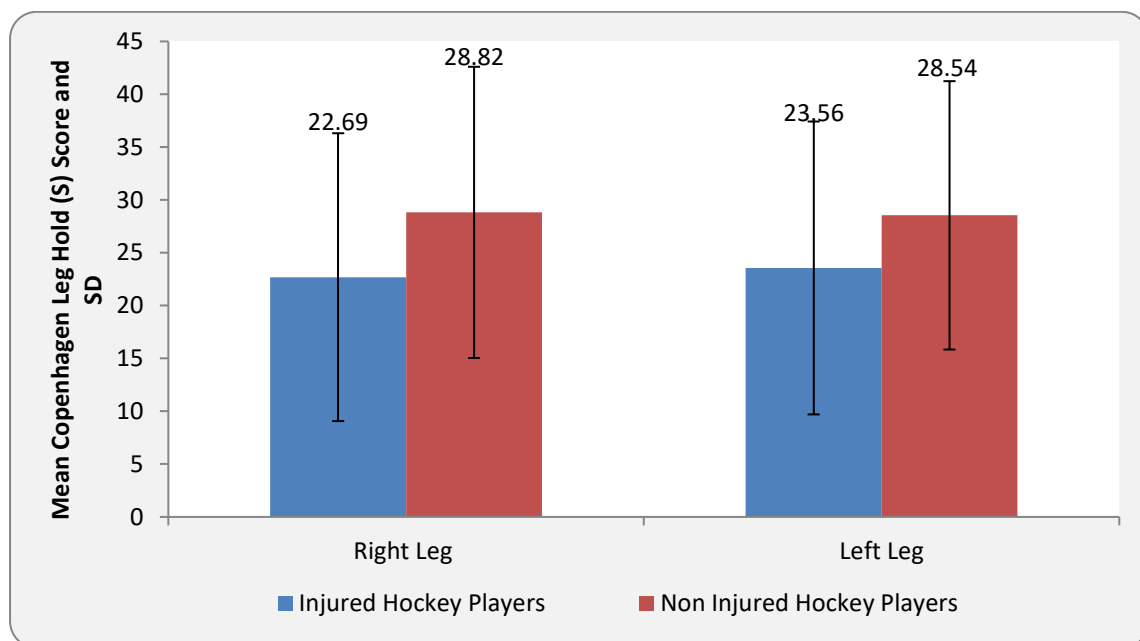


Sprint decrement, which reflects fatigue accumulation across repeated sprints, is higher in the injured group ($0.08 \pm 0.03\%$) compared to the non-injured group ($0.06 \pm 0.02\%$, $t = 2.35$, $p = 0.025$). A greater decrement indicates reduced resilience to high-intensity efforts, translating to decreased effectiveness in repeated explosive activities during a game. This highlights the importance of fatigue resistance and conditioning in post-injury training regimens

Table 14: Comparison of Copenhagen - Right and Left Leg Hold (S) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group→	Injured Hockey Players	Non-Injured Hockey Players	t-value
Right Leg	22.69±13.62	28.82±13.78	2.14 P=0.035,S
Left Leg	23.56±13.86	28.54±12.70	1.79 P=0.076,NS

Graph 14: Comparison of Copenhagen - Right and Left Leg Hold (S) in injured hockey players and non-injured hockey players

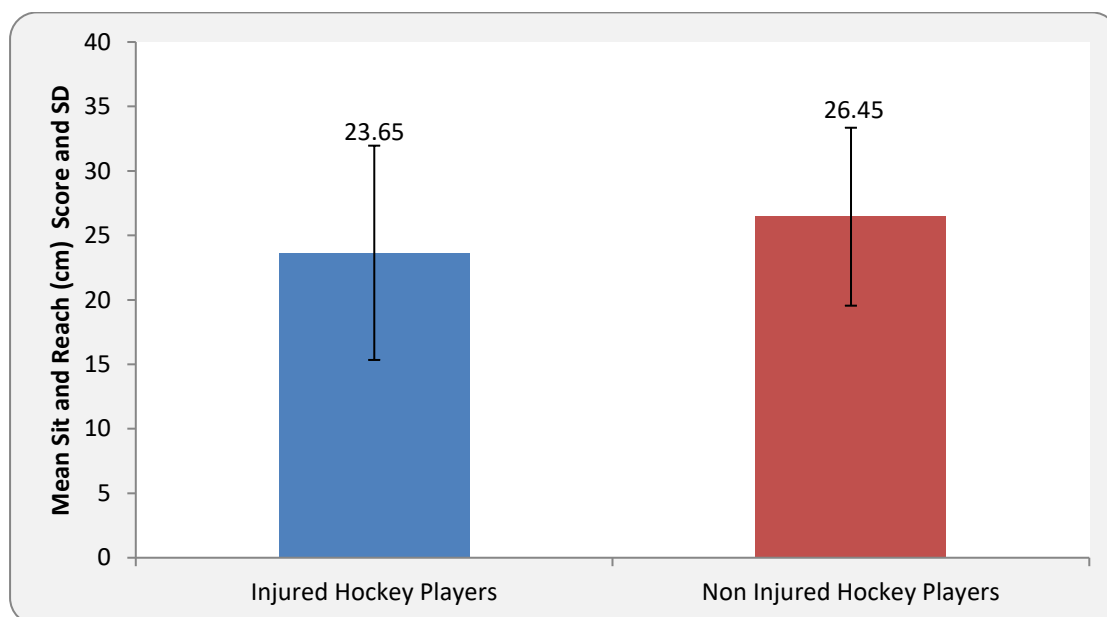


A significant difference is observed in Copenhagen right leg hold times: non-injured players average 28.82 ± 13.78 seconds versus 22.69 ± 13.62 seconds in injured players ($t = 2.14$, $p = 0.035$). However, left leg hold times do not differ significantly ($p = 0.076$)

Table 15: Comparison of Sit and Reach (cm) in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Injured Hockey Players	46	23.65	8.31	1.22	1.75 P=0.082,NS
Non-Injured Hockey Players	46	26.45	6.90	1.01	

Graph 15: Comparison of Sit and Reach (cm) in injured hockey players and non-injured hockey players

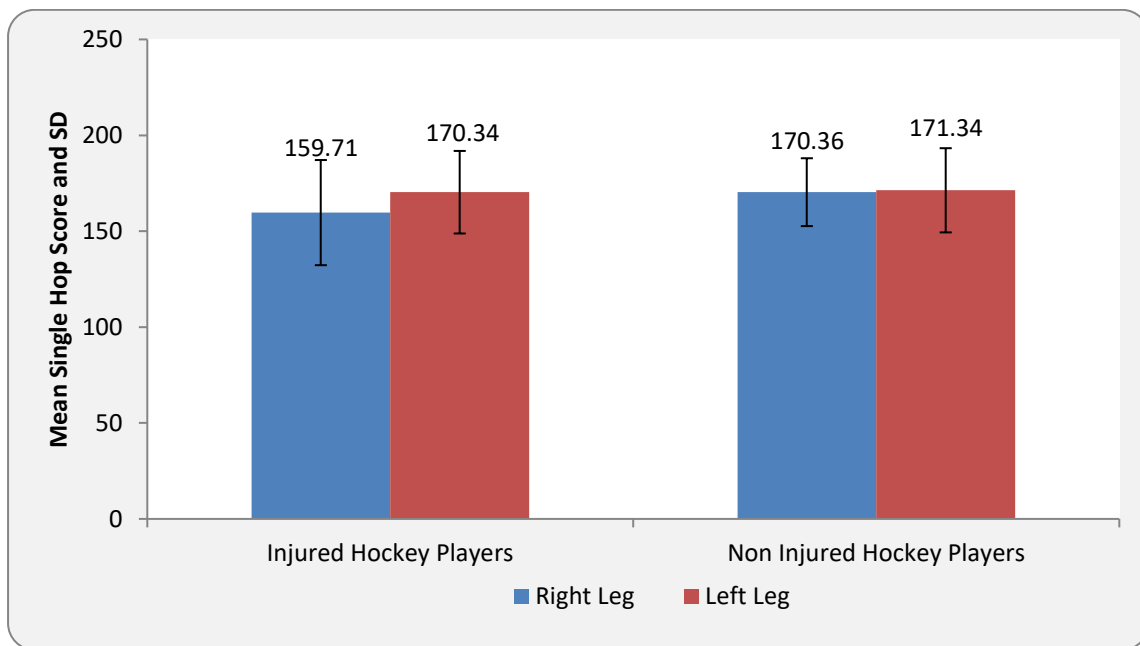


Flexibility, as measured by the sit-and-reach test, does not show a statistically significant difference between groups ($p = 0.082$). Injured players have an average reach of 23.65 ± 8.31 cm compared to 26.45 ± 6.90 cm in non-injured players.

Table 16: Comparison Single Hop of Right and Left leg in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group→	Injured Hockey Players	Non-Injured Hockey Players	t-value
Right Leg	159.71±27.41	170.36±21.52	2.07 P=0.041,S
Left Leg	170.34±17.69	171.34±21.95	0.24 P=0.81,NS

Graph 16: Comparison Single Hop of Right and Left leg in injured hockey players and non-injured hockey players

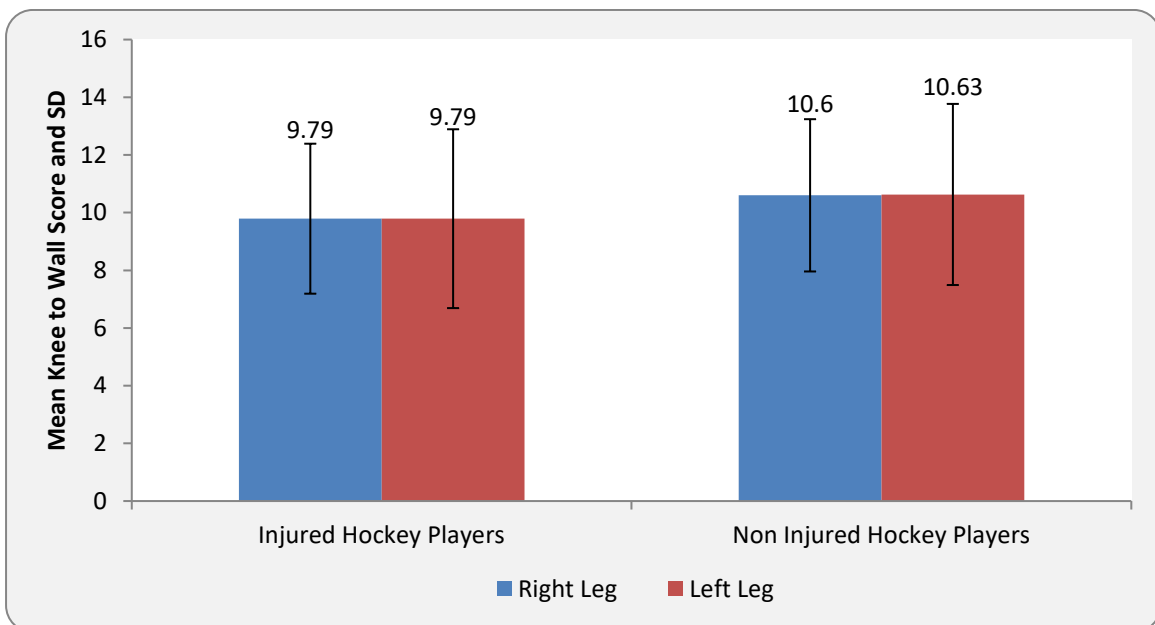


Analysis of single-leg hop distance reveals that for the right leg, non-injured players outperform injured players (170.36 ± 21.52 cm vs. 159.71 ± 27.41 cm, $t = 2.07$, $p = 0.041$), indicating impaired balance and power on the previously injured side. Left leg hop distances are similar between groups ($p = 0.81$). This persistent asymmetry underscores the need for functional, unilateral strength and power training during recovery.

Table 17: Comparison of Knee to Wall(cm) score in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group→	Injured Hockey Players	Non-Injured Hockey Players	t-value
Right Leg	9.79±2.60	10.60±3.10	1.35 P=0.17,NS
Left Leg	9.79±2.64	10.63±3.14	1.38 P=0.16,NS

Graph 17: Comparison of Knee to Wall(cm) score in injured hockey players and non-injured hockey players

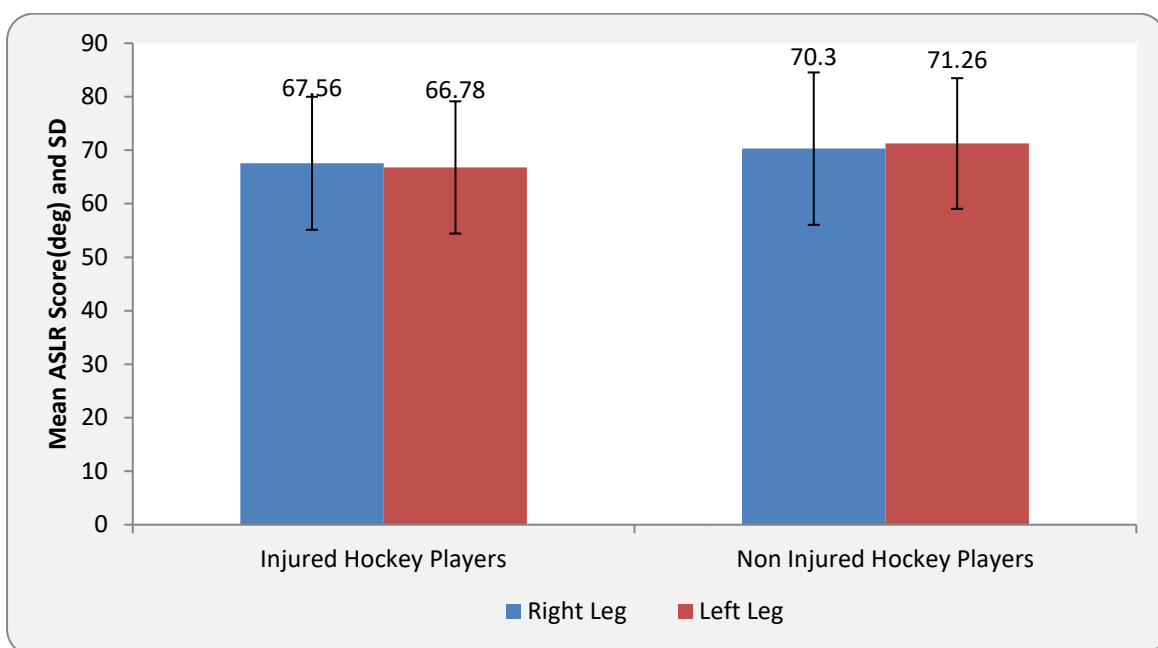


Measurements of ankle dorsiflexion mobility with the knee-to-wall test show no significant difference between groups for either leg ($p > 0.1$), indicating that this aspect of joint mobility recovers well after injury in these athletes.

Table 18: Comparison of ASLR (degree) score in injured hockey players and non-injured hockey players (Student's unpaired t test)

Group→	Injured Hockey Players	Non-Injured Hockey Players	t-value
Right Leg	67.56±12.43	70.30±12.36	1.05 P=0.29,NS
Left Leg	66.78±14.24	71.26±12.21	1.61 P=0.10,NS

Graph 18: Comparison of ASLR (degree) score in injured hockey players and non-injured hockey players



Active SLR, indicating hamstring and hip flexibility, does not differ significantly between injured and non-injured groups for either leg ($p > 0.1$).

DISCUSSION

30 M SPRINT-

The present study revealed a statistically significant difference in the 30 m sprint performance between injured and non-injured field hockey players. Injured players demonstrated a mean sprint time which was considerably slower than recorded by non-injured players. This result highlights that injury status has a profound impact on sprinting ability, which is a critical determinant of performance in field hockey.

Sprint performance in team sports such as hockey is essential because match-play is characterized by repeated bouts of short, high-intensity running and rapid accelerations. Previous studies have emphasized that sprint speed, particularly over short distances (5–30 m), is a distinguishing factor in elite players' performance profiles (Leslie et al., 2012; Noblett et al., 2023)

The slower sprint times among injured athletes may also be linked to persistent deficits following rehabilitation. Even after medical clearance to return to sport, athletes frequently demonstrate residual neuromuscular impairments, decreased explosive power, and psychological hesitation in high-intensity efforts (Jagan Jyoti Das et al., 2023; Barboza et al., 2018)

From a practical perspective, the 30 m sprint test serves not only as a performance metric but also as a sensitive marker of post-injury recovery status. Monitoring sprint times may help physiotherapists and coaches to identify lingering deficits in force production and velocity, guiding the implementation of targeted strength and conditioning interventions. Re-establishing optimal sprint mechanics through neuromuscular retraining, plyometric loading, and resisted sprint drills may be essential to bridging the performance gap observed in this study.

VERTICAL JUMP-

The results of the vertical jump test reveal a statistically significant difference between injured and non-injured field hockey players, with injured players demonstrating a lower average jump height compared to their non-injured counterparts, and this difference reached significance. This discrepancy indicates that injury adversely affects explosive lower-body power, a critical component of performance in field hockey. Explosive power, as measured by vertical jump height, correlates with the ability to accelerate, change direction rapidly, and execute powerful movements during gameplay.

These findings align with existing research emphasizing the importance of lower-body muscular power for elite performance in hockey and other team sports. Notably, Keogh et al. (2002) observed that higher performing female field hockey players achieved significantly greater vertical jump heights, highlighting power as a key differentiator between player standards. Similar conclusions have been reported in soccer, where vertical jump performance correlates with sprinting and agility capabilities (Arslanoğlu et al., 2013).

In addition, impaired jump performance in injured players may reflect residual deficits in neuromuscular function, musculotendinous integrity, and motor control post-injury, which can compromise athletic movements requiring explosive force generation.

Future research should investigate the relationship between vertical jump performance and specific injury types, as well as the effectiveness of targeted interventions in improving both performance outcomes and injury prevention. The development of field hockey-specific normative data across different competition levels, ages, and playing positions would enhance the clinical application of vertical jump testing in this population.

SEATED MEDICINE BALL THROW TEST –

Upper body power, as measured by the SMBT, is essential for effective stick control and forceful ball propulsion in field hockey. The diminished performance in injured players likely reflects residual deficits in muscular strength, coordination, and neuromuscular efficiency post-injury, potentially compounded by time away from training and competition. Such impairments can compromise an athlete's ability to perform match-essential skills at optimal levels, underscoring the importance of targeted rehabilitation.

These findings resonate with established literature on team sports athletes where reduction in upper body power following injury is commonly observed and linked to declines in sport-specific performance. For example, the NL Sports Centre's Hockey Physical Test Battery highlights the importance of measuring upper body power via medicine ball throws as a key fitness component in hockey. Moreover, studies in related sports emphasize integrating upper body strength and power training within rehabilitation programs to restore functional performance (e.g., strength and conditioning protocols for hockey players).

The significant difference observed in our study aligns with established evidence that upper body strength and power deficits are associated with increased injury risk in field hockey players. The 0.76-meter deficit in throwing distance among injured players represents a substantial reduction in explosive power capacity that may reflect underlying neuromuscular dysfunction or compensatory movement patterns.

Considering the demanding upper body dynamics involved in field hockey movements, integrating progressive resistance training and sport-specific power drills during post-injury rehabilitation is vital.

Recovery of upper body power measured through SMBT can serve as a practical benchmark for monitoring rehabilitation progress and readiness to return to competition.

YO-YO IRT LEVEL 1-

The Yo-Yo Intermittent Recovery Test Level 1 (YYIRT L1) results reveal significant deficits in the aerobic and intermittent endurance capacities of injured field hockey players compared to non-injured players.

Injured players covered an average of 1350.43 meters, markedly less than the 1868.69 meters covered by non-injured counterparts, and achieved significantly lower levels (16.73 vs. 18.30), indicating compromised performance in repeated high-intensity exercise crucial for field hockey demands. This aligns with findings from Bangsbo et al. (2008) and Krstrup et al. (2003), who noted YYIRT as a sensitive measure of the ability to sustain high-intensity intermittent work in team sports.

Such reductions in YYIRT performance post-injury likely reflect lingering impairments in cardiovascular fitness, muscular endurance, and recovery mechanisms resulting from injury and rehabilitation processes (Leslie, 2012). This underscores the clinical importance of tailored rehabilitation emphasizing aerobic capacity restoration and intermittent endurance conditioning, which are critical for successful return to competitive play (Boby & Badhan, 2023). Moreover, YYIRT performance has been positively correlated with match activity intensity and overall endurance capacity in intermittent sports, reinforcing its value in monitoring fitness levels and guiding rehabilitation protocols (Bangsbo, Iaia & Krstrup, 2008; Krstrup et al., 2003).

The significant difference in YYIRT results also supports the role of aerobic fitness in differentiating between injury statuses and possibly playing standards in field hockey (Leslie, 2012). Targeted conditioning programs using YYIRT as an evaluative measure can not only optimize performance but potentially reduce the risk of reinjury by ensuring players regain adequate high-intensity aerobic fitness before return to play (Boby & Badhan, 2023; Krstrup et al., 2003).

The YYIRT Level 1 test is a valid, reliable, and practical tool for assessing aerobic and intermittent endurance fitness differences between injured and non-injured hockey players. Its application in rehabilitation reflects its utility in objectively evaluating recovery and guiding appropriate fitness interventions to enhance player outcomes and injury prevention.

5-10-5 AGILITY SHUTTLE-

Agility is essential for field hockey players as the sport demands quick changes in direction to evade opponents, intercept play, and execute skilful manoeuvres. The 5-10-5 shuttle, a recognized test of change-of-direction speed, effectively assesses an athlete's ability to rapidly decelerate, pivot, and re-accelerate, reflecting game-like physical demands [NL Sports Centre, 2023]. The slower times observed in injured players likely stem from compromised neuromuscular control, diminished lower limb power, and proprioceptive deficits ensuing from injury and subsequent inactivity or incomplete rehabilitation.

These findings align with existing research emphasizing that injuries, particularly to the lower extremities, can impair agility due to pain, strength imbalances, and altered motor patterns [Sayers, 2015]. Supporting this, studies have shown that change-of-direction performance is closely related to sprint acceleration ability and lower body power, both of which are susceptible to decline post-injury [Young et al., 2001; Sheppard and Young, 2006]. Hence, rehabilitation programs focusing on restoring explosive strength, proprioception, and movement efficiency are vital for regaining agility and reducing re-injury risk.

Furthermore, the magnitude of difference in 5-10-5 agility times between injured and non-injured athletes underlines the importance of incorporating agility-specific assessments in return-to-play decision-making protocols within hockey. Monitoring these parameters can guide tailored interventions ensuring athletes meet sport-specific functional benchmarks prior to resuming competition.

The significantly impaired pro agility performance among injured field hockey players highlights the adverse impact of injury on agility and change-of-direction capacity. This underscores the necessity for comprehensive rehabilitation strategies encompassing agility training to restore optimal performance and safeguard athlete health.

REPEATED HIGH INTENSITY ENDURANCE TEST(RHIET)/ RSA - TOTAL

SPRINT TIME-

This clearly indicates that injury adversely affects players' ability to perform repeated high-intensity sprint efforts efficiently. The prolonged sprint times may reflect residual neuromuscular deficits, decrease muscle power or endurance, and compromise metabolic function following injury and rehabilitation.

These findings align with the foundational work by Rampinini et al. (2009), who demonstrated the close relationship of RSA to physiological responses such as blood lactate accumulation, hydrogen ion buffering, VO₂ max, and oxygen uptake kinetics in intermittent sports. Leslie (2012) similarly highlighted the pivotal role of aerobic fitness and intermittent endurance for recovery and sustained high-intensity efforts in field hockey, which can be altered by injury.

Recent research specifically investigating RSA kinetics in national-level hockey players has reinforced the paramount importance of repeated sprint performance metrics as valid indicators of anaerobic endurance and fatigue resistance (2023). This study underscores that consistent RSA testing is essential for tracking functional recovery in injured athletes.

Incorporating recent findings from 2023 research on RSA in hockey players, repeated sprint tests reliably reflect anaerobic endurance and fatigue resistance critical to performance monitoring and rehabilitation decision-making in field hockey. Accordingly, rehabilitation programs should integrate high-intensity interval training and metabolic conditioning to improve VO₂ kinetics and buffering capacity, thereby minimizing sprint decrement and optimizing performance as suggested by Bailey et al. (2009) and McKay et al. (2009).

COPENHAGEN HOLD –

Adductor strength and endurance are crucial for field hockey players, as these muscles play a vital role in stabilization and control during rapid lateral movements, cutting manoeuvres, and maintaining balance during complex plays. The Copenhagen hold, a well-recognized test of eccentric adductor muscle endurance, has been linked with injury prevention and rehabilitation in sports involving high hip adduction demands (Harøy et al., 2017). A deficit in adductor capacity, as observed in injured players, suggests lingering muscular weakness or endurance loss that may compromise functional performance and elevate reinjury risk. The findings highlight the importance of targeted rehabilitation to restore tissue capacity, particularly eccentric strength and endurance of the hip adductors, post-injury. Strengthening these muscles can enhance the ability to cope with repeated high-load demands experienced during match play, ultimately reducing overuse and traumatic injury risk. Research suggests that individuals with higher adductor capacity demonstrate lower injury incidence, emphasizing the clinical relevance of endurance-focused training in hockey athletes (Harøy et al., 2021).

Additionally, the trend of bilateral asymmetry observed—with greater significant deficit in the right leg—may reflect injury-specific lateral dominance or compensatory adaptations. Attention to correcting such asymmetries through individualized conditioning programs could further optimize rehabilitation outcomes and performance.

In conclusion, the statistically significant reduction in Copenhagen hold duration on the right leg among injured field hockey players underscores compromised tissue capacity that must be addressed through eccentric-strengthening interventions. Restoring adductor endurance is essential to enhancing stability, reducing injury risk, and facilitating successful return-to-play for hockey athletes.

SIT AND REACH –

This suggests that while flexibility is important for field hockey performance, injury status in this sample did not significantly affect sit and reach test results.

Flexibility contributes to efficient movement patterns, injury prevention, and optimal performance in hockey, where dynamic postures and rapid direction changes are frequent. The findings correspond with Georgieva (2016), who highlighted the role of flexibility in hockey but noted its limited utility in distinguishing injured from non-injured players when comprehensive training and rehabilitation are employed. It appears that other factors—such as strength, balance, and endurance—may be more sensitive markers of post-injury deficits in this population.

However, lower flexibility has been associated in literature with increased risk of muscle strains, especially in the hamstrings and lower back, which are common injury sites in field hockey (Leelavathy & Madhu, 2021). Thus, maintaining or improving flexibility remains a critical component of holistic conditioning programs aimed at minimizing injury risk and supporting athlete longevity.

Overall, despite the non-significant difference, the sit and reach test remains a practical, easy-to-administer evaluation for flexibility that should be included in routine screening and post-injury monitoring for field hockey players. Targeted flexibility interventions should be maintained or introduced within rehabilitation and training protocols to support optimal mobility and injury prevention.

SINGLE LEG HOP –

Single leg hop performance integrates balance, neuromuscular control, and lower limb explosive strength—all critical for the demands of field hockey involving frequent unilateral loading and rapid directional changes. The diminished hop distance on the injured right leg suggests residual deficits in these domains, potentially reflecting muscle weakness, proprioceptive impairments, or altered motor control following injury. These deficits can predispose athletes to reinjury and compromised performance, underscoring the clinical relevance of the single leg hop as a functional balance assessment tool.

The discussed findings align with the study by Brito et al. (2023), which highlighted significant correlations between single leg balance, hop test performance, and agility in female field hockey players, thereby reinforcing the importance of dynamic unilateral assessments in injury prevention screening. Reduced hop distance and balance deficits have been associated with an elevated risk of lower extremity injuries, particularly in sports with high cutting and pivoting demands like hockey.

Moreover, the asymmetry between right and left leg performance observed may indicate side-specific vulnerabilities or compensatory adaptations post-injury. Targeted rehabilitation should therefore focus on restoring balanced neuromuscular function and power symmetry to mitigate injury risk and enhance athletic readiness.\

In conclusion, the significant reduction in right leg single hop distance in injured field hockey players highlights persistent balance and functional power impairments. Regular incorporation of single leg hop testing into screening and rehabilitation programs may facilitate timely identification of deficits, guiding individualized interventions aimed at injury prevention and optimal performance restoration

KNEE TO WALL-

Ankle dorsiflexion range, as measured by the KTW test, is critical for the dynamic movements intrinsic to field hockey, including lunging, cutting, and quick directional changes. Sufficient dorsiflexion mobility allows for optimal force absorption and distribution during these movements, thereby reducing compensatory strategies that might predispose athletes to injury. The absence of significant mobility restriction in injured players suggests that either the rehabilitation programs effectively restored ankle dorsiflexion post-injury or that dorsiflexion limitations were not a major persistent deficit in this population. This finding aligns with prior research emphasizing the importance of ankle mobility in lower-limb function but underscores that injury status does not necessarily translate to chronic dorsiflexion deficits, provided appropriate injury management and rehabilitation protocols are in place (NL Sports Centre, 2023). However, subtle mobility impairments not captured by the KTW test, or other factors such as neuromuscular control, strength asymmetries, and proprioception, may still contribute to injury risk and functional performance. Moreover, adequate ankle dorsiflexion has been associated with improved performance in agility and balance tasks, which are essential for high-level hockey play (Sánchez-Migallón et al., 2020). Therefore, maintaining and regularly assessing ankle mobility remains crucial within athlete monitoring frameworks to prevent potential performance decrements and injury recurrence.

In conclusion, while the KTW test revealed no statistically significant differences in ankle dorsiflexion mobility between injured and non-injured field hockey players, ongoing vigilance in mobility assessment and targeted interventions to preserve ankle function are warranted to support athlete health and performance.

ACTIVE STRAIGHT LEG RAISE (ASLR) –

The ASLR test is widely recognized as an indicator of hamstring flexibility as well as neuromuscular and neural mobility, which are crucial for optimal lower limb function and injury prevention in dynamic sports such as field hockey. The lack of significant difference suggests that hamstring flexibility may not remain persistently impaired following rehabilitation in injured players or that it does not significantly vary with injury status in this cohort. This aligns with findings documented in previous studies where effective rehabilitation programs successfully restore hamstring length and function, minimizing mobility deficits post-injury (NL Sports Centre, 2023).

Maintaining adequate hamstring flexibility is paramount for field hockey athletes due to the repetitive demand for rapid accelerations, decelerations, and changes of direction. Insufficient flexibility can contribute to altered biomechanics and an increased risk of strains, which are prevalent in the sport (Leelathy & Madhu, 2021). While the current results indicate no substantial flexibility loss as measured by ASLR, it is essential to recognize that flexibility deficits might co-exist with other impairments such as muscle weakness or proprioceptive deficits, which collectively affect overall function and injury risk.

Furthermore, the ASLR serves not only as a test of hamstring length but also as a screen for neural tissue mobility, which can impact movement quality and pain perception. The marginally lower ASLR scores in injured players, albeit not statistically significant, highlight the need for ongoing monitoring and targeted flexibility interventions within rehabilitation and training programs to address subtle impairments and support injury prevention.

In conclusion, the ASLR test results indicate comparable hamstring and neural mobility between injured and non-injured field hockey players, demonstrating successful restoration of flexibility post-rehabilitation. However, continual assessment and individualized interventions remain essential to sustain mobility and optimize performance in this athletic population.

CONCLUSION

The findings of this study compellingly demonstrate that injured field hockey players, even after rehabilitation, exhibit significant deficits across critical fitness parameters including speed, power, endurance, agility, and muscular capacity compared to their non-injured counterparts. These persistent impairments underline that medical clearance alone does not equate to full functional recovery, emphasizing the complex interplay between neuromuscular deficits, psychological readiness, and sport-specific demands that influence return-to-play outcomes. The notable differences observed in sprint times, vertical jump height, aerobic endurance, and agility reinforce the need for comprehensive, multifaceted rehabilitation protocols tailored not only to address injury resolution but also to restore the intricate physical capabilities essential for high-level field hockey performance. Furthermore, the use of objective, sport-relevant assessments such as the 30 m sprint, Yo-Yo Intermittent Recovery Test Level 1, and Copenhagen holds provides practical tools for clinicians and coaches to monitor recovery progress and guide targeted interventions.

Importantly, the study adds valuable insight by integrating the influence of playing position, highlighting that fitness deficits and rehabilitation success cannot be universally applied but must consider the unique demands of forwards, midfielders, defenders, and goalkeepers. This nuanced understanding fosters the development of individualized training and conditioning strategies designed to optimize player health, performance, and injury prevention in competitive field hockey. Ultimately, this research advances sports physiotherapy by promoting evidence-based, position-specific rehabilitation frameworks that enhance athlete longevity and elevate the standards of care within the dynamic, high-intensity environment of field hockey competition.

LIMITATIONS

- The sample size, while sufficient for detecting significant differences, may not fully represent the broader population of field hockey players across various competition levels and geographic regions.
- The convenience sampling method used may have introduced selection bias, limiting generalizability.
- Fitness assessments were conducted post-rehabilitation at a single time point, not capturing longitudinal changes or the trajectory of recovery over time.
- Psychological factors, such as fear of reinjury or motivation, which can affect performance post-injury, were not evaluated.
- Position-specific subgroup analyses might have been underpowered due to smaller numbers within each category.
- Environmental conditions during physical testing (e.g., surface type, weather) were not strictly uniform, potentially affecting performance results

FUTURE SCOPE

- Longitudinal studies are recommended to track changes in fitness parameters from injury through various rehabilitation stages to return-to-play, enabling more precise evaluation of recovery kinetics.
- Development and validation of position-specific rehabilitation protocols integrating strength, endurance, neuromuscular control, and psychological readiness tailored to the demands of forwards, midfielders, defenders, and goalkeepers.
- Investigations into the effectiveness of specific training interventions such as contrast training, plyometrics, and sport-specific power drills on restoring deficits observed in injured players.
- Exploration of biomechanical and neuromuscular mechanisms underlying persistent impairments to design targeted injury prevention strategies.
- Inclusion of psychological and cognitive assessments post-injury to better understand their role in functional recovery and performance.
- Expansion of normative data for fitness tests in diverse field hockey populations to enhance clinical interpretation and benchmarking.
- Integration of wearable technology and real-time monitoring to individualize load management and optimize rehabilitation progress.
- Research into the interaction of injury history with susceptibility to reinjury and subsequent performance decrements, especially considering cumulative load and recovery.

SUMMARY

The thesis titled "The Effect of Post Rehabilitation on Fitness Parameters in Injured Versus Non-Injured Field Hockey Players Across Different Playing Positions" investigates the disparities in physical fitness between injured players following rehabilitation and their uninjured counterparts, with a focus on the influence of playing position. Conducted as a cross-sectional observational study involving male and female field hockey athletes aged 18-30, the research measures key fitness components such as speed, muscular power, aerobic and anaerobic endurance, agility, flexibility, balance, and mobility using validated sport-specific tests including the 30-meter sprint, vertical jump, seated medicine ball throw, Yo-Yo Intermittent Recovery Test, agility shuttle, and tissue capacity assessments.

Findings reveal significant deficits in injured players across multiple fitness domains, notably slower sprint times, reduced explosive power in both upper and lower body, compromised aerobic capacity, and impaired agility. These residual impairments persist despite completion of rehabilitation and medical clearance, highlighting the need for comprehensive and position-specific recovery protocols that address not only physical but also neuromuscular and psychological factors influencing return-to-play readiness. The study underscores the importance of individualized assessment and targeted interventions tailored to the unique demands of forwards, midfielders, defenders, and goalkeepers, to optimize performance and minimize reinjury risk. Overall, this research contributes valuable insights for clinicians, coaches, and sports scientists aiming to elevate rehabilitation strategies and enhance long-term athlete health and competitive success in field hockey.

DATA AVAILABILITY STATEMENT

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

CONFLICT OF INTEREST

The authors state that the research was carried out without any commercial or financial ties that could be interpreted as a potential conflict of interest.

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ANNEXURE:1

CONSENT FORM

I _____, aged ____ years, confirm that I have understood about the requirement of the study for testing of fitness parameters and the potential benefits on athletes as explained by Pratik Nitin Naxine and is as mentioned in his study which is taking place under the guidance of Dr. Asifuzzaman Shahriyar Ahmed (PT), Associate professor, Abhinav Bindra sports medicine and research institute (ABSMARI) and, co-guidance of Dr. Partha Ranjan Das (PT), Assistant Professor, 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

ANNEXURE:2

ASSESSMENT FORM

Name: _____ Dominant hand: _____
 Age/Gender: _____ Dominant Leg: _____
 Height: _____ Weight: _____
 Playing Position - _____ Injury details – _____
 Parameters- _____

Participant ID	Age	Gender	30 m sprint (s)	Vertical Jump (cm)	Seated Medicine Ball Throw Test (8lb) (m)	Yo-Yo IRT Level 1 (m)

Yo-Yo IRT L1- LEVEL ACHEIVED	5-10-5 Agility Shuttle (s)	RSA - TOTAL SPRINT TIME (S)	RSA - Sprint Decrement (%)	COPENHAGEN Hold	SINGLE LEG HOP	Knee to Wall	ASLR

ANNEXURE:3

ICE INSTUTIONAL ETHICAL COMMITTEE



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSOReg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/166

Date: 09/05/2025

APPROVAL LETTER APPENDIX- VIII

To,

PRATIK NITIN NAXINE
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: The Effect of Post Rehabilitation on Fitness Parameters in Injured Versus Non-Injured Field Hockey Players Across Different Playing Positions.

Protocol ID.: ABS-IEC-2025-PHY-059

Subject: Approval for the conduct of the above referenced study

Dear **Mr./Ms./Dr Pratik Nitin Naxine**

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



1

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ANNEXURE:4

PHOTOS –



FIG.1 – 30M SPRINT TEST



FIG. 2 – VERTICAL JUMP TEST



FIG. 3- SEATED MEDICINE BALL THROW TEST(8LB)



FIG. 4 YO-YO INTERMITTENT RECOVERY LEVEL 1 TEST



FIG . 5 - 5-10-5 Agility Shuttle Test



FIG . 6 REPEATED HIGH INTENSITY ENDURANCE TEST(RHIET)/REPEATED SPRINT ABILITY(RSA)



FIG. 7 – COPENHAGEN HOLD



FIG. 8 – SIT AND REACH TEST



FIG. 9 SINGLE LEG HOP



FIG. 10 KNEE TO WALL TEST



FIG. 11 ACTIVE STRAIGHT LEG RAISE

ANNEXURE – 5

MASTERCHART

INJURED AND NON- INJURED FIELD HOCKEY PLAYERS

	A	B	C	D	E	F	G
1	Participant ID	Age	Gender	Position	30-meter Sprint (s)	Vertical Jump (cm)	Seated Medicine Ball Throw Test (8lb) (m)
2	P1	18	Male	Goalkeeper	2.6	48	5.8
3	P2	18	Male	Goalkeeper	2.56	41	6.2
4	P3	20	Male	Goalkeeper	2.58	36	5.5
5	P4	21	Male	Defender	3.12	55	7
6	P5	18	Male	Defender	3.15	44	6.1
7	P6	20	Male	Defender	2.59	32	5.9
8	P7	26	Male	Defender	2.7	51	6.8
9	P8	24	Male	Defender	2.88	38	5.7
10	P9	25	Male	Defender	2.81	40	7.1
11	P10	22	Male	Defender	3.15	53	6.5
12	P11	19	Male	Midfielder	2.6	30	5.6
13	P12	19	Male	Midfielder	2.25	46	6
14	P13	19	Male	Midfielder	2.75	34	7.3
15	P14	19	Male	Midfielder	2.55	56	5.4
16	P15	19	Male	Midfielder	2.97	39	6.7
17	P16	19	Male	Midfielder	2.9	31	5.3
18	P17	19	Male	Midfielder	2.6	58	6.9
19	P18	19	Male	Midfielder	2.78	37	5.2
20	P19	20	Male	Midfielder	2.79	45	7.2
21	P20	27	Male	Forward	2.99	42	6.3
22	P21	25	Male	Forward	3.1	30	5.1
23	P22	24	Male	Forward	3.4	54	6.6
24	P23	26	Male	Forward	3.8	33	7.4
25	P24	18	Male	Forward	3.62	35	6.4
26	P25	18	Male	Forward	3.61	33	5
27	P26	18	Male	Forward	2.99	49	7.5
28	P27	19	Male	Forward	2.76	39	6
29	P28	22	Male	Forward	2.8	43	5.8
30	P29	19	Male	Forward	2.58	52	6.2
31	P30	18	Male	Forward	2.59	37	6.5
32	P31	19	Female	Goalkeeper	2.61	51	7
33	P32	19	Female	Goalkeeper	2.63	38	5.1
34	P33	19	Female	Defender	2.65	40	7.1
35	P34	19	Female	Defender	2.67	53	6.5
36	P35	19	Female	Defender	2.68	30	5.6
37	P36	19	Female	Defender	2.7	46	6
38	P37	19	Female	Midfielder	2.72	34	7.3
39	P38	19	Female	Midfielder	2.74	56	5.4
40	P39	19	Female	Midfielder	2.76	48	6.7
41	P40	19	Female	Midfielder	2.78	41	5.3
42	P41	21	Female	Midfielder	2.79	36	6.9
43	P42	21	Female	Forward	2.62	55	5.2
44	P43	22	Female	Forward	2.64	44	7.2
45	P44	21	Female	Forward	2.66	32	6.3
46	P45	19	Female	Forward	2.69	36	5.1
47	P46	22	Female	Forward	2.71	37	6.1

H	I	J	K	L	M
Yo-Yo IRT Level 1 (m)	YYIRT L1- LEVEL ACHIEVED	5-10-5 Agility Shuttle (s)	RSA - TOTAL SPRINT TIME (S)	RSA - Sprint Decrement (%)	COPENHAGEN - RIGHT LEG HOLD (S)
1800	18	4.65	27.2	0.04	42
2100	19	4.38	28.1	0.061	35
1650	17.6	4.52	29.5	0.083	20
1920	18.5	4.8	26.8	0.035	58
1750	17.9	4.45	28.7	0.068	30
2050	18.9	4.71	30.8	0.098	13
1580	17.4	4.3	27.5	0.048	37
2200	19.4	4.6	29.2	0.075	18
1900	18.4	4.95	28.4	0.064	26
1720	17.8	4.42	27.1	0.039	46
2300	19.8	4.77	31.2	0.105	9
1600	17.5	4.25	27.9	0.054	32
2000	18.7	4.58	30	0.088	16
1550	17.3	5.1	27.6	0.046	39
2150	19.2	4.35	28	0.057	25
1700	17.7	4.7	30.4	0.092	14
1950	18.6	4.48	26.9	0.037	49
1680	17.7	4.9	29.3	0.07	21
2250	19.6	4.28	28.5	0.066	29
1850	18.2	4.63	29.7	0.08	24
1450	16.9	5.25	31.8	0.11	10
2450	20.2	4.4	26.5	0.032	51
1350	16.5	5.05	32.5	0.125	8
1780	18	4.75	29	0.071	22
2080	18.9	4.55	30.1	0.086	15
1620	17.5	4.85	27.4	0.045	35
1980	18.6	4.32	29.8	0.076	23
1730	17.8	4.68	28.6	0.063	33
2350	20	4.99	27.3	0.043	45
1820	18.1	4.47	29.4	0.074	28
1580	17.2	4.4	29.5	0.083	20
2200	18	5.05	26.8	0.035	58
1900	19	4.75	28.7	0.068	30
1720	17.6	4.55	30.8	0.098	13
2300	18.5	4.85	27.5	0.048	37
1600	17.9	4.42	29.2	0.075	18
1580	18.9	4.77	28.4	0.064	26
2200	17.4	4.25	27.1	0.039	46
1900	19.4	4.58	31.2	0.105	9
1720	18.4	5.1	27.9	0.054	32
2300	17.8	4.35	26.9	0.037	49
1600	19.8	4.7	29.3	0.07	21
1800	17.5	4.48	28.5	0.066	29
2100	18.9	4.9	29.7	0.08	24
1650	17.5	4.68	31.8	0.11	10
1500	18.6	4.99	26.5	0.032	51

N	Q	P	Q	R
COPENHAGEN - LEFT LEG HOLD (S)	Sit and Reach (cm)	SINGLE LEG HOP - RIGHT(CM)	SINGLE LEG HOP - LEFT(CM)	Knee to Wall - RT(cm)
45	8	178	175	12
33	35	190	192	13.5
22	23	160	158	9.5
55	31	200	205	15
28	26	175	180	10
15	38	148	145	7.5
38	21	185	188	13
20	30	162	165	8
25	24	173	170	11.5
48	33	195	198	14.5
10	18	130	135	6
31	29	180	182	11.8
18	25	153	150	9
40	36	203	200	15.5
27	20	169	172	9.8
12	32	142	140	6
50	27	208	210	15.8
23	15	158	160	8.5
30	34	183	185	12
26	22	165	168	10
8	19	128	125	5.5
52	37	197	195	14
9	17	125	130	4
24	28	164	162	9
16	24	157	155	8
36	30	176	178	13
21	20	165	167	9.5
34	31	181	183	12
47	25	188	190	14.7
29	29	170	171	10.5
28	26	175	180	10
15	38	148	145	7.5
38	21	185	188	13
20	30	162	165	8
25	24	173	170	11.5
48	33	195	198	14.5
10	18	130	135	6
31	29	180	182	11.8
18	25	153	150	9
40	36	203	200	15.5
27	20	169	172	9.8
12	32	142	140	6
50	27	208	210	15.8
23	15	158	160	8.5
30	34	183	185	12
26	22	165	168	10

T	U
ASLR - RT(Deg)	ASLR - LT(Deg)
72	75
85	88
68	65
92	90
69	70
55	58
78	80
60	62
75	73
84	86
50	52
77	78
63	60
90	89
66	68
54	56
90	91
62	64
74	76
65	67
50	48
86	87
48	50
67	66
60	61
80	82
71	70
77	79
84	85
70	72
69	70
55	58
78	80
60	62
75	73
84	86
50	52
77	78
63	60
90	89
66	68
54	56
90	91
62	64
74	76
65	67

	A	B	C	D	E	F	G	H	I
1	Participant ID	Age	Gender	Position	Injury Type	Injury	30-meter Sprint (s)	Vertical Jump (cm)	Seated Medicine Ball Throw Test (8lb) (m)
2	P1		25 Female	Goalkeeper	Acute	ACL injury	5.3	29	4
3	P2		22 Female	Midfielder	Acute	Adductor strain	4.9	35	5.1
4	P3		23 Female	Midfielder	Acute	Hamstring strain	5.05	38	5.8
5	P4		23 Female	Midfielder	Acute	Hamstring strain	5	37	5.3
6	P5		23 Female	Defender	Chronic	Achilles tendinopathy	5.8	27	3.5
7	P6		23 Female	Midfielder	Chronic	Stress fracture tibia at ankle	4.8	40	5.5
8	P7		23 Female	Defender	Acute	MCL injury knee	5.6	31	3.8
9	P8		23 Female	Midfielder	Chronic	Proximal biceps tendon injury	4.45	48	6.9
10	P9		19 Female	Midfielder	Acute	Thigh muscle haematoma	5.25	30	4.5
11	P10		19 Female	Defender	Acute	Ankle sprains	4.72	44	6.8
12	P11		20 Female	Defender	Acute	Ankle sprains	5.9	26	3.3
13	P12		27 Female	Forward	Acute	Quadriceps strain	4.55	49	7.2
14	P13		25 Female	Defender	Chronic	Achilles tendinopathy	5.7	28	3.6
15	P14		24 Female	Defender	Acute	Ankle sprains	4.35	52	7.5
16	P15		26 Female	Forward	Acute	Quadriceps strain	5.4	30	4.2
17	P16		18 Female	Midfielder	Acute	Achilles tendon injury	4.5	47	7
18	P17		18 Female	Midfielder	Chronic	Rectus abdominus tendinopathy	5.05	38	5.8
19	P18		18 Female	Goalkeeper	Acute	Medial and lateral meniscal tears	5.6	31	3.8
20	P19		19 Female	Forward	Acute	Ear laceration/abrasion	4.65	42	6.2
21	P20		22 Male	Goalkeeper	Acute	ACL injury	4.9	35	5.1
22	P21		19 Male	Defender	Acute	Ear laceration/abrasion	5.3	29	4
23	P22		18 Male	Forward	Chronic	Shin splints	4.75	45	6.5
24	P23		19 Male	Midfielder	Acute	Adductor strain	5.15	33	4.9
25	P24		20 Male	Midfielder	Acute	Patellar dislocation	4.8	40	5.5
26	P25		21 Male	Midfielder	Acute	Adductor strain	4.4	50	7.3
27	P26		22 Male	Goalkeeper	Chronic	Chronic regional pain syndrome	5.8	27	3.5
28	P27		18 Male	Defender	Acute	Eyebrow laceration	4.7	43	6
29	P28		18 Male	Midfielder	Acute	GRONINJURY	4.6	46	7.1
30	P29		20 Male	Forward	Chronic	Lumbar disc prolapse	5	37	5.3
31	P30		21 Male	Forward	Acute	Acromioclavicular joint sprain	5.5	32	4
32	P31		18 Male	Midfielder	Acute	Hamstring strain	5.2	36	5
33	P32		20 Male	Midfielder	Acute	Hamstring strain	4.95	41	6.3
34	P33		26 Male	Defender	Acute	MCL injury knee	5.1	39	5.2
35	P34		24 Male	Midfielder	Acute	Distal femoral fracture	4.85	34	4.8
36	P35		22 Male	Defender	Acute	MCL injury knee	5.35	35	5
37	P36		19 Male	Midfielder	Chronic	Lumbar pain	4.98	40	6.1
38	P37		18 Male	Goalkeeper	Acute	ACL INJURY	5.08	38	5.6
39	P38		19 Male	Forward	Acute	Acromioclavicular joint sprain	4.75	45	6.5
40	P39		20 Male	Forward	Acute	Quadriceps strain	5.15	33	4.9
41	P40		21 Male	Forward	Chronic	Chronic regional pain syndrome	4.4	50	7.3
42	P41		22 Male	Midfielder	Chronic	Proximal biceps tendon injury	4.7	43	6
43	P42		26 Male	Midfielder	Chronic	Chronic Shoulder Instability	5.4	30	4.2
44	P43		27 Male	Defender	Chronic	Lumbar disc prolapse	4.6	46	7.1
45	P44		28 Male	Goalkeeper	Acute	ACL & MENISCAL INJURY	5.5	32	4
46	P45		27 Male	Midfielder	Chronic	Lumbar pain	4.35	52	7.5
47	P46		22 Male	Midfielder	Acute	Quadriceps strain	4.95	41	6.3
48									
49									

J	K	L	M	N	O
Yo-Yo IRT Level 1(m)	Yo-Yo IRT L1- LEVEL ACHIEVED	5-10-5 Agility Shuttle (s)	RSA - TOTAL SPRINT TIME (S)	RSA - Sprint Decrement (%)	COPENHAGEN - RIGHT LEG HOLD (S)
880	15.2	5.25	32.5	0.115	7
1280	16.5	4.9	30	0.085	16
1400	17	4.75	29	0.07	20
1320	16.6	4.85	29.8	0.08	19
520	14.2	5.65	35	0.14	10
1520	17.3	4.8	29.5	0.075	21
680	14.6	5.4	34	0.13	5
1920	18.5	4.45	27.7	0.048	40
1080	15.8	5.1	31.8	0.11	13
1760	18	4.62	28	0.055	35
600	14.4	5.8	36	0.15	6
1880	18.4	4.42	27	0.038	43
720	14.7	5.5	33.5	0.125	7
2040	19	4.28	26.5	0.032	54
960	15.5	5.15	31.5	0.105	14
1800	18.2	4.48	27.2	0.04	38
1400	17	4.75	29	0.07	20
680	14.6	5.4	34	0.13	5
1600	17.5	4.65	28.5	0.062	23
1280	16.5	4.9	30	0.085	16
880	15.2	5.25	32.5	0.115	7
1720	17.8	4.55	27.8	0.05	35
1040	15.7	5.05	31	0.098	10
1520	17.3	4.8	29.5	0.075	21
1960	18.6	4.35	26.8	0.035	46
520	14.2	5.65	35	0.14	10
1640	17.6	4.6	28.3	0.058	27
2120	19.3	4.4	27.5	0.046	40
1320	16.6	4.85	29.8	0.08	19
760	14.9	5.3	33	0.12	8
1120	16	4.95	30.5	0.092	17
1560	17.4	4.7	28.8	0.065	28
1200	16.2	5	30.2	0.088	18
1440	17.1	4.78	29.3	0.073	16
1160	16.1	5.08	30.8	0.095	20
1680	17.7	4.72	29.2	0.068	26
1360	16.8	4.88	31	0.09	22
1720	17.8	4.55	27.8	0.05	35
1040	15.7	5.05	31	0.098	10
1960	18.6	4.35	26.8	0.035	46
1640	17.6	4.6	28.3	0.058	27
960	15.5	5.15	31.5	0.105	14
2120	19.3	4.4	27.5	0.046	40
760	14.9	5.3	33	0.12	8
2040	19	4.28	26.5	0.032	54
1560	17.4	4.7	28.8	0.065	28

V	W	X
Knee to Wall - LT	ASLR - RT(Deg)	ASLR - LT(Deg)
6	50	52
8	63	60
9.5	65	68
10	64	65
7.5	50	40
11.5	69	70
5	48	45
13.5	83	84
8.2	61	59
12	79	80
6.5	45	42
13.2	82	83
7.8	58	50
15	88	90
8.5	62	58
13	87	85
9.5	65	68
5	48	45
10.5	70	72
8	63	60
6	50	52
12	75	78
7	60	55
11.5	69	70
14	89	88
7.5	50	40
9	76	75
12.5	85	86
10	64	65
7	55	53
9	60	62
11	72	73
8.8	65	67
9.5	66	64
10	67	69
11.8	75	77
9.8	68	66
12	75	78
7	60	55
14	89	88
9	76	75
8.5	62	58
12.5	85	86
7	55	53
15	88	90
11	72	73

ANNEXURE – 6

PLAGIARISM REPORT

Pratik Naxine

The Effect of Post Rehabilitation on Fitness Parameters in Injured Versus Non-Injured Field Hockey Players Across Differ...

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