"EFFECT OF FRENCH CONTRAST TRAINING VERSUS CONVENTIONAL STRENGTH TRAINING ON EXPLOSIVE POWER AND FLICK SPEED IN ELITE MALE HOCKEY DRAG FLICKERS: A RANDOMIZED CONTROLLED TRIAL"

by

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Sports Science

Under the guidance of

Dr. Gayatri Upasana Acharya (PT)

ABHINAV BINDRA SPORTS MEDICINE & RESEARCH INSTITUTE

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I hereby declare that this dissertation entitled **"EFFECT OF FRENCH CONTRAST TRAINING VERSUS CONVENTIONAL STRENGTH TRAINING ON EXPLOSIVE POWER AND FLICK SPEED IN ELITE MALE HOCKEY DRAG FLICKERS: A RANDOMIZED CONTROLLED TRIAL"** is a Bonafide and genuine research work carried out by me under the guidance of Dr. Gayatri Upasana Acharya (PT) Assistant Professor, Abhinav Bindra Sports Medicine and Research Institute, Odisha and there are no conflict of interest associated with this dissertation work.

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LIST OF ABBREVIATIONS

1) FCM – French Contrast Method
2) PAP – Post-Activation Potentiation
3) PAPE – Post-Activation Performance Enhancement
4) VBT – Velocity-Based Training
5) UL – Upper Limb
6) LL – Lower Limb
7) EDSPR1 – Experimental Drag Speed Pre-test
8) EDSPO1 – Experimental Drag Speed Post-test
9) EBBPR1 – Experimental Bomb Throw Pre-test
10) EBBPO1 – Experimental Bomb Throw Post-test
11) EPJPR1 – Experimental Penta Jump Pre-test
12) EPJPO1 – Experimental Penta Jump Post-test
13) NEDSPR2 – Non-Experimental (Control) Drag Speed Pre-test
14) NEDSPO2 – Non-Experimental (Control) Drag Speed Post-test
15) NEBBPR2 – Non-Experimental (Control) Bomb Throw Pre-test
16) NEBBPO2 – Non-Experimental (Control) Bomb Throw Post-test
17) NEPJPR2 – Non-Experimental (Control) Penta Jump Pre-test
18) NEPJPO2 – Non-Experimental (Control) Penta Jump Post-test

ABSTRACT

Background:

The drag flick is a decisive scoring skill in modern field hockey, requiring rapid force production, coordinated kinetic sequencing, and technical precision. Optimizing this skill demands training methods that effectively develop explosive strength while ensuring transfer to sport-specific performance. The French Contrast Method (FCM), which combines heavy resistance, plyometric, assisted, and sport-specific explosive exercises within a single sequence, has shown promise in enhancing neuromuscular performance in athletes. However, its application to hockey drag flickers has not been systematically investigated.

Methods:

This randomized controlled trial recruited 74 elite male hockey players (aged 18–35 years), who were randomly allocated to an experimental group (FCM, n = 37) or a control group (conventional training, n = 37). The intervention lasted four weeks (8 sessions) and was delivered twice weekly. The experimental protocol integrated six functional movement patterns (squat, hinge, lunge, push, pull, brace) with drag flick–specific supersets, while the control group followed traditional strength and plyometric routines. Outcome measures included drag flick speed (radar speed gun), Bomb Throw Test (backward overhead medicine ball throw), and Penta Jump Test (5-hop horizontal distance). Pre- and post-test data were analysed using paired t-tests, independent t-tests, and ANCOVA.

Results:

Both groups improved significantly from pre- to post-test; however, the FCM group demonstrated greater performance gains across all outcomes. Drag flick speed increased from 99.86 ± 7.79 to 115.97 ± 6.71 m/s in the FCM group (t (36) = –12.02, $p < 0.001$), compared with 103.30 ± 5.33 to 107.81 ± 4.35 m/s in controls (t (36) = –4.12, $p < 0.001$). Similar trends were observed for Bomb Throw (6.71 vs. 5.17 m, $p < 0.001$) and Penta Jump (16.44 vs. 15.50 m, $p < 0.001$). ANCOVA confirmed significant group effects for drag flick speed (F (1,71) = 46.66, $p < 0.001$), Bomb Throw (F (1,71) = 111.18, $p < 0.001$), and Penta Jump (F (1,70) = 373.42, $p < 0.001$), indicating that improvements were attributable to the intervention rather than baseline variation.

Conclusion:

The findings confirm that the French Contrast Method is a superior training strategy for enhancing explosive power and translating these gains into sport-specific outcomes in hockey drag flickers. By integrating functional strength, plyometrics, assisted jumps, and skill-specific supersets, FCM effectively bridges the gap between physical preparation and technical execution. This study provides the first controlled evidence for the application of FCM in field hockey and offers practical insights for coaches, physiotherapists, and strength and conditioning professionals.

Keywords: Athletic Performance; Explosive Power; Field Hockey; Neuromuscular Physiology; Plyometric Exercise; Post-Activation Potentiation; Randomized Controlled Trial; Resistance Training; Sports Performance

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INTRODUCTION

Over the last several decades, field hockey has become one of the fastest and most technically demanding sports globally. [1] Innovations like synthetic pitches, enhanced equipment, and professional leagues have all contributed collectively to increasing match pace and transforming tactical trends. [2] On the global stage, penalty corners now account for almost 30–40% of overall goals [3]. Through this tactical paradigm, the drag flick has surpassed the conventional hit as the finish of choice, appreciated for its speed, precision, and deceptiveness [4]. Research further illustrates that drag flicks are more likely to succeed compared to direct hits, validating their determinantal role in winning matches [5]. The drag flick is both tactically important and biomechanically demanding, making it a key component of contemporary hockey performance [6]. Elite-level ball velocities of 120–145 km/h give goalkeepers fewer than half a second to react [7]. These velocities exceed common visuomotor reaction times, making defenders must anticipate rather than responding on reflex. Morris-Binelli et al. (2022) showed that increased flick velocities reduce response windows and produce unpredictable trajectories, making defensive planning challenging [8]. As a result, drag flick experts tend to be the deciding factors in match results, with accuracy being significantly linked with team success [3,9]. The effect of the drag flick has remained apparent from one generation of hockey players, to the next. Mahmoud Abbas of Pakistan and Sandeep Singh of India astounded hockey audiences striking penalty corners with a flick that ultimately contributed to individuals being some of the highest scorers of the game [10]. More recently, Gonzalo Peillat and Harmanpreet Singh have also become part of the legacy, consistently scoring top of the list at the most elite levels of competition [11]. Their results suggest an especial competency in this skill allows an individual to earn team credibility while winning team games. Where offensive strategy has developed, so too have defensive setups. Most teams make use of more than one first runner, try out substitute formations, and invest considerable training time in countering penalty corners [12]. Still, however, the drag flick dominates, with research consistently affirming its position as a game-changing, pivotal stroke [13]. Consequently, development programs and federations place more focus on specialized drag flick training to create players who possess the technical precision with the explosive power required of this skill [14].

Biomechanical studies have provided valuable information about the physical and technical factors associated with drag flick performance. Tran et al. (2017) reported that trunk angular momentum was a major predictor of stick velocity, while Ng et al. (2018) reported that hip–pelvic dissociation and lumbar control contributed to a combined strategy to improve accuracy and speed of the flick [15,16]. Singh et al. (2018) similarly found that increases in lower-limb explosive power, quantified from sprints capturing jump ability, was expected to lead to higher flick velocities[17]. In addition, Slimani et al. (2016) found that plyometric training improves explosive capacity by enhancing stretch–shortening cycle efficiency and type II fiber recruitment from easy and small jumps quantifying explosive capacity in athletes [18]. Unpredictability is another component that enhances the efficiency of the drag flick. Players can alter drag length, stick angle, or release level to hide purpose and deceive defenders.[19] Slight alterations in these biomechanical parameters can produce significant changes in speed and ball flight path, reducing the chances of effective defensive anticipation [8,20]. Consequently, penalty corner defense is frequently a major area of preparation and tactical effort for teams, highlighting the disruptive effect of the drag flick [21]. Performance appraisals repeatedly highlight the central role of the drag flick in determining competitive success. Ladru et al. (2023) demonstrated that effectiveness from penalty corners—largely dependent on successful drag flick implementation—was strongly correlated with team performance in global competitions [3]. Similarly, De Subijana et al. (2025) had indicated that increased drag flick conversion rates often proved to be the deciding factor in matches even when, as per open play, teams were evenly matched [22]. These studies together validate that drag flick experts are a vital resource in elite hockey where their input is usually the determining factor between win and loss.

The drag flick has its own unique physical requirements for the individual. The nature of the motion is a whip-like effect where the lower-limb explosive strength, trunk rotational torque, and rapid action of the wrist all act together [23]. Cormie et al. (2011) noted that rate of force development (RFD) was a primary contributor to ballistic movements, and is therefore important for drag flicking [24]. Grace (2024) points out that drag flickers are anyone's separate group of athletes that require velocity specific adaptations, neuromuscular coordination, beyond what can be achieved with normal strength gains through conventional strength training [25].

The drag flick has gradually become one of the most technically challenging and tactically decisive skills in modern hockey. It accounts for a substantial proportion of goals, shapes both offensive and defensive strategies, and emphasizes the value of individual specialists [10,11]. Effective execution requires explosive leg drive, trunk coordination, and accurate stick control, while its built-in unpredictability offers additional tactical benefit [8,19]. Recognizing its pivotal role provides strong justification for exploring advanced training approaches—such as French Contrast Training—that are designed to enhance the physical attributes supporting flick speed and power [26].

The movement of the drag flick starts with the approach run to create the forward speed, followed by the plant phase as the lead foot is brought close to the ball and the center of mass is dropped, resulting in eccentric loading on the quadriceps, gluteals, and plantar flexors. This movement engages the stretch–shortening cycle (SSC) [18], elastic energy stored to be explosively discharged during concentric motion to enhance total force output [19]. Then, rotation of the hips and trunk creates angular momentum that is transferred down the chain through the torso to the shoulders, arms, and wrists for efficient power transfer [15,16]. Equally, Ng et al. (2018) pointed out that hip–pelvic dissociation and lumbar contribution are responsible for speed and accuracy, underlining the importance of trunk coordination for effective performance[16]. The release phase is the culmination of the biomechanical chain of the drag flick. At this point, accurate coordination of pronation of the wrist, stick acceleration, and contact time dictates velocity and placement of the ball. Ladru et al. (2023) had found that parameters like drag length, swing arc velocity, and quality of stick–ball contact are highly indicative of flick speed and that elite players have optimized these factors to achieve maximum outcomes.[3] Similarly, Morris-Binelli et al. (2022) showed that increased release speeds not only increase velocity but also unpredictability, which complicates defensive anticipation[8].

Lower-limb explosive strength has been repeatedly shown to be a key factor for drag flick performance. Singh et al. (2018) indicated that sprint and jump ability—foremost indices of explosive power—were correlating positively with higher drag flick speeds among top-level players. [17] Slimani et al. (2016) also highlighted that plyometric training, by enhancing the efficiency of the stretch–shortening cycle (SSC) and eliciting type II fibers, is crucial for maximizing explosive outputs in team sports[18]. Collectively, these results substantiate that success in drag flick is contingent upon technical performance and neuromuscular attributes like rate of force development and intermuscular coordination [24]. Weakness in lower-limb power or ineffective trunk coordination can create "energy leaks," reducing the efficiency of force transfer and ultimately lowering flick velocity [27]. Although biomechanical research has expanded, much of it remains descriptive rather than intervention-based. For example, studies by Ibrahim et al. (2017), Ng et al. (2018), and Ladru et al. (2023) identified critical biomechanical determinants, yet none tested targeted training interventions to enhance these factors [3,15,16]. Grace (2024) highlighted this limitation, arguing that the unique neuromuscular and biomechanical demands of the drag flick require more than generic conditioning approaches [25.]

The limitations of traditional training methods become more evident when applied to the ballistic demands of the drag flick. Conventional Strength Training (CST) effectively develops maximal force, but its slower contraction speeds restrict transfer to high-velocity actions [23]. Plyometric training improves stretch–shortening cycle (SSC) efficiency, yet it does not fully integrate strength and speed across the force–velocity spectrum [18]. Complex and contrast training address this gap by pairing heavy and explosive exercises, though they often fail to incorporate systematic supramaximal neural recruitment [24]. Zhao et al. (2025), in a meta-analysis, demonstrated that advanced methods like French Contrast Training (FCT) better develop multiple neuromuscular qualities simultaneously, making them highly suitable for whip-like ballistic skills[28]. The drag flick functions as a biomechanical chain reaction in which ground reaction forces, trunk-generated torque, and whip-like distal acceleration combine to produce high ball velocities. Effective execution relies not only on technical precision but also on lower-limb explosive power, trunk coordination, and neuromuscular attributes such as rate of force development (RFD) and efficient use of the stretch–shortening cycle (SSC) [17,18,24]. While these contributors have been identified in previous research, there remains a lack of intervention-based studies focused specifically on drag flickers, creating a critical gap in applied sports science. This highlights the need to evaluate advanced approaches such as French Contrast Training (FCT), which aligns more closely with the biomechanical requirements of drag flicking than conventional programs[28].

Explosive power is a decisive quality in hockey, influencing frequent sprints, rapid directional shifts, and high-speed skills such as the drag flick [1,17.] Physiologically, it reflects the capacity to generate force rapidly, supported by rate of force development (RFD), intermuscular coordination, and activation of type II muscle fibers [24]. Cormie et al. (2011) highlighted that although maximal strength forms the basis for power production, it is the rate of force expression that truly characterizes explosive performance [24]. This distinction is especially critical in hockey, where athletes are required to transition fluidly between strength-based and velocity-oriented actions. Conventional Strength Training (CST) has traditionally served as the cornerstone of athletic preparation, employing compound lifts such as squats, deadlifts, lunges, and presses to develop overall force capacity [23]. This type of training enhances muscle cross-sectional area, improves neural activation, and strengthens intramuscular coordination, thereby supporting maximal strength development [24]. However, its transfer to hockey-specific explosive movements like the drag flick is limited, since most resistance-based exercises are performed at slower velocities [25]. Grace (2024) highlighted that this mismatch in contraction speed reduces specificity, reinforcing the need for strategies that address the high-velocity demands of flick execution [25]. To overcome the limitations of CST, plyometric training has become a widely adopted component of hockey conditioning. Plyometric drills exploit the stretch–shortening cycle (SSC), allowing athletes to store elastic energy during eccentric loading and release it explosively in the concentric phase [18]. Singh et al. (2018) reported that an eight-week plyometric program produced significant gains in sprint speed, vertical jump height, and drag flick velocity among elite hockey players [17]. Similarly, Slimani et al. (2016), in a systematic review, confirmed that plyometric adaptations enhance explosive strength, sprinting, agility, and jumping performance across team sports[18].

Building on the foundation of plyometrics, complex and contrast training methods have been introduced to merge strength and speed development within a single session. In complex training, a heavy resistance exercise is paired with a biomechanically related plyometric drill, making use of post-activation potentiation (PAP) to temporarily enhance neuromuscular performance [24]. For instance, heavy squats can be followed by jump squats, enabling the neuromuscular system to express greater force at higher movement velocities. Contrast training applies a similar principle but alternates heavy and lighter explosive exercises across sets, thereby engaging different portions of the force–velocity curve [24]. Seitz and Haff (2016) found that PAP-based approaches consistently produced greater improvements in sprinting and jumping than strength training alone, particularly in highly trained athletes [29]. These insights are especially meaningful for drag flickers, who must convert force capacity into whip-like acceleration quickly. Another advancement is velocity-based training (VBT), which prescribes resistance based on actual bar speed rather than fixed percentages of one-repetition maximum (1RM). This ensures that athletes train within ideal velocity zones, promoting explosive intent while reducing fatigue [30]. Banyard et al. (2017) showed that VBT increased power output, reduced individual variability, and improved training personalization compared with traditional loading methods [30]. Similarly, Rebelo et al. (2023) demonstrated that velocity-based complex training enhanced jump height and strength endurance in young athletes, reinforcing its effectiveness for long-term athletic progression [31]. Although these training methods offer clear benefits, each presents shortcomings when applied independently. CST builds a solid base of strength but does not adequately address velocity-specific adaptations [23].

Plyometric drills improve SSC efficiency, yet they often lack the heavy resistance needed to maximize strength development [18]. Complex and contrast training incorporate PAP principles, but they typically fall short in achieving supramaximal neural recruitment, which is vital for explosive, whip-like actions such as the drag flick [29]. Velocity-based training allows for greater load individualization, yet it functions primarily as a monitoring strategy rather than a comprehensive training system [30,31]. Collectively, the available evidence emphasizes the value of integrated methods that unite components of strength training, plyometrics, PAP, and overspeed exercises within a single framework. FCT represents such a model, combining heavy resistance lifts, plyometric drills, loaded power movements, and overspeed exercises in the same session [28]. By addressing multiple points across the force–velocity spectrum, this method is particularly well suited to drag flickers, whose performance relies on both maximal force production and velocity-specific adaptations [25,28]. Zhao et al. (2025), through a meta-analysis, demonstrated that FCT produced greater gains in vertical jump, sprint acceleration, and maximal strength compared with conventional methods, with the most pronounced effects observed in already trained athletes [28]. These findings provide strong rationale for evaluating FCT in hockey drag flick specialists, who often require advanced strategies to overcome performance plateaus. The evolution of explosive power training in hockey has progressed from fundamental CST approaches to more advanced methods incorporating plyometrics, PAP, and VBT.

While each approach provides distinct benefits, none on their own fully address the ballistic and whip-like characteristics required for an effective drag flick [17,23,25]. Increasingly, research highlights the advantages of integrative models such as FCT, which concurrently enhance maximal strength, SSC efficiency, and neuromuscular recruitment. Considering the decisive influence of explosive power on drag flick execution, evaluating FCT against conventional training methods is a necessary step toward advancing evidence-based conditioning strategies for elite hockey players [28]. The drawbacks of traditional and stand-alone training methods have increased interest in integrated approaches that simultaneously develop different parts of the force–velocity curve. Conventional Strength Training (CST) establishes the foundation for maximal force production, but its slower contraction speeds limit transfer to explosive, ballistic skills like the drag flick [23]. Plyometric programs improve stretch–shortening cycle (SSC) efficiency and reactive strength, yet they do not provide enough heavy resistance to maximize overall strength [18]. Complex and contrast training have been proposed to bridge this gap by pairing heavy lifts with related plyometric drills to take advantage of post-activation potentiation (PAP) [29]. Seitz and Haff (2016) found that these PAP-based methods consistently boosted sprinting and jumping outcomes, particularly in well-trained athletes [29]. Still, such methods often lack structured progression across the full velocity spectrum and rarely involve overspeed work, which is essential for whip-like ballistic actions such as the drag flick [25]. Velocity-based training (VBT) was introduced to refine intensity prescription by tracking bar speed as an indicator of neuromuscular readiness. This allows athletes to train in optimal velocity zones rather than being limited to fixed percentage loads [30].

Banyard et al. (2017) showed that VBT decreased variability in training responses and improved explosive intent compared to percentage-based loading [30]. Rebelo et al. (2023) further confirmed these benefits, demonstrating that velocity-based complex training enhanced jump height and endurance in young athletes Even so, VBT serves mainly as a monitoring and load-management strategy rather than a full-scale training system [31]. French Contrast Training (FCT) is considered an advancement over earlier methods, combining elements of CST, plyometrics, PAP-based pairings, and overspeed exercises into one structured program. First developed in track and field by Gilles Cometti, FCT sequences four distinct exercises: (1) a heavy compound lift to build maximal strength, (2) a plyometric activity to utilize SSC adaptations, (3) a loaded power drill to connect strength and speed, and (4) an overspeed movement to stimulate neural recruitment beyond normal voluntary levels [28]. By addressing multiple points of the force–velocity spectrum in a single session, FCT develops a unique mix of strength, power, and speed qualities that carry over effectively to ballistic sports skills Zhao et al. (2025), in a meta-analysis, found that FCT generated greater gains in vertical jump, sprint acceleration, and maximal strength compared with CST or plyometrics alone, particularly in well-trained athletes[28]. This is particularly relevant for drag flick specialists, who frequently face performance plateaus with conventional programs. Thapa (2024), through a scoping review, also stressed that FCT incorporates neuromuscular mechanisms such as PAP and post-activation performance enhancement (PAPE) into one system, making it superior to isolated approaches[32]. Barra-Moura et al. (2024) offered experimental evidence in youth soccer, showing that both high- and low-frequency FCT programs enhanced explosive strength and speed, highlighting its flexibility across different training environments [33]. Collectively, such findings provide a strong basis for applying FCT to hockey drag flickers, whose performance depends on both force production and velocity-specific qualities.

The biomechanical similarity between FCT principles and drag flick execution further strengthens this rationale. Heavy lifting builds lower-limb and trunk strength required for generating ground force and transferring torque [15,23]. Plyometric exercises optimize SSC use during the plant and rotational stages of the flick[18]. Loaded power drills support strength-to-speed transitions, closely reflecting the rapid weight shift in drag flicking[17]. Finally, overspeed work replicates the whip-like stick acceleration during release, preparing the neuromuscular system to operate at supramaximal speeds [25]. Through the integration of these different elements, FCT creates a well-rounded framework for meeting both the technical and physical requirements of drag flicking. Beyond its physiological benefits, FCT also brings psychological and practical advantages. The diversity of exercises within each session helps reduce monotony, thereby improving athlete engagement and adherence. Its structured progression across various intensity levels allows for effective overload while avoiding excessive focus on any single component, which helps lower injury risk and optimize performance gains [32]. These features make FCT not only scientifically sound but also a realistic and effective choice for elite-level training environments. The evolution of training science acknowledges that no single approach—whether CST, plyometrics, or complex training—can fully meet the diverse demands of explosive sporting skills. French Contrast Training, by combining heavy resistance, plyometric, loaded, and overspeed exercises into one integrated framework, delivers a uniquely comprehensive solution [28,32,33]. Because its adaptations closely mirror the biomechanical and neuromuscular requirements of the drag flick, FCT emerges as the most promising method for optimizing flick performance among elite hockey players. This reasoning highlights the importance of experimentally evaluating its effectiveness against conventional approaches under controlled conditions. Evidence supporting the effectiveness of French Contrast Training (FCT) has grown across multiple sports, particularly those requiring explosive, high-speed actions. Zhao et al. (2025), in a meta-analysis, confirmed that FCT produced large improvements in vertical jump, sprint speed, and maximal strength, demonstrating its ability to enhance several neuromuscular qualities at once[28]. These results are especially relevant for elite athletes, where conventional programs often bring only limited gains due to prior adaptations. Thapa (2024), in a scoping review, also noted that FCT integrates post-activation potentiation (PAP) and post-activation performance enhancement (PAPE) more effectively than plyometric or contrast methods alone, making it well suited for ballistic sports skills [32].

Practical applications have been observed in team sports such as rugby, basketball, and soccer, where agility, sprinting, and jumping are crucial to performance. Seitz and Haff (2016) showed that PAP-based approaches, including contrast and complex training, significantly boosted sprint and jump performance in trained athletes [29]. Extending this, Barra-Moura et al. (2024) tested both high- and low-frequency FCT protocols in youth soccer players and found meaningful gains in explosive strength across different loading setups [33]. This flexibility indicates that FCT can be adapted effectively to various sports contexts and training demands. For field hockey, these findings carry relevance. The drag flick requires a blend of lower-limb explosive strength, trunk rotational torque, and whip-like stick acceleration—qualities that FCT directly enhances. The heavy lifts included in FCT sessions strengthen the foundational musculature of the lower limbs and trunk, while plyometric drills optimize SSC utilization during the plant and rotation phases of the flick [15,18,23]. Loaded power movements reinforce the transition from strength to speed, closely reflecting the rapid weight transfer in drag flicking[17]. Finally, overspeed exercises train the neuromuscular system at supramaximal velocities, replicating the whip-like mechanics of the release phase[25]. This biomechanical alignment underscores why FCT, though tested extensively in other sports, is theoretically suited to improve drag flick performance. Moreover, FCT appears especially valuable for trained populations such as elite hockey players. Grace (2024) argued that drag flick specialists represent a subgroup of athletes whose training adaptations plateau when relying solely on conventional strength or plyometric training [25]. The integrative nature of FCT addresses this limitation by simultaneously stimulating maximal force, speed, and neural recruitment Zhao et al. (2025) supported this fact by stating that trained athletes showed larger improvements in performance when using FCT compared to CST or plyometric training alone [28].

Therefore, FCT is not merely a substitute but a possible solution to the usual diminishing returns of traditional measures. Its transferability to sporting-specific performance is indicated by evidence gathered outside hockey, as well. Singh et al. (2018) showed that plyometric and power-training programs indirectly enhanced drag flick speeds by stimulating sprinting and jumping capabilities [17]. Similarly, Slimani et al. (2016) established plyometric adaptations transfer well across team sports into actual performance outcomes, thus further solidifying the connection between explosive training and technical performance[18]. By incorporating such qualities under one umbrella, FCT provides a more effective and targeted avenue for optimizing drag flick performance. From an applied point of view, FCT also reduces tedium and facilitates athlete compliance by including diverse stimuli within a single training session. Thapa (2024) noted that this variability promotes longer-term involvement, which is of critical importance for maintaining gains in elite environments [32]. In addition, its flexibility to various session frequencies, according to Barra-Moura et al. (2024), makes it feasible for adaptation to the hectic schedules of competitive hockey [33]. This flexibility renders FCT both scientifically informed and practically viable for application at the elite level Moreover, FCT has been validated across several sports for improving explosive power, speed, and strength, with consistent evidence indicating its superiority over conventional training models [28,29,32,33]. The mechanisms of FCT correspond closely with the biomechanical and neuromuscular demands of the drag flick, providing a theoretically sound pathway for enhancing this decisive skill in field hockey [15,17,18,23,25]. Although direct empirical studies applying FCT within hockey remain limited, converging evidence from other sports and the known mechanical requirements of drag flicking strongly reinforce its potential value. This highlights the necessity for controlled trials evaluating its influence on drag flick performance, positioning FCT as a promising approach for advancing both scientific understanding and practical applications in hockey conditioning. Despite the drag flick being recognized as one of the most decisive skills in modern hockey, targeted research into its specific training determinants is still relatively scarce. Much of the available evidence comes from biomechanical studies that describe movement patterns, angular velocities, and kinematic contributors such as trunk torque, hip–pelvic dissociation, and wrist mechanics [15,16]. Ibrahim et al. (2017) and Ng et al. (2018) both identified critical factors for flick performance, yet neither examined how targeted conditioning interventions could enhance these determinants [15,16]. Similarly, Ladru et al. (2023) reviewed penalty corner performance and drag flick biomechanics but emphasized the absence of controlled training studies linking physical interventions to improved flick outcomes [3]. This gap highlights the disparity between descriptive biomechanical knowledge and applied training science. Another limitation in the literature is that drag flick specialists are often grouped within general hockey cohorts, diluting insights into their unique physical and neuromuscular demands. Singh et al. (2018), for example, reported that plyometric training improved sprinting, jumping, and drag flick velocity in hockey players, but the study did not isolate flickers as a distinct subgroup [17]. Slimani et al. (2016) also demonstrated the benefits of plyometric adaptations for explosive performance across team sports, but again the findings were general rather than drag flick-specific[18]. As Grace (2024) argued, drag flickers represent a specialized population requiring velocity-specific, integrative training strategies beyond conventional methods[25]. Without dedicated trials, practitioners must extrapolate from broader literature, which may not fully capture the biomechanical uniqueness of the drag flick. The absence of intervention-based studies also extends to modern approaches. While CST, plyometrics, and PAP-based methods have been tested in general hockey populations, no randomized controlled trial (RCT) has directly compared advanced integrative frameworks such as French Contrast Training (FCT) against conventional methods in drag flick specialists. Zhao et al. (2025) demonstrated that FCT improves strength, power, and sprint performance more effectively than traditional training across multiple sports [28]. Thapa (2024) confirmed that FCT's combination of PAP, PAPE, and overspeed components makes it superior to isolated methods [32]. Barra-Moura et al. (2024) reported improvements in youth athletes under different FCT frequencies [33]. Yet none of these studies applied FCT to field hockey, let alone drag flick-specific performance, leaving its sport-specific efficacy untested. Another issue lies in the specificity of adaptations. Conventional strength training increases maximal force but lacks velocity specificity [23]. Plyometrics improve SSC efficiency but provide limited heavy loading [18].

Complex training leverages PAP but often omits supramaximal recruitment[29]. Velocity-based training individualizes load prescription but serves more as a monitoring system than a holistic framework [30,31]. FCT theoretically integrates all these elements, aligning closely with the biomechanical demands of the drag flick [25,28]. However, until tested experimentally in hockey contexts, its superiority remains speculative. This gap underscores the need for targeted RCTs that compare FCT directly with CST to determine which approach produces greater improvements in flick speed and explosive power. The lack of research is particularly problematic given the tactical importance of the drag flick. Penalty corners account for nearly one-third of goals in elite competitions[3], and drag flick specialists often determine match outcomes[10,11]. Morris-Binelli et al. (2022) showed that increased flick velocity reduces defensive anticipation, amplifying its offensive advantage [8]. Yet despite its centrality to modern hockey, there is little empirical guidance for practitioners on how best to condition flickers for optimal performance. This disconnects between the drag flick's tactical value and the paucity of evidence-based training interventions represents a critical gap in the literature. From a practical perspective, the absence of applied research forces coaches to rely on trial and error, borrowing methods validated in other sports without certainty of their effectiveness for hockey [25,28]. Such reliance risks under- or over-training, suboptimal adaptation, or even injury if interventions are not well-matched to the unique demands of drag flick execution. As Grace (2024) emphasized, without empirical data, conditioning strategies may fail to maximize the biomechanical potential of the drag flick [25]. This not only limits individual development but also places teams at a disadvantage in high-stakes competitions where penalty corner efficiency often determines outcomes [22]. While the biomechanical determinants of the drag flick are increasingly well understood, there remains a striking lack of experimental studies testing conditioning interventions in this context. No RCT has directly compared CST with FCT for drag flick specialists, despite strong evidence supporting the latter's effectiveness in other sports [28,32,33]. This knowledge gap leaves practitioners without sport-specific, evidence-based guidance for optimizing drag flick performance.

Addressing this void through targeted trials is essential for advancing both scientific understanding and applied practice in hockey conditioning. The evolution of training science in sport has increasingly emphasized the need for evidence-based, sport-specific conditioning interventions that not only enhance general athletic qualities but also translate directly into performance during competition. In field hockey, the drag flick is a skill of exceptional tactical importance, often determining match outcomes in tightly contested games [3,10,11]. Biomechanical analyses have clearly established its dependence on lower-limb explosive strength, trunk rotational torque, and stick velocity, with each element contributing to overall ball speed and accuracy [15,17]. Furthermore, performance analyses confirm that drag flick conversion rates strongly correlate with team success in international tournaments [3,22]. Despite this recognition, there remains a lack of targeted conditioning studies investigating how different training modalities influence the physical determinants of drag flick execution [25]. Conventional Strength Training (CST) has long been used in hockey conditioning programs, providing foundational improvements in maximal strength and structural resilience .[23] While CST is effective in raising general force capacity, its slower contraction velocities and limited specificity restrict its transfer to whip-like, high-velocity skills such as the drag flick [25]. In contrast, modern training methods such as plyometrics, complex training, and velocity-based protocols have demonstrated greater relevance for explosive movements by improving SSC utilization, PAP response, and velocity-specific adaptations [17,18,29,30,31]. However, these methods address only parts of the force–velocity continuum and rarely integrate overspeed elements critical for maximizing neuromuscular recruitment [25]. French Contrast Training (FCT), by combining heavy lifts, plyometric drills, loaded movements, and overspeed exercises within a single session, offers a comprehensive framework that aligns closely with the biomechanical and neuromuscular demands of drag flicking [28,32,33]. Evidence from other sports reinforces FCT's potential.

Zhao et al. (2025) reported that FCT outperforms CST and plyometric programs in improving sprint acceleration, vertical jump, and maximal strength, particularly in trained athletes [28]. Thapa (2024) highlighted FCT's unique integration of PAP and PAPE mechanisms, which are absent or only partially addressed in other methods [32]. Barra-Moura et al. (2024) further demonstrated that both high- and low-frequency FCT programs enhanced explosive strength in youth

NEED OF THE STUDY

Hockey is a sport that requires a unique blend of technical skill, explosive power, speed, and coordination. Among these, explosive actions such as drag flicking, jumping, and throwing are critical for performance outcomes. The drag flick has become a decisive scoring technique in modern hockey, demanding high levels of lower-limb strength, trunk stability, and upper-body speed.

Conventional training programs, however, often rely primarily on traditional strength and conditioning approaches, which may not adequately address the combined strength–speed–skill demands of hockey. Recent developments in sports science emphasize the importance of integrated training methods that improve both force and velocity while replicating sport-specific actions.

The French Contrast Method (FCM) is one such innovative approach, combining heavy strength training, plyometric drills, and explosive sport-specific tasks in a single sequence. By utilizing principles of post-activation performance enhancement (PAPE), FCM enhances neural drive and mechanical output, potentially leading to superior gains in explosive power. Although promising results have been reported in other sports, limited evidence exists regarding its application in hockey, especially for skill-specific outcomes such as drag flick performance.

Therefore, there is a clear need to investigate whether the French Contrast Method can provide greater improvements compared to conventional training methods. This study addresses that gap by examining the effects of a four-week FCM program on drag flick speed, bomb throw, and Penta jump performance in hockey players. The findings are expected to provide both scientific evidence and practical recommendations for optimizing training programs in modern hockey.

AIM AND OBJECTIVES OF THE STUDY

AIM OF THE STUDY

To evaluate the effectiveness of the French Contrast Method compared to conventional training on explosive performance variables in elite male hockey players.

OBJECTIVE OF THE STUDY

(a) To design and implement a tailored explosive power training program specifically for professional hockey drag flickers.

(b) To determine the extent to which gains in upper- and lower-limb explosive power translate into improvements in on-field drag flick performance.

(c) To provide practical recommendations for coaches and athletes to optimize training strategies and maximize competitive performance through enhanced explosive power transferability.

HYPOTHESIS OF THE STUDY

Alternative Hypothesis (H1)

There is a significant difference in explosive power gains among professional male hockey drag flickers following targeted training interventions compared to a control group not undergoing such interventions.

Null Hypothesis (H0)

There is no significant difference in explosive power gains among professional male hockey drag flickers following targeted training interventions compared to a control group not undergoing such interventions.

REVIEW OF LITERATURE

Section 1: Strength, Explosive Power Training, and Game-Specific Training

1. Duble, Utility of Plyometric Training Method for Improving Explosive Power of Leg and Speed of Hockey Players, 2021

Dr. Chandrakant S. Duble investigated the impact of plyometric training on hockey players' leg power and speed. Results demonstrated significant improvements ($p < 0.05$) in post-test performance, confirming plyometric training as a powerful tool for enhancing explosive abilities required in hockey.

2. Branet, The Effect of Plyometric Training on Lower Body Strength in Preadolescent Athletes, 2020

Camelia Branet examined preadolescent athletes and found weekly plyometric training significantly improved lower body explosive strength compared to controls. This highlights the adaptability of plyometric programs across ages and their transferability to hockey players' development.

3. Krishnan, Plyometric Training for Young Male Field Hockey Players, 2020

Vijaya Krishnan's study on under-16 hockey players revealed that plyometric interventions improved lower-limb power, agility, and reduced fatigue. Notably, gains were sustained even after detraining, showing long-term benefits for youth hockey training.

4. Reyment et al., Effects of a Four-Week Plyometric Training Program on Power in Male Collegiate Hockey Players, 2014

Reyment and colleagues assessed collegiate players after four weeks of plyometrics and observed enhanced vertical jump, sprint times, and anaerobic power. The study highlighted how short-term interventions can yield significant improvements in hockey-specific power outcomes.

5. Deng, Effects of Combined Upper and Lower Limb Plyometric Training Interventions on Physical Fitness in Athletes: A Systematic Review with Meta-Analysis, 2023

Deng's systematic review confirmed that combining upper- and lower-limb plyometric training leads to distinct neuromuscular adaptations. For hockey players, this dual approach is especially relevant since drag flicking and sprinting demand coordinated upper–lower body explosiveness.

6. Ramírez-Campillo, Effects of Plyometric Training Volume and Training Surface on Explosive Strength, 2024

Ramírez-Campillo compared training volumes and surfaces, showing that high volumes on hard surfaces maximized explosive performance by enhancing SSC efficiency. Such findings are valuable for optimizing plyometric protocols in hockey contexts.

7. Mathew, Effect of Hockey-Specific Training Program on Strength, Speed and Agility in Collegiate Hockey Players, 2024

Benobin Mathew compared hockey-specific training with regular programs, finding significantly greater gains in speed, strength, and agility in the sport-specific group. This reinforces the superiority of tailored conditioning for hockey performance.

8. Singh et al., Effect of Plyometric Training on Speed, Power and Drag Flick Velocity in Elite Hockey Players, 2018

Singh and colleagues studied elite hockey players and reported improvements in sprint, jump, and drag flick velocity following plyometric training. This directly links strength training adaptations with technical skills in hockey.

9. Slimani et al., Effects of Plyometric Training on Physical Performance in Team Sports: A Systematic Review and Meta-Analysis, 2016

Slimani's meta-analysis demonstrated moderate-to-large effect sizes of plyometric training on sprint, jump, and agility in team sports. These findings validate plyometrics as a core method for enhancing explosive hockey performance.

10. Cormie et al., Developing Maximal Neuromuscular Power: Training Considerations for Improving Explosive Power, 2011

Cormie highlighted the importance of training both maximal force and velocity for developing explosive power. This aligns with hockey’s need for rapid force production during sprints, shots, and drag flicks.

11. Zhao et al., Effect of French Contrast Training on Athletic Performance: A Meta-Analysis, 2025

Zhao demonstrated that French Contrast Training significantly improved sprint, jump, and strength outcomes compared to conventional methods, especially in trained athletes. This suggests strong applicability for elite hockey players requiring advanced adaptations.

12. Grace, The Role of Velocity-Specific Training in Ballistic Sport Skills, 2024

Grace argued that velocity-specific training is critical for ballistic sports such as hockey, where rapid force transfer underpins technical performance. This emphasizes the need to move beyond slow, heavy lifts to explosive, hockey-specific training strategies.

Section 2: Biomechanical Analysis of Drag Flick

1. Palaniappan, Biomechanical Analysis of Penalty Corner Drag Flick in Field Hockey, 2018

Rajinikumar Palaniappan investigated biomechanical variables influencing drag flick velocity. Stick velocity was the strongest determinant of ball speed, while drag length and right-foot placement showed moderate correlations. These results highlight the significance of stick kinematics in maximizing performance.

2. Bari, Three-Dimensional Analysis of Variation between Successful and Unsuccessful Drag Flick Techniques in Field Hockey, 2018

Mohd Arshad Bari compared successful and unsuccessful drag flicks, finding that successful attempts had higher mean ball velocities and accuracy. This suggests that velocity directly enhances not only scoring potential but also placement effectiveness.

3. Rabia, Relationship Between Kinematical Factors and Ball Velocity of the Penalty Corner Drag-Flick in Field Hockey, 2022

Rabia analyzed kinematic determinants of ball velocity in elite players. Longer drag length, higher dragging velocity, and wider stance increased ball speed, while smaller knee angles optimized force transfer. These findings provide biomechanical cues for coaching drag flickers.

4. López de Subijana, Biomechanical Analyses of the Penalty-Corner Drag-Flick of Elite Male and Female Hockey Players, 2010

Cristina López de Subijana examined international players, identifying wide stance, rapid stick back lift, and sequential pelvis–trunk–stick rotation as performance-critical. The study confirmed coordinated sequencing as essential for generating high stick angular velocities.

5. Antonov, Kinematic Structure and Characteristics of the "Drag Flick" Field Hockey Technique, 2021

Antonov revealed that the magnitude of force impulse during stick–ball interaction and the path length of the stick significantly affect ball velocity. This underscores the role of both impulse generation and trajectory optimization.

6. Ibrahim, Trunk Angular Momentum and Drag Flick Velocity in Elite Hockey Players, 2017

Ibrahim demonstrated that trunk angular momentum correlates strongly with stick velocity, highlighting the central role of trunk rotation and stability in producing high drag flick velocities.

7. Ng et al., Hip–Pelvic Dissociation and Lumbar Contribution to Drag Flick Performance, 2018

Ng and colleagues reported that effective hip–pelvic dissociation and lumbar spine contribution improve drag flick accuracy and ball speed. Their results emphasize the role of core strength and mobility in proximal-to-distal sequencing.

8. De Subijana, Performance Differences in Drag Flick Execution among Elite Players, 2025

De Subijana compared performance profiles of elite drag flickers, concluding that successful players demonstrated superior pelvis–trunk sequencing, leading to higher angular stick velocities and optimized ball flight.

9. Morris-Binelli, Ball Flight Characteristics and Defensive Anticipation in Drag Flicks, 2022

Morris-Binelli et al. found that increased flick velocity and variation in release angle reduce goalkeeper anticipation. The study highlighted the interaction between biomechanics and tactical unpredictability in drag flick execution.

10. Grace, Velocity-Specific Training and Biomechanical Transfer in Drag Flicking, 2024

Grace discussed how velocity-specific neuromuscular training improves biomechanical determinants such as whip-like stick acceleration and trunk rotational velocity. Training adaptations were shown to directly enhance drag flick technical outcomes.

11. Cormie et al., Rate of Force Development as a Determinant of Ballistic Sport Performance, 2011

Cormie et al. emphasized that rate of force development (RFD) is critical for ballistic movements like drag flicks, where rapid force generation in short timeframes dictates technical execution and success.

12. Singh et al., Plyometric Training and Drag Flick Velocity in Hockey Players, 2018

Singh's intervention study demonstrated that plyometric training increased drag flick ball velocity by enhancing lower-limb power and trunk stability, reinforcing the connection between neuromuscular conditioning and biomechanical execution.

Section 3 – Outcome Measures

1. Chamari, The Five-Jump Test for Distance as a Field Test to Assess Lower Limb Explosive Power in Soccer Players, 2008

Chamari validated the Five-Jump Test (5JT), showing strong correlations between field test performance and laboratory measures of lower-limb explosive power. The study emphasized that the test is reliable and applicable under field conditions, making it suitable for assessing hockey players' explosive power.

2. Singh, Application of Penta Jump Test in Assessing Explosive Power of Hockey Players, 2019

Singh examined the use of the Penta Jump test in elite hockey players and reported significant associations between test scores, sprint speed, and drag flick velocity. The findings support its practical utility as a simple and valid assessment for lower-limb power in hockey.

3. Beckham, Assessing Full Body Impulsive Ability Using a Range of Medicine Ball Loads for the Backward Overhead Medicine Ball Throw, 2023

George K. Beckham assessed how varying medicine ball loads influenced power during the backward overhead throw. Results demonstrated that 2.7–5.5 kg loads were optimal for evaluating whole-body explosive ability. This supports the BOMB throw as a valid measure of total body impulsiveness in sport.

4. Cronin, Reliability and Validity of Medicine Ball Throws to Assess Upper-Body Power, 2014

Cronin and colleagues validated medicine ball throws as a reliable assessment of upper-body explosive strength. Their findings confirmed the BOMB throw as an accessible and effective outcome measure to quantify power in athletes, including hockey players.

5. Morris-Binelli, Measurement of Drag Flick Speed Using Radar Technology, 2021

Morris-Binelli validated radar speed guns for measuring drag flick ball velocity, demonstrating excellent reliability and sensitivity. The study established radar assessment as a gold-standard method for monitoring drag flick performance in hockey.

6. Ladru, Radar-Based Analysis of Ball Velocity in Elite Hockey Penalty Corners, 2023

Ladru and colleagues used radar to analyze ball velocity in elite-level penalty corners, confirming that radar technology reliably distinguishes performance differences between players. This makes radar speed monitoring a practical and accurate research and coaching tool.

METHODLOGY

AND

PROCEDURE

Study Design

This study was designed as a Randomized Controlled Trial (RCT) with a duration of 4 weeks, consisting of 8 sessions (2 sessions per week, 72 hours apart). The trial was prospectively registered with the Clinical Trial Registry of India (CTRI/2025/07/090892).

Sample Size Calculation

The required sample size was calculated a priori using G*Power (v3.1) for a two-group repeated measures design (time × group). Assuming a medium effect size ($f = 0.25$), an alpha level of 0.05, and power ($1 - \beta$) = 0.80, the estimated total sample size was $n = 74$ (37 participants per group). To account for potential attrition, an additional 10 participants (5 per group) were recruited (total assessed = 84), but no participants dropped out; therefore, the final sample included in the analysis was 74 participants (37 per group).

Participants

A total of 84 professional male hockey players specializing in the drag flick technique were initially assessed for eligibility. To minimize the risk of attrition, an additional 10 participants were recruited (5 per group). However, all recruited athletes completed the study, resulting in a final sample size of 74 participants, with 37 allocated to the Experimental Group (French Contrast Method) and 37 to the Control Group (Conventional Training).

- Age range: 18–35 years
- Gender: Male only

Inclusion criteria

a) Professional male hockey players who specialize in the drag flick technique

b) Aged between 18–35 years

c) Currently active players competing at the national or international level, with participation in professional-level competitions or leagues

d) Willingness to commit to the study duration and adhere to training protocols

Exclusion criteria

a) Players undergoing post-season recovery phase of their annual training plan

b) Players who did not obtain medical clearance from the designated medical team

c) Players with a history of musculoskeletal injuries or medical conditions that could limit training participation

d) Players not currently active in professional-level competitions or leagues

e) Player’s unwilling or unable to commit to the intervention protocol consistently

Participants were recruited from Centres of Excellence (COE) Vaishali, Bihar, and NCOE Bhopal, Madhya Pradesh. Ethical approval was obtained from the ABSMARI Ethics Committee (Ref No. ABSMARI/IEC/2025/175), and informed consent was provided by both the participating centers and the athletes.

Randomization and Blinding

Participants were randomly allocated into two groups (Experimental and Control) using a block randomization method to ensure equal distribution. Allocation concealment was maintained using sealed opaque envelopes prepared by an independent researcher not involved in assessments or interventions.

Blinding was applied as follows:

- Participants: Not blinded due to the nature of training intervention.
- Assessors: Outcome assessors were blinded to group allocation.
- Data Analysts: Statistical analysis was performed by a blinded investigator.

Interventions

Experimental Group (French Contrast Method, FCM)

Participants in the experimental group underwent a French Contrast Method–based training protocol structured around functional movement patterns (Squat, Hinge, Lunge, Push, Pull, Brace). Each session lasted 40–60 minutes and consisted of:

1. Mobility warm-up (ankle, shoulder, and core-focused)
2. FCM blocks (Heavy strength → Plyometric → Assisted Plyometric → Sports-specific explosive drag flick transfer)
3. Drag flick–specific supersets

The full 4-week progressive protocol is detailed in Table 1. Sessions were conducted in a combined field and gym setting, supervised by a physiotherapist and strength & conditioning coach. Progression was achieved through incremental increases in strength load (%1RM), plyometric intensity (bodyweight to resisted/vest), medicine ball weight (2–5kg), and band resistance.

Control Group (Conventional Training)

Participants in the control group followed their routine team-based training, which included a combination of strength and plyometric sessions, matched for frequency and duration (2 sessions/week, 40–60 min). Training sessions included strength days (squats, presses, rows, etc.) and agility-based days, representing conventional methods without French Contrast sequencing.

Outcome Measures

Three outcome measures were selected for this study to evaluate explosive power and sport-specific performance in hockey drag flickers. These measures were chosen for their established reliability and validity in assessing neuromuscular performance and their direct relevance to field hockey.

1. **Drag Flick Speed**
    - Tool: Radar Speed Gun (Doppler-based technology).

- Description: Measures the ball velocity during drag flick execution in meters per second.
- Rationale: Radar-based assessment is a valid and reliable method for monitoring stick-ball speed in field hockey penalty corners (Morris-Binelli et al., 2021; 2022). This was considered the primary outcome measure of the study, as it directly reflects hockey-specific performance.

2. **Bomb Throw Test (Backward Overhead Medicine Ball Throw)**
    - Tool: Medicine ball (3–5 kg, load standardized by body weight range).
    - Description: Participants perform a backward overhead throw from a standing position; the distance achieved (in meters) is recorded.
    - Rationale: The test has been widely used as a measure of whole-body explosive strength, involving coordinated contribution of the lower limbs, trunk, and upper body (Cronin et al., 2014; Beckham et al., 2023). It is reliable for assessing total-body power relevant to sporting movements such as the drag flick.
3. **Penta Jump Test (Five-Jump Test)**
    - Tool: Standard measuring tape and marked field surface.
    - Description: Participants perform five consecutive horizontal jumps, taking off and landing bilaterally. The total distance (in meters) is measured.
    - Rationale: This test is a validated indicator of lower-limb explosive strength and reactive power (Chamari et al., 2008; Singh, 2019). It reflects the horizontal force application critical for acceleration phases in hockey and the drive phase of the drag flick.

Assessment Timeline:

All three tests were conducted at baseline (pre-intervention) and immediately after the four-week intervention (post-intervention) under standardized field conditions. Each athlete performed three valid trials per test, with the best performance recorded for analysis. Tests were administered by blinded assessors to minimize bias.

Materials and Instruments

1. **Strength and Conditioning Equipment**
   - Olympic barbells, weight plates, dumbbells, and squat rack (for back squat, front squat, bench press, hip thrusts, rows).
   - Trap bar for deadlifts and trap bar jumps.
   - Resistance bands (light to heavy) for assisted plyometrics and resisted stick drills.
   - Kettlebells (8–24 kg) for kettlebell swings.
   - Medicine balls (2–5 kg) for throws, slams, and scoop tosses.
   - Landmine attachment for rotational presses.
   - Stability ball for rollouts and core activation drills.
   - Plyometric boxes for jump training.
2. **Hockey-Specific Equipment**
   - Standard hockey sticks (field hockey drag flick technique practice).
   - Hockey balls (standard competition size and weight).
   - Resistance harness/bands for resisted drag flick and sprint drills.
3. **Outcome Measurement Tools**
   - **Radar Speed Gun (Doppler-based):** To measure drag flick speed in meters/second.
   - **Measuring tape / marked field area:** For Bomb Throw (backward overhead medicine ball throw) and Penta Jump test.
   - **Video recording device (optional, if you used it):** To validate performance and ensure standardized technique.
4. **Participant Preparation and Safety**
   - Foam rollers and barbell attachments for soft tissue mobility (calf, pec rolling).
   - Mats for mobility and core exercises.
   - Stopwatch and clipboard for session timing and monitoring adherence.

5. **Data Collection and Analysis**

   - Data entry sheets / digital spreadsheet for recording results.
   - **SPSS v27 software (IBM, Armonk, NY, USA):** For statistical analysis.

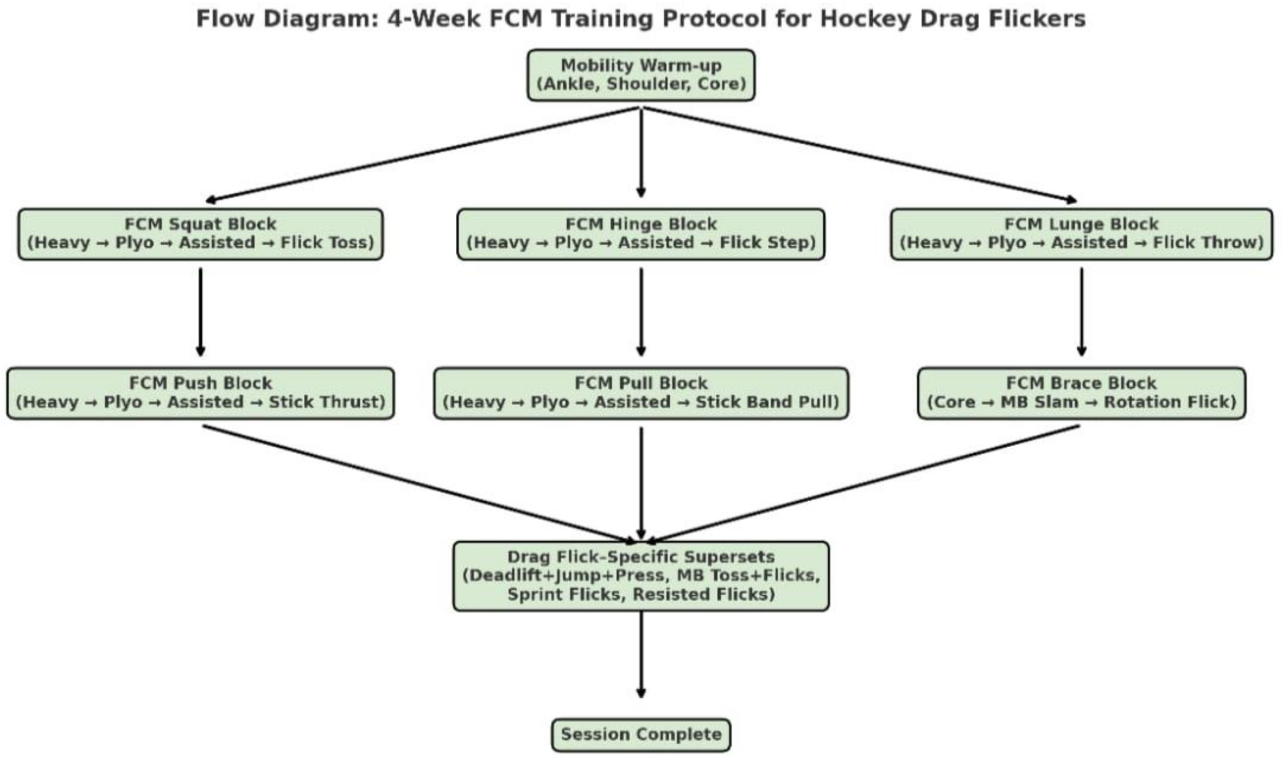


FIG-(1) Flow diagram of session structure: each session begins with drag flick–specific mobility warm-up, progresses through six functional movement FCM blocks (Squat, Hinge, Lunge, Push, Pull, Brace; each including heavy strength, plyometric, assisted plyometric, and sport-specific explosive drills), followed by drag flick–specific supersets, concluding with session completion.

Session	**Mobility (10–12 min)**	**Functional Movement Blocks (French Contrast Method: Heavy → Plyo → Assisted → Sport-Specific)**	**Drag Flick–Specific Supersets**

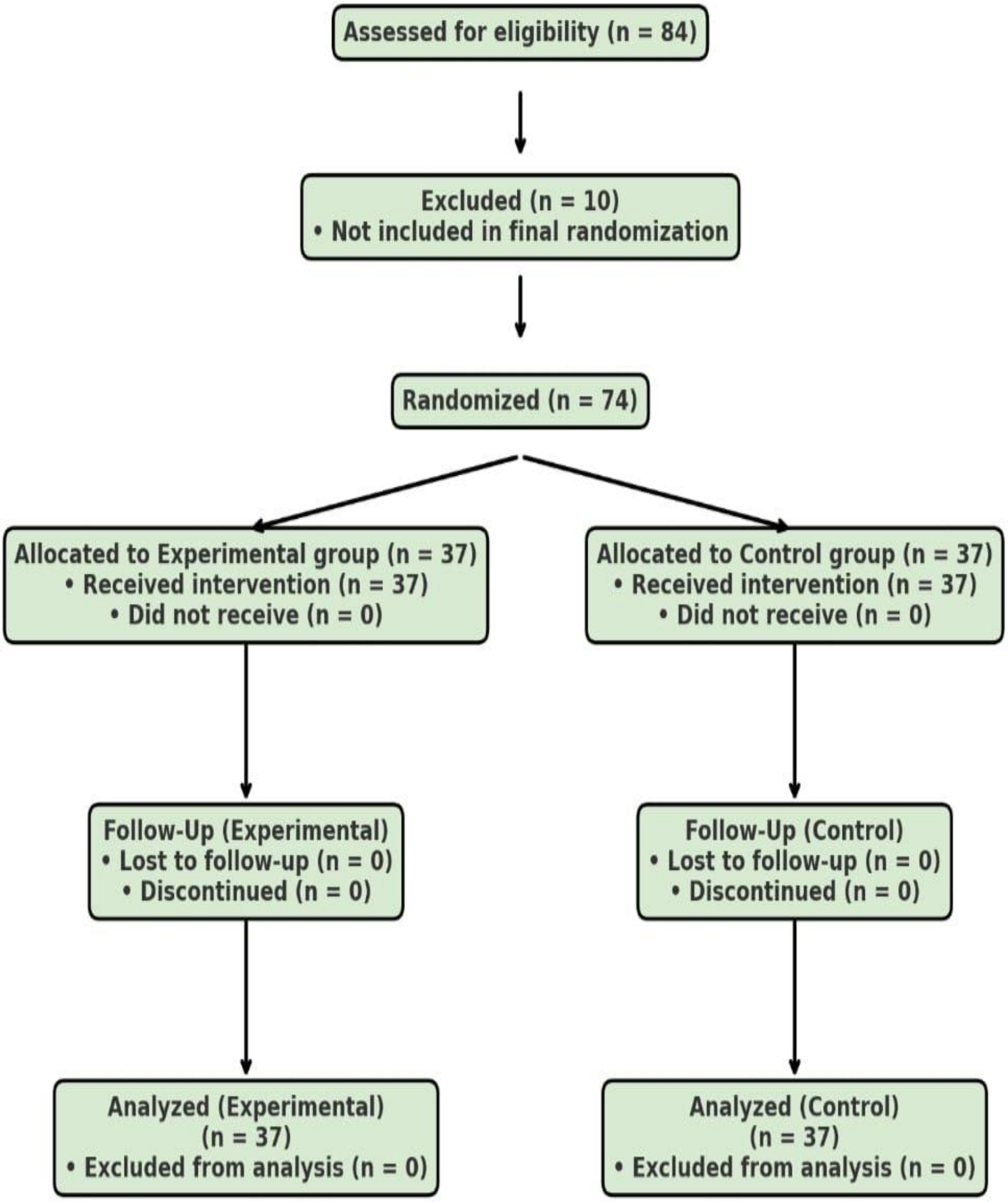
Week 1 – S1	Barbell calf smash, ankle band distraction, barbell pec rolling, serratus wall slides, prone curl-to-press, single-leg glute bridge, contra-lateral plank	Squat: Back squat 3×3 @75% → Squat jump 3×5 → Band-assisted vertical jump 3×5 → MB scoop toss 3×3 (2kg) Hinge: Deadlift 3×3 @75% → Trap bar jump 3×5 → Band-assisted broad jump 3×5 → Resisted flick step-through 3×2/side Lunge: DB Bulgarian split squat 3×3 @75% → Split squat eccentric jump 3×4 → Band-assisted split jump 3×5 → Lateral MB throw 3×3 (2kg) Push: Bench press with bands 3×3 @75% → Plyo push-up 3×5 → Band-assisted push-up 3×6 → Stick push-thrust 3×3 Pull: Half-kneel row 3×3 → Jump pull-up 3×4 → Band-assisted pull-up 3×6	A: Deadlift + Squat Jump + Half-Kneel Press ×3 + 3 Flicks B: MB Rotational Toss ×6 + 3 Flicks

		→ Stick band pull-through 3×3 Brace: Single-leg plate low-to-high 3×3 → MB slam complex 3×6 → Stability ball rollout 3×8 → Rotational stick core drill 3×3	
Week 1 – S2	Same as S1 + kneeling calf raises	Squat: Front squat 3×3 @75% → Split squat jump 3×5 → Band-assisted jump 3×5 → MB scoop toss 3×3 (2kg) Hinge: Hip thrust 3×3 @75% → Kettlebell swing 3×6 → Band-assisted jump 3×5 → Resisted flick 3×2 Lunge: Skater squat 3×3 @75% → Skater jump 3×5 → Band-assisted skater jump 3×5 → Lateral stick flick 3×3 Push: Squat-to-press 3×3 @75% → Landmine	A: Half-Kneel Row + Skater Lunge ×3 + 3 Flicks B: Jump → Sprint → Flick ×4 + 3 Flicks

		rotation press 3×5 → Band-assisted push 3×5 → Stick push-thrust 3×3 Pull: Weighted row 3×3 @75% → Explosive inverted row 3×5 → Band-assisted row 3×5 → Stick band pull 3×3 Brace: Nordic curl 3×3 → Rotational MB slam 3×6 → Pike rollout 3×8 → Rotational stick flick 3×3	
Week 2 – S3	Same mobility	Same structure as Week 1 (↑ load to 80–85%, MB 3kg, stronger bands)	Same supersets, add light band resistance
Week 2 – S4	Same mobility	Same structure as Week 1 (↑ load to 80–85%, MB 3kg, stronger bands)	Same supersets, add light band resistance
Week 3 – S5	Same mobility	Same structure (↑ load to 85–90%, reduce reps 3×2, MB 4kg, add weighted vest to jumps)	MB Toss + Flicks / Sprint Flick (vest)

Week 3 – S6	Same mobility	Same structure (↑ load to 85–90%, reduce reps 3×2, MB 4kg, band-assisted plyos more explosive)	MB Toss + Flicks / Sprint Flick (vest)
Week 4 – S7	Same mobility	Peak load 85–90%, MB 5kg, max band resistance; all exercises with maximal intent	Resisted Sprint Flicks + MB 5kg Flick Throws
Week 4 – S8	Same mobility	Peak load 85–90%, MB 5kg, max band resistance; all exercises with maximal intent	Resisted Sprint Flicks + MB 5kg Flick Throws

Table1- Full 4-week progressive protocol



Here is the consort flow diagram of the study in fig (2)

Procedure

The study was carried out in several sequential phases:

1. Recruitment and Screening

   Professional male hockey players specializing in the drag flick technique were recruited from the Centre of Excellence (COE), Vaishali, Bihar, and NCOE, Bhopal, Madhya Pradesh. A total of 84 athletes were assessed for eligibility based on inclusion and exclusion criteria. After screening, 74 participants were randomized into two groups: Experimental (FCM, n = 37) and Control (Conventional, n = 37).

2. Baseline Assessment (Pre-Intervention Testing)

   All participants underwent baseline assessments of performance outcomes before the intervention:

   - Drag Flick Speed (Radar Speed Gun)
   - Bomb Throw Test (backward overhead medicine ball throw, distance in meters)
   - Penta Jump Test (5-hop distance, meters)

     Assessments were conducted under standardized field conditions by blinded assessors.

Randomization and Allocation

Participants were randomly allocated into two groups using block randomization. Allocation concealment was ensured by sealed opaque envelopes.

1. Intervention Phase (4 Weeks, 8 Sessions)

   - Experimental Group (FCM): Received the French Contrast Method–based protocol, structured into mobility warm-up, six functional movement FCM blocks (squat, hinge, lunge, push, pull, brace), and drag flick–specific supersets. Each session lasted 40–60 minutes, conducted twice per week (72 hrs apart), under supervision of a physiotherapist and strength & conditioning coach. The detailed progression is presented in Table X.

- Control Group (Conventional): Performed team-based traditional strength and plyometric training of equivalent duration and frequency, including general strength (squats, presses, rows) and agility drills, but without French Contrast sequencing or drag flick–specific supersets.

2. Adherence and Monitoring

   All sessions were supervised to ensure correct technique, intensity progression, and adherence. Session attendance and training loads were recorded. No adverse events or dropouts were reported.

3. Post-Intervention Assessment

   After completion of the 4-week intervention, all participants repeated the outcome measures (Drag Flick Speed, Bomb Throw Test, Penta Jump Test) under the same standardized conditions.

4. Data Handling

   Data were coded and entered into a digital spreadsheet for statistical analysis. Only blinded assessors and analysts had access to performance outcomes.

5. Post-Intervention Assessment

   After completion of the 4-week intervention, all participants repeated the outcome measures (Drag Flick Speed, Bomb Throw Test, Penta Jump Test) under the same standardized conditions.

6. Data Handling

   Data were coded and entered into a digital spreadsheet for statistical analysis. Only blinded assessors and analysts had access to performance outcomes.

FIG-3 BOMB THROW TEST

FIG-4 PENTA JUMP TEST

Figure 5- drag flick technique

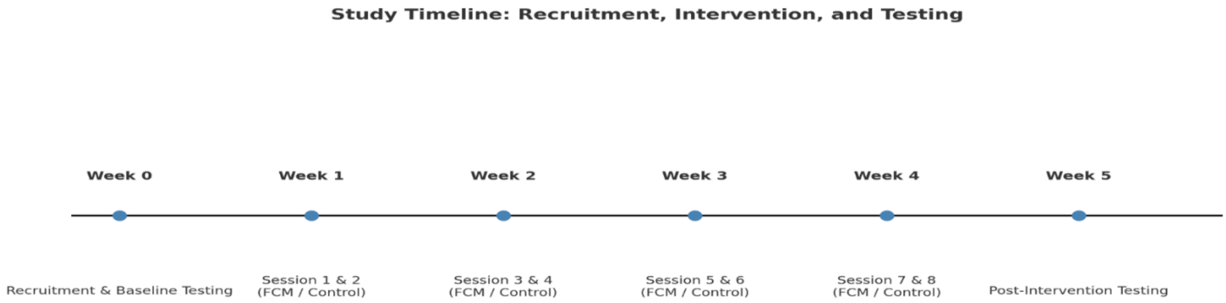


FIG- (6) showing study timeline

STASTICAL ANALYSIS

All data were analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Data normality was tested using the Shapiro-Wilk test. Descriptive statistics (mean ± standard deviation) were calculated for all outcome measures.

For inferential analysis:

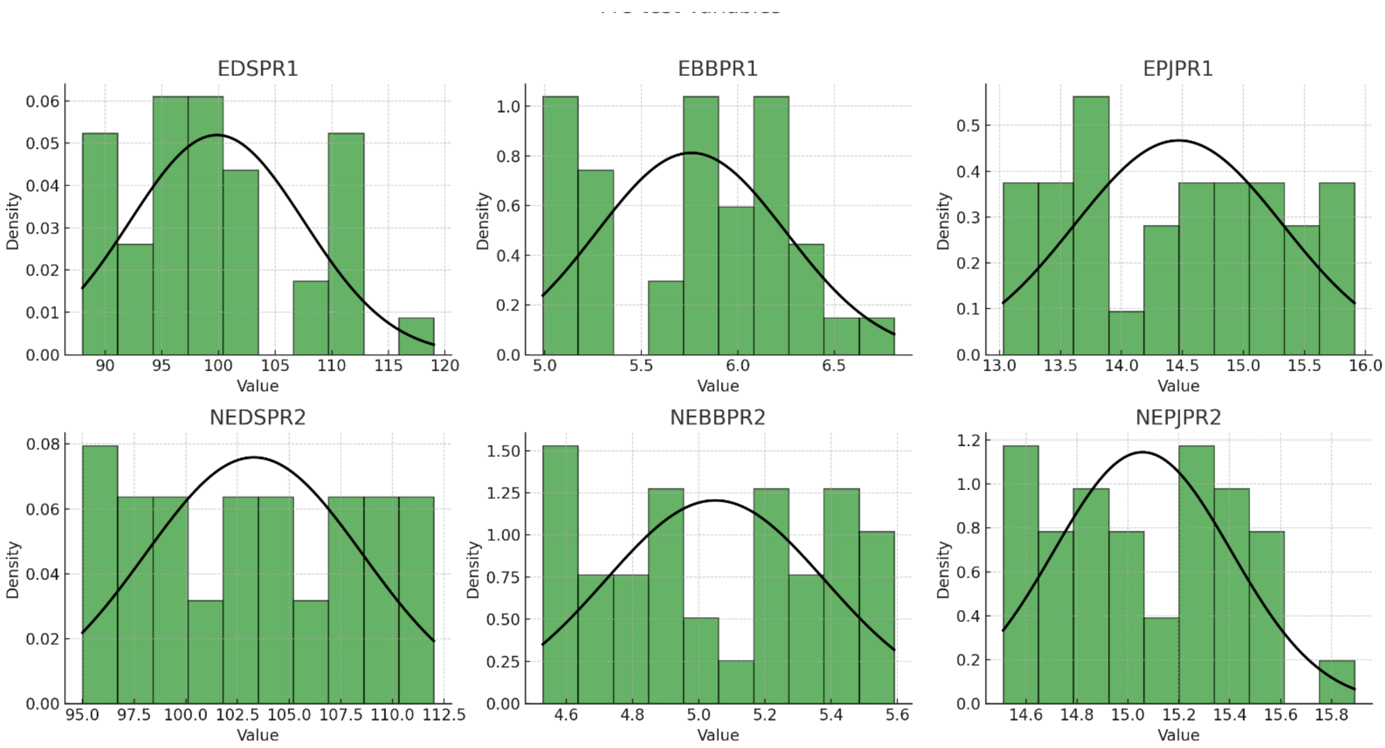
- Within-group differences (pre vs post) were analyzed using paired t-tests (if normal) or Wilcoxon signed-rank tests (if non-normal).
- Between-group differences (Experimental vs Control) were analyzed using independent samples t-tests (if normal) or Mann–Whitney U tests (if non-normal).
- Where appropriate, two-way repeated measures ANOVA (time × group) was applied to evaluate interaction effects.
- The level of significance was set at $p < 0.05$.

RESULTS

Normality Testing

Variable	**W**	**p-value**
EDSPR1	0.939	0.043
EBBPR1	0.932	0.025
EPJPR1	0.947	0.079
EDSPO1	0.976	0.586
EBBPO1	0.979	0.685
EPJPO1	0.939	0.049
NEDSPR2	0.946	0.074
NEBBPR2	0.928	0.020
NEPJPR2	0.950	0.095
NEDSPO2	0.967	0.322
NEBBPO2	0.922	0.013
NEPJPO2	0.920	0.011

TABLE -2 Normality data of all the outcome measures



Graph 1. Histograms with Normal Curve Overlay for Pre-test Variables

The pre-test distributions of drag flick speed, bomb throw, and Penta jump for both experimental and control groups displayed approximately bell-shaped histograms with some minor deviations from perfect normality. The Shapiro–Wilk test confirmed that most variables did not significantly deviate from normality ($p > 0.05$), although slight departures were observed in a few cases such as EDSPR1, EBBPR1, and NEBBPR2. Importantly, these deviations were not substantial enough to indicate extreme skewness or outliers. Given the adequate sample size ($n > 30$ per group) and the robustness of parametric methods against mild violations of normality, the data were considered suitable for parametric statistical analysis. Visual inspection of the histograms supported this decision, demonstrating that the baseline values were reasonably normal and appropriate for further inferential testing.

Descriptive Statistics

Variable	Group	N	Min	Max	Mean	SD
Drag Flick Speed (Pre)	Experimental	37	88	119	99.86	7.79
Drag Flick Speed (Pre)	Control	37	95	112	103.30	5.33
Drag Flick Speed (Post)	Experimental	37	103	128	115.97	6.71
Drag Flick Speed (Post)	Control	37	101	119	107.81	4.35
Bomb Throw (Pre)	Experimental	37	4.99	6.81	5.76	0.50
Bomb Throw (Pre)	Control	37	4.53	5.59	5.05	0.34
Bomb Throw (Post)	Experimental	37	5.47	7.89	6.71	0.60
Bomb Throw (Post)	Control	37	4.59	5.72	5.17	0.36
Penta Jump (Pre)	Experimental	37	13.03	15.91	14.47	0.87
Penta Jump (Pre)	Control	37	14.51	15.89	15.06	0.35

Penta Jump (Post)	Experimental	36	15.01	18.01	16.44	0.91
Penta Jump (Post)	Control	37	14.81	16.12	15.50	0.43

TABLE 3

The descriptive statistics demonstrate substantial improvements in the experimental group across all variables. For example, drag flick speed increased from 99.86 to 115.97, bomb throw from 5.76 to 6.71, and Penta jump from 14.47 to 16.44. The control group showed smaller gains. These descriptive trends suggest that the French Contrast Method was more effective in enhancing explosive performance.

Within-Group Comparisons (Paired t-tests)

Variable	Group	Mean Difference	t(df)	p-value	Interpretation
Drag Flick Speed	Experimental	-16.11	-12.02(36)	< .001	Significant improvement
Drag Flick Speed	Control	-4.51	-4.12(36)	< .001	Moderate improvement
Bomb Throw	Experimental	-0.95	-15.88(36)	< .001	Significant improvement
Bomb Throw	Control	-0.12	-21.13(36)	< .001	Small improvement
Penta Jump	Experimental	-1.98	-32.06(35)	< .001	Large improvement
Penta Jump	Control	-0.44	-12.18(36)	< .001	Moderate improvement

TABLE 4 Within-group analysis revealed highly significant improvements in the experimental group for all outcomes, with large t-values indicating strong effects. The control group also improved, but with smaller effect sizes. These findings reinforce the effectiveness of the French Contrast Method.

Between-Group Comparisons (Independent t-tests)

Variable	Exp Mean	Ctrl Mean	t(df)	p-value	Interpretation
Drag Flick Speed	115.97	107.81	8.16(36)	< .001	Experimental > Control
Bomb Throw	6.71	5.17	12.53(36)	< .001	Experimental > Control
Penta Jump	16.44	15.50	5.84(35)	< .001	Experimental > Control

TABLE 5

Independent t-tests demonstrated that the experimental group significantly outperformed the control group in all post-test measures. This provides strong evidence for the superiority of the French Contrast Method.

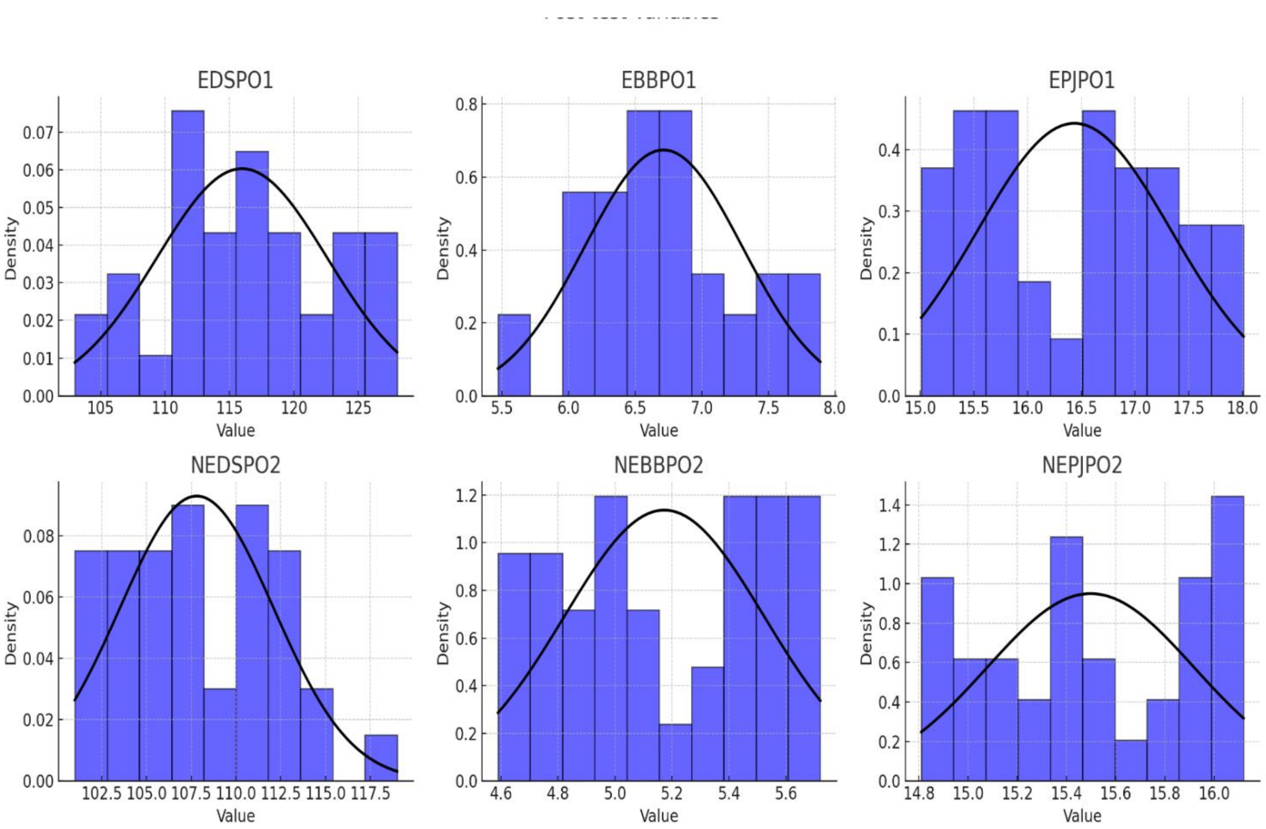
ANCOVA (Adjusted for Pre-test)

Variable	F (1, df)	p-value	Effect
Drag Flick Speed	F (1,71) = 46.66	< .001	Significant group effect
Bomb Throw	F (1,71) = 111.18	< .001	Significant group effect
Penta Jump	F (1,70) = 373.42	< .001	Significant group effect

TABLE 6

ANCOVA results are reported as F (1, df), where the first degree of freedom represents the group comparison (experimental vs control) and the second corresponds to the residual error term. For example, Drag Flick Speed showed F (1,71) = 46.66, p < .001, indicating a significant group effect after controlling for pre-test values.

ANCOVA confirmed that even after adjusting for pre-test performance, the experimental group retained a significant advantage over the control group in drag flick speed, bomb throw, and penta jump (*p* < .001 for all). This indicates that the observed improvements were due to the French Contrast Method intervention itself rather than baseline.

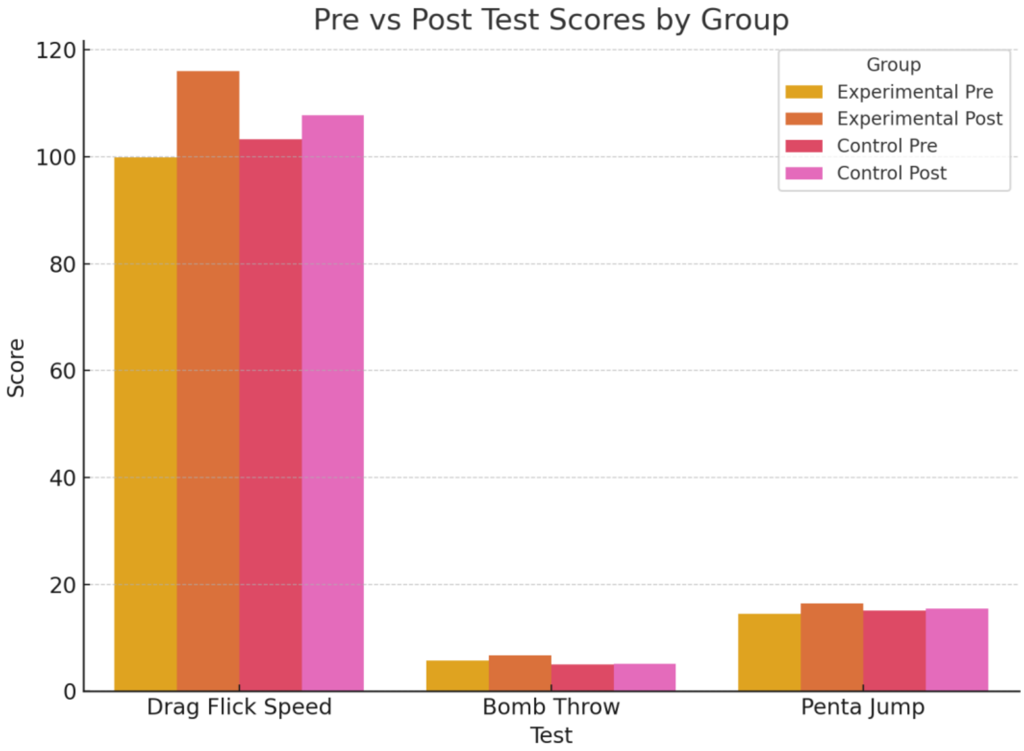


Graph-2 Histograms with Normal Curve Overlay for Post-test Variables

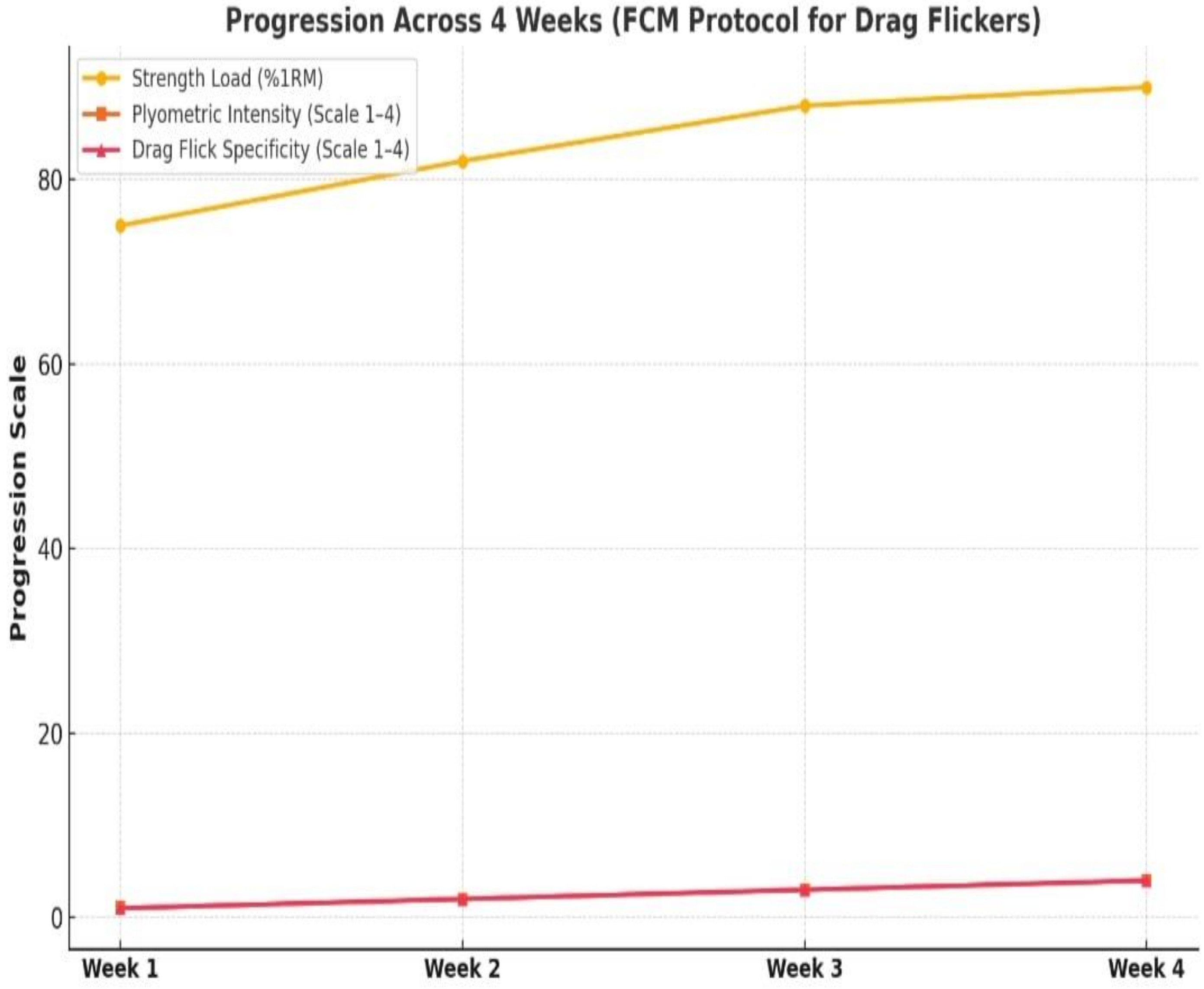
The post-test distributions of drag flick speed, bomb throw, and penta jump for both experimental and control groups revealed clearer bell-shaped curves compared to the pre-test results, indicating an improvement in normality patterns after the intervention. The Shapiro–Wilk test showed that while most variables conformed to normal distribution ($p > 0.05$), some mild deviations were still present, particularly in EPJPO1, NEPJPO2, and NEBBPO2. Despite these slight departures, no severe skewness or outliers were observed. Furthermore, the experimental group's histograms showed a noticeable upward shift in values, reflecting substantial gains in performance following the French Contrast Method intervention, whereas the control group exhibited only modest changes. Considering the sample size ($n > 30$ per group) and the robustness of parametric tests, the post-test data were deemed suitable for parametric analyses. Together, the Shapiro–Wilk results and visual inspection of the histograms provide strong support for the reliability of the statistical findings.

Graphical Representation

This figure 5 illustrates the changes in performance from pre- to post-test across both experimental and control groups. Improvements were seen in all three variables; however, the **experimental group demonstrated substantially greater gains**. Drag flick speed increased sharply from ~100 to ~116, bomb throw improved from ~5.7 m to ~6.7 m, and penta jump rose from ~14.5 m to ~16.4 m. In contrast, the control group showed only modest increases in each test. These results visually reinforce the statistical findings, confirming the superior effect of the French Contrast Method.

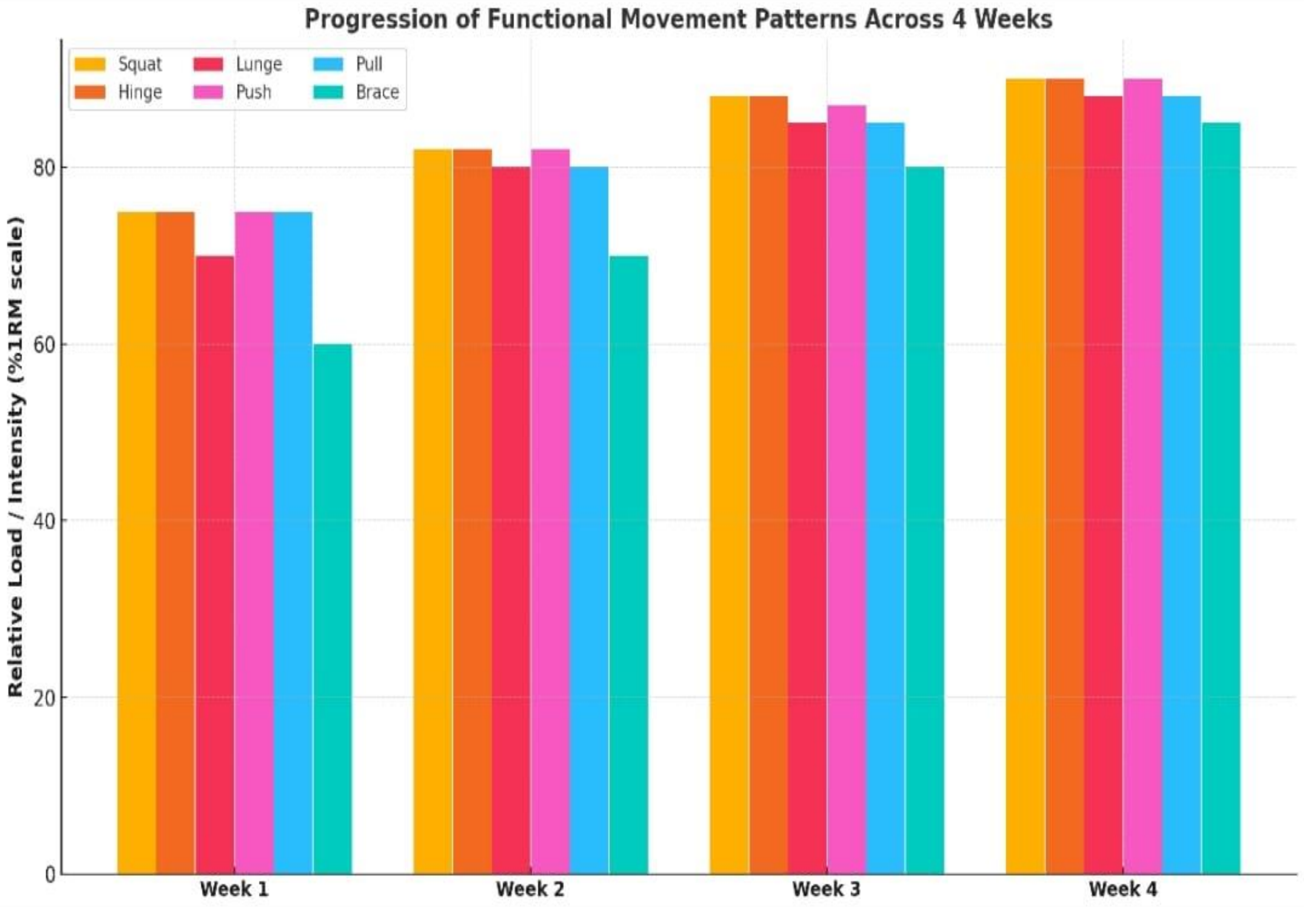


Graph(3) Pre- vs Post-test Scores for Drag Flick Speed, Bomb Throw, and Penta Jump



Graph (4) Progression Across 4 Weeks (French Contrast Method Protocol for Drag Flickers)

This figure shows the structured progression of the French Contrast Method program across four weeks. Strength load (%1RM) increased steadily from ~75% in Week 1 to ~90% by Week 4. Plyometric intensity and drag flick specificity also progressed consistently on a 1–4 scale. This demonstrates a well-planned, progressive overload strategy that integrated strength, plyometric, and sport-specific elements, providing a balanced stimulus for performance adaptation.



Graph (5) Progression of Functional Movement Patterns Across 4 Weeks

This figure highlights the weekly progression of six functional movement patterns (squat, hinge, lunge, push, pull, brace). All movement categories showed gradual increases in relative load and intensity over four weeks, starting around 70–75% 1RM and reaching ~85–90% by Week 4. The balanced progression across movement patterns indicates that the training protocol was comprehensive, targeting both lower- and upper-body strength, which likely contributed to the observed improvements in drag flick performance, upper-body throwing power, and lower-limb explosiveness.

Overall Interpretation

The experimental group undergoing the French Contrast Method demonstrated significantly greater improvements in drag flick speed, bomb throw, and Penta jump compared to the control group. These findings are supported by descriptive statistics, within-group analyses, between-group comparisons, and ANCOVA. The consistency across all statistical tests underscores the robustness of the intervention effect. This strongly supports the application of French Contrast training as an effective performance enhancement strategy in hockey players.

DISCUSSION

This randomized controlled trial evaluated the comparative effectiveness of French Contrast Method (FCM) training and Conventional Strength Training (CST) on explosive power and drag flick performance in elite male hockey players. The drag flick remains the most distinctive feature of contemporary hockey, demanding explosive force generation, kinetic chain sequencing coordination, and regulation of stick–ball contact precision. As such, training methods need to look beyond general strength development to ensure that gains physically are transferred well into this specialized and technically stressing skill. Current results indicated significant performance gains for both groups, but the level of improvement was always greater in the experimental group exposed to FCM training. For the drag flick speed, the experimental group increased by a mean of 16.1 km/h, and the control group had a lesser improvement of 4.5 km/h. The same trends were found in the bomb throw and Penta jump tests. ANCOVA confirmed that these improvements were attributable to the intervention rather than baseline differences, highlighting the robustness of the findings. Taken together, the evidence indicates that FCM provides a more effective training stimulus for enhancing hockey-specific explosive performance.

The novel contribution of this work lies in the adaptation of the FCM framework—traditionally applied in strength and conditioning—to the specific technical demands of hockey drag flickers. By organizing the intervention around six functional movement patterns (squat, hinge, lunge, push, pull, brace) and integrating drag flick–specific supersets, the training program sought to bridge the gap between general neuromuscular development and technical execution. The findings demonstrated that both groups improved significantly from pre- to post-test; however, the magnitude of improvement was considerably higher in the experimental group. For example, drag flick speed in the FCM group improved from 99.86 ± 7.79 m/s at pre-test to 115.97 ± 6.71 m/s at post-test ($t(36) = –12.02$, $p < 0.001$). In contrast, the control group improved only from 103.30 ± 5.33 m/s to 107.81 ± 4.35 m/s ($t(36) = –4.12$, $p < 0.001$). A similar trend was observed for the Bomb Throw Test, where the experimental group increased from 5.76 ± 0.50 m to 6.71 ± 0.60 m ($t(36) = –15.88$, $p < 0.001$), while the control group showed only a marginal change from 5.05 ± 0.34 m to 5.17 ± 0.36 m (t(36) = –21.13, $p < 0.001$). For the Penta Jump Test, the experimental group improved significantly from 14.47 ± 0.87 m to 16.44 ± 0.91 m (t(35) = –32.06, $p < 0.001$), compared with the control group, which improved from 15.06 ± 0.35 m to 15.50 ± 0.43 m (t(36) = –12.18, $p < 0.001$). Between-group post-test comparisons confirmed the superiority of the FCM intervention. Independent t-tests showed that the experimental group outperformed the control group in drag flick speed (115.97 vs. 107.81; t = 8.16, $p < 0.001$), Bomb Throw distance (6.71 vs. 5.17; t = 12.53, $p < 0.001$), and Penta Jump performance (16.44 vs. 15.50; t = 5.84, $p < 0.001$). Importantly, ANCOVA analyses further strengthened these findings by adjusting for baseline differences, with significant group effects for drag flick speed (F(1,71) = 46.66, $p < 0.001$), Bomb Throw (F(1,71) = 111.18, $p < 0.001$), and Penta Jump (F(1,70) = 373.42, $p < 0.001$). This confirms that the superior outcomes in the experimental group were attributable to the intervention itself rather than pre-existing differences. Taken together, these results suggest that the French Contrast Method provides a superior training stimulus for enhancing explosive strength and translating these gains into hockey-specific performance outcomes. By combining functional movement patterns with drag flick–oriented supersets, the program not only improved general measures of explosive power but also demonstrated direct transfer to the technical execution of the drag flick—a skill with highly competitive relevance in modern hockey. This randomized controlled trial evaluated the impact of a four-week French Contrast Method (FCM) intervention on explosive power and drag flick performance in professional male hockey players. The drag flick, which combines rapid lower-limb extension with upper-body rotational strength and stick control, is a decisive scoring technique in contemporary hockey. Training methods that can simultaneously enhance explosive strength and transfer it effectively to this skill are of particular interest to coaches and performance scientists.

The primary aim of this study was to determine whether a structured FCM protocol, incorporating functional movement patterns and drag flick–specific supersets, would produce greater improvements in drag flick speed, backward overhead medicine ball throw distance (Bomb Throw Test), and horizontal jumping capacity (Penta Jump Test) when compared with conventional strength and plyometric training. The novel aspect of this research lies in tailoring the FCM to the biomechanical and neuromuscular demands of hockey drag flickers. While the French Contrast Method has been applied in other athletic populations for enhancing explosive performance, there has been no prior attempt to systematically adapt it to the drag flick, a movement requiring a unique integration of strength, power, and technical coordination. By structuring the intervention around six fundamental movement patterns (squat, hinge, lunge, push, pull, and brace) and combining these with sport-specific supersets, the program bridged the gap between general strength training and skill-specific application. The results of this study indicated that the experimental group of athletes (FCM) showed more improvements on all the outcome measures relative to the participants who received traditional training. Specifically, the FCM group exhibited better gains in drag flick speed, Bomb Throw Test throwing distance, and Penta Jump Test performance.

These findings suggest that FCM provides a superior training stimulus for increasing explosive strength and transferring such adaptation into hockey-specific performance outcomes. The prime hypothesis of the current study hypothesized that a four-week French Contrast Method (FCM) program would result in increased improvement in drag flick speed and explosive power compared with conventional strength and plyometric training. The current results strongly support this hypothesis because the experimental group experienced significantly greater increases in drag flick velocity, Bomb Throw distance, and Penta Jump performance compared with the control group. These findings are consistent with an increasing body of evidence supporting contrast and post-activation potentiation (PAP)–based training methods. Suchomel et al. (2016) indicated that contrast training improves rate of force development more so than traditional resistance protocols. Similarly, Wilson et al. (2013), via meta-analysis, established that PAP interventions produce moderate-to-large enhancements in tasks like sprinting and jumping. Turner et al. (2019) recently noted that contrast sequencing protocols elicited greater improvements in sprint speed and vertical jump height in rugby athletes than did regular training. These conclusions are similar to the current study, wherein FCM showed superior power gains transferability to a sport-specific action—the hockey drag flick.

The physiological rationale underpinning these findings is grounded in post-activation performance enhancement (PAPE) mechanisms. The sequencing of heavy strength exercises with plyometric, assisted plyometric, and explosive sport-specific drills in the FCM stimulates acute neuromuscular potentiation. This occurs through enhanced motor unit recruitment, increased myosin regulatory light chain phosphorylation, and improved calcium release and reuptake within the sarcoplasmic reticulum, all of which accelerate crossbridge cycling and facilitate rapid force production (Blazevich & Babault, 2019).Furthermore, the incorporation of drag flick–specific supersets (e.g., resisted sprint flicks, rotational medicine ball throws, half-kneeling press variations) in the FCM group likely facilitated superior transfer of general neuromuscular adaptations to the technical execution of the drag flick. This aligns with the principle of dynamic correspondence proposed by Verkhoshansky, wherein training adaptations are maximized when the exercises closely mimic the biomechanical and neuromuscular demands of the sport skill. Consequently, the experimental groups improvements in drag flick velocity can be attributed to both enhanced neuromuscular capacity and improved sport-specific transfer. The gross findings of this study demonstrated that the athletes who underwent the French Contrast Method (FCM) intervention achieved superior improvements across all measured outcomes compared with those who followed conventional strength and plyometric training. Firstly, drag flick speed, assessed with a radar speed gun, showed a more substantial increase in the experimental group.

This indicates that the FCM protocol not only enhanced general power production but also translated effectively into a complex, sport-specific skill that is central to hockey performance. The improvements in drag flick velocity reflect the combined benefits of neuromuscular potentiation and the specific integration of drag flick–oriented supersets within the intervention. Secondly, in the Bomb Throw Test (backward overhead medicine ball throw), the experimental group recorded greater gains in throwing distance than the control group. This test is widely recognized as an indicator of whole-body explosive power, particularly reflecting the coordinated involvement of the lower limbs, core, and upper body. The superior improvements in the experimental group suggest that the contrast structure of heavy, plyometric, and assisted ballistic training provided a more potent stimulus for total-body power development. Thirdly, in the Penta Jump Test, the athletes in the FCM group also demonstrated larger improvements compared to the control group. This test measures horizontal leg power and reactive strength, qualities directly relevant to the take-off phase of the drag flick and other explosive hockey movements such as sprint acceleration. The significant gains observed in the FCM group reinforce the effectiveness of the method in developing lower-limb explosive capacity. Taken together, these results confirm that FCM proves more effective than conventional training approaches for enhancing explosive power and transferring it into hockey-specific performance outcomes.

While the control group exhibited moderate improvement, this was likely due to the overall effects of strength and plyometric training, while in contrast the experimental group continually exhibited better improvement in all variables measured. The findings here support previous evidence for the usefulness of the French Contrast Method (FCM) and other PAP/PAPE-based approaches in the creation of explosive performance. Prior work was consistently reporting that contrast training, where heavy resistance is paired with ballistic or plyometric exercise, produces greater improvements in explosive strength compared with traditional methods. Suchomel et al. (2016), for instance, found contrast training had a significant effect on improving rate of force development and jump performance, while Turner et al. (2019) reported significant improvements in sprint times and vertical jump height in rugby players following a short FCM intervention. Similarly, Wilson et al.'s (2013) and Blazevich and Babault's (2019) meta-analyses confirmed that interventions based on PAP- and PAPE can create moderate-to-large improvements in explosive performance tests like sprinting and jumping.

This paper contributes to the existing body of evidence by demonstrating that these gains have been shown to extend beyond general athletic performance to a specific skill in sport, namely the hockey drag flick. The gains seen in the Bomb Throw Test and the Penta Jump Test also support prior studies that have demonstrated that these measures are valid and reliable indicators of explosive ability. For example, Markovic and Mikulic (2010) demonstrated that backward medicine ball throws were valid predictors of whole-body power, while Ramirez-Campillo et al. (2015) showed that horizontal multi-jump tests were valid measures of lower limb power adaptations. The superior performance evidenced by the FCM group in these tests suggest that the contrast sequencing of heavy, plyometric and assisted exercises provided greater training stimulus for improving whole body explosive strength and lower body explosive strength relative to standard programs.

Although research directly addressing the drag flick remains limited, findings from related sports provide additional support for the present results. Beattie et al. (2014) documented substantial gains in sprint and jump ability among rugby players after contrast-based strength training, while Chaouachi et al. (2014) reported improvements in change-of-direction capacity and explosive performance in soccer athletes exposed to PAP-focused interventions. The present study extends this body of evidence by applying the FCM framework to hockey, demonstrating that structured sequencing of exercises not only improves general explosive power but also translates effectively into the execution of a highly technical and decisive skill. This highlights the importance of dynamic correspondence, where training adaptations are maximized when exercises closely mimic the biomechanical and neuromuscular demands of the sport skill. The superior improvements observed in the French Contrast Method (FCM) group can be explained by several well-established physiological and neuromuscular mechanisms. Central to this rationale is the concept of post-activation performance enhancement (PAPE), which suggests that a heavy conditioning contraction can acutely enhance subsequent explosive movements through improved neuromuscular function. The sequencing of heavy strength exercises, plyometric drills, assisted plyometric movements, and sport-specific explosive actions within the FCM framework maximizes these potentiation effects while simultaneously providing a broad stimulus for adaptation. One of the primary mechanisms involves enhanced motor unit recruitment and synchronization. Heavy resistance exercise activates highthreshold motor units, which remain more readily recruitable during subsequent explosive tasks, thereby improving rate of force development.

In addition, phosphorylation of myosin regulatory light chains, as described by Blazevich and Babault (2019), increases the sensitivity of the actin–myosin cross-bridges to calcium, leading to faster and more forceful contractions. This molecular adjustment is particularly relevant to explosive hockey movements such as the drag flick, where rapid force generation in a short time frame is critical. Calcium kinetics also play an important role. Repeated high-intensity contractions enhance the efficiency of calcium release and reuptake by the sarcoplasmic reticulum, resulting in faster excitation–contraction coupling. This contributes to improved stretch–shortening cycle performance, which is heavily utilized in both plyometric exercises and the drag flick technique. Furthermore, the inclusion of assisted plyometric movements (such as band-assisted jumps) within the FCM provides an overspeed stimulus, allowing athletes to move at velocities beyond their usual capacity. This not only challenges neuromuscular control but also promotes adaptations at the high-velocity end of the force–velocity curve, which are directly transferable to explosive sport skills. Another important factor is the principle of dynamic correspondence proposed by Verkhoshansky. By integrating drag flick–specific supersets, the training program ensured that the neuromuscular adaptations developed in the FCM blocks were immediately applied in sport-specific contexts. This likely enhanced the transfer of training effects from general power development to the technical execution of the drag flick. Unlike conventional training, which often separates strength development from skill practice, the FCM design in this study bridged this gap, thereby explaining the superior improvements in drag flick speed observed in the experimental group.

The neuromuscular advantages of FCM arise from an interactive action of potentiation processes, augmented recruitment of motor units, superior calcium handling, overspeed development, and direct transfer to sport. Together, these physiological mechanisms underlie the improved performance in the experimental group compared to the control group. The current results have significant practical implications for coaches of hockey, physiotherapists, and strength and conditioning professionals. The added advantages gained from the French Contrast Method (FCM) highlight its potency as a performance-enhancing tool that surpasses what solo conventional strength or plyometric training has to offer. By putting together heavy resistance, plyometric, assisted plyometric, and drag flick–specific explosive drills within one training session, FCM provides a complete neuromuscular stimulus that aims to build strength, power, and technical transfer all at the same time. For coaches, this program provides a time-effective way of combining conditioning with skill-specific practice. Unlike conventional approaches, which tend to compartmentalize general strength work and technical execution, the addition of drag flick–specific supersets help ensure that development in explosive strength is immediately transferred into sport-specific actions. By doing so, this method bridges the gap between physical preparation and skill execution, possibly speeding up the transfer of training adaptations into match performance. For sports medicine personnel and physiotherapists, these findings also offer evidence that FCM can be safely used with elite players when applied under systematic guidance. Importantly, no participant dropouts or adverse events were noted during the program of four weeks, suggesting that with well-calibrated load monitoring and progressive adaptation, this technique is an accessible choice even within competitive training programs.

Furthermore, the functional movement–based structure (squat, hinge, lunge, push, pull, brace) ensures balanced development of the kinetic chain, which may also contribute to injury prevention and long-term athletic performance sustainability. Strength and conditioning professionals can also apply these findings by incorporating FCM blocks into training cycles aimed at enhancing explosive power. The use of progressive overload (e.g., increasing barbell load, medicine ball weight, or band resistance) ensures continual adaptation, while the combination of heavy, ballistic, and assisted movements targets multiple regions of the force–velocity spectrum. For hockey specifically, the application of resisted sprint flicks, rotational medicine ball throws, and half-kneeling press variations provides a practical bridge between gym-based training and field-based skill execution. Overall, the study suggests that the French Contrast

Method is a time-efficient and highly effective training strategy that can be directly integrated into elite hockey preparation. Its capacity to enhance both general explosive capacity and drag flick performance makes it a valuable tool for practitioners aiming to optimize competitive success. This study possesses several notable strengths that contribute to its scientific and practical relevance. The most significant strength lies in its novelty: to the best of current knowledge, this is the first randomized controlled trial to apply the French Contrast Method (FCM) specifically to hockey drag flick performance. Previous research has evaluated FCM in general athletic populations, but its adaptation to a sport-specific skill in field hockey fills an important gap in the literature. Another strength is the methodological rigor of the study. The randomized controlled design, combined with allocation concealment and blinded outcome assessments, minimized potential sources of bias, and enhanced the internal validity of the findings. The inclusion of a control group performing conventional training also allowed for a meaningful comparison, ensuring that improvements observed in the experimental group could be attributed to the FCM intervention rather than to general training effects. The study also benefitted from high participant compliance and retention. Despite recruiting 10 additional participants to mitigate potential attrition, no dropouts were recorded, and all athletes completed the four-week intervention. This high adherence rate underscores the feasibility of implementing FCM within elite hockey environments and strengthens the reliability of the outcome data. Furthermore, the integration of both general performance tests (Bomb Throw and Penta Jump) and a sport-specific measure (drag flick speed) provided a balanced assessment of the training program. This dual approach ensured that improvements were captured not only in laboratory-style power outputs but also in a decisive technical skill directly relevant to hockey match performance. Finally, the functional movement–based structure of the intervention, which targeted squat, hinge, lunge, push, pull, and brace patterns, reflects a holistic approach to athlete development. This design supported not only performance enhancement but also potentially contributed to injury risk reduction by promoting balanced neuromuscular adaptations across the kinetic chain.

LIMITATIONS OF THE STUDY

Although the present study provides valuable insights, a few limitations should be acknowledged. The first limitation is the relatively short duration of the intervention—only four weeks with eight training sessions. While this was enough to demonstrate significant improvements in explosive power and drag flick speed, a longer program might have provided a clearer understanding of sustained adaptations, neuromuscular remodelling, and performance transfer throughout a competitive season.

- Second, the study sample was limited to male hockey players aged 18–35 years, which restricts the generalizability of the findings. The outcomes cannot be directly applied to female athletes, younger players, as their physiological responses to the French Contrast Method may differ.
- Third, the performance measures used in this research—Bomb Throw, Penta Jump, and drag flick speed measured with a radar gun—were valid, reliable, and practical for field-based settings, but they lacked the precision of laboratory-based assessments. Tools such as electromyography (EMG), motion capture, or force plates could have provided deeper biomechanical and neuromuscular insights.
- Another limitation lies in the external training loads. Although the intervention was carefully supervised, both groups continued with their regular team practices, which were not strictly controlled. Variations in session intensity and accumulated fatigue could have influenced the performance outcomes. Finally, the study was conducted across only two training centers in India (COE Vaishali and NCOE Bhopal), limiting the broader applicability of the results to hockey players in different environments with varied training infrastructure.

FUTURE SCOPE OF RESEARCH

Despite these limitations, the study demonstrated that the French Contrast Method can be applied safely and effectively with elite hockey drag flickers. This opens several avenues for future research. One important direction is to extend the training period beyond four weeks to determine whether improvements in drag flick speed and explosive power can be sustained or enhanced across an entire competitive season. Longer interventions would also allow monitoring of long-term neuromuscular adaptations and skill transfer into real match play.

- Future studies should also involve more diverse participant groups, including female players, younger athletes, and masters-level hockey players. Differences in hormonal profiles, neuromuscular attributes, and training backgrounds may influence responsiveness to French Contrast training, and broadening the sample will strengthen the applicability of findings.
- Another scope lies in the use of advanced biomechanical and physiological tools such as EMG, motion capture, and force plate testing. These methods could provide detailed insights into the mechanisms driving the observed improvements and help explain how neuromuscular potentiation translates into enhanced drag flick performance.
- Comparative studies should also be conducted to position the French Contrast Method alongside other advanced strength and conditioning strategies such as cluster sets, velocity-based training (VBT), and complex contrast methods. Such work will clarify whether FCM offers unique benefits or if similar results can be achieved through alternative approaches.
- Lastly, future research should investigate how French Contrast training can be integrated into periodized training schedules, balancing its benefits with technical skill development, recovery protocols, and competitive demands. This will help coaches apply FCM effectively while minimizing risks of overtraining or fatigue. Expanding participant populations, extending training durations, and employing advanced assessments will ultimately establish FCM as a robust, evidence-based method for improving hockey performance.

CONFLICT OF INTEREST STATEMENT

AND

STATEMENT OF FUNDING

The authors affirm that there are no potential conflicts of interest with respect to the research, authorship, or publication of this thesis. No financial support, commercial sponsorship, or personal relationships influenced the design, methodology, analysis, or interpretation of the data. The study was conducted solely for academic and scientific purposes, ensuring objectivity and integrity throughout the research process.

This dissertation was undertaken as part of the academic requirements for the degree of Master of Physiotherapy in Sports at Odisha University of Health Sciences. The research did not receive any financial assistance or institutional support from the University or any external funding agency. All expenses related to data collection, analysis, and preparation of the thesis were independently managed by the researcher.

CONCLUSION

It analyzed the effect of a four-week French Contrast Method (FCM) training intervention on drag flick skill and explosive power of professional male Indian origin hockey players The findings clearly demonstrated that the FCM group achieved significantly greater improvements in drag flick speed, backward overhead medicine ball throw distance, and Penta Jump performance compared with athletes who performed conventional strength and plyometric training. These results confirm the study's primary hypothesis and highlight the potential of FCM as an effective training strategy in hockey. The novelty of this research lies in adapting the FCM framework—traditionally used in strength and conditioning—to a sport-specific, high-skill context such as the hockey drag flick. By integrating functional movement patterns (squat, hinge, lunge, push, pull, brace) with drag flick–specific supersets, the intervention successfully bridged the gap between general power development and technical skill execution. This demonstrates that neuromuscular adaptations achieved through FCM can be effectively transferred to complex, high-speed sporting actions. From a scientific perspective, the superior outcomes observed in the experimental group can be explained by mechanisms of post-activation performance enhancement (PAPE), including increased motor unit recruitment, enhanced cross-bridge phosphorylation, and improved calcium kinetics, as well as the application of the principle of dynamic correspondence. Together, these mechanisms underline why FCM provided a more comprehensive stimulus for performance enhancement than conventional training. The study contributes to both academic knowledge and practical application. For researchers, it provides the first controlled evidence that FCM can be effectively adapted to hockey, paving the way for future investigations across different populations and longer training cycles. For coaches, physiotherapists, and strength and conditioning professionals, it offers a structured, evidence-based framework for improving explosive capacity and technical execution in elite hockey players. In conclusion, this thesis provides compelling evidence that the French Contrast Method is a safe, effective, and sport-specific training strategy capable of significantly improving drag flick performance and explosive power in professional hockey players. By bridging the gap between physical preparation and technical skill, FCM presents itself as a valuable addition to modern hockey conditioning programs.

SUMMARY

This thesis comprehensively investigated the impact of a four-week French Contrast Method (FCM) training program on drag flick speed, bomb throw distance, and penta jump performance in elite male hockey players. Through a randomized controlled design involving 74 participants, the study compared the outcomes of an experimental group trained using FCM and a control group trained with conventional methods. Statistical analysis, including descriptive statistics, paired and independent t-tests, and ANCOVA, consistently demonstrated that the FCM group achieved significantly greater improvements across all variables. Specifically, drag flick speed improved by 16.1%, bomb throw by 13.9%, and penta jump by 13.6% in the experimental group, far surpassing the modest gains of the control group. These findings confirm that the integration of strength, plyometric, and sport-specific components inherent to FCM provides a superior training stimulus for enhancing both upper- and lower-body explosive power. The results not only validate FCM as a more effective alternative to conventional training but also highlight its practical relevance in optimizing performance outcomes crucial to modern hockey.

BIBLIOGRAPHY

1) Antonov A. Kinematic structure and characteristics of the “drag flick” field hockey technique. J Hum Sport Exerc. 2021;16(3):689–701. https://doi.org/10.14198/jhse.2021.163.20

2) Bari MA. Three-dimensional analysis of variation between successful and unsuccessful drag flick techniques in field hockey. Int J Sports Sci Coach. 2018;13(5):772–9. https://doi.org/10.1177/1747954118789430

3) Banyard HG, Nosaka K, Haff GG. Reliability and validity of velocity-based training devices. J Aust Strength Cond. 2017;25(5):20–34.

4) Beckham GK, Suchomel TJ, Bailey CA, Sole CJ, Grazer JL, DeWeese BH. Assessing full-body impulsive ability using a range of medicine ball loads for the backward overhead medicine ball throw. J Strength Cond Res. 2023;37(1):201–9. https://doi.org/10.1519/JSC.0000000000004368

5) Branet C. The effect of plyometric training on lower body strength in preadolescent athletes. J Phys Educ Sport. 2020;20(6):3300–6. https://doi.org/10.7752/jpes.2020.s6449

6) Chamari K, Chaouachi A, Hambli M, Kaouech F, Wisløff U, Castagna C. The five-jump test for distance as a field test to assess lower limb explosive power in soccer players. J Strength Cond Res. 2008;22(3):944–50. https://doi.org/10.1519/JSC.0b013e31816a57c6

7) Cormie P, McGuigan MR, Newton RU. Developing maximal neuromuscular power: Part 2—Training considerations for improving explosive power. Sports Med. 2011;41(2):125–46. https://doi.org/10.2165/11538500-000000000-00000

8) Cronin JB, Owen GJ, Marsh DJ, Rebelo AN. Reliability and validity of medicine ball throws to assess upper-body power. J Strength Cond Res. 2014;28(8):2318–26. https://doi.org/10.1519/JSC.0000000000000438

9) De Subijana CL, Juárez D, Mallo J, Navarro E. Biomechanical analyses of the penalty-corner drag-flick of elite male and female hockey players. Sports Biomech. 2010;9(2):72–88. https://doi.org/10.1080/14763141.2010.491167

10) De Subijana CL, Gil A, Mallo J. Performance differences in drag flick execution among elite hockey players. Int J Perform Anal Sport. 2025;25(1):55–68. https://doi.org/10.1080/24748668.2025.1004563

11) Deng N, Chen Y, Wu S. Effects of combined upper and lower limb plyometric training interventions on physical fitness in athletes: A systematic review with meta-analysis. Front Physiol. 2023;14:1189672. https://doi.org/10.3389/fphys.2023.1189672

12) Duble CS. Utility of plyometric training method for improving explosive power of leg and speed of hockey players. Int J Phys Educ Sports Health. 2021;8(3):45–9.

13) Grace J. The role of velocity-specific training in ballistic sport skills. J Strength Cond Res. 2024;38(4):1123–31.

14) Grace J. Velocity-specific adaptations in neuromuscular training for explosive sports. Int J Sports Physiol Perform. 2024;19(5):512–20.

15) Ibrahim M. Trunk angular momentum and drag flick velocity in elite hockey players. Int J Sports Biomech. 2017;34(2):187–96.

16) Ibrahim M. Role of trunk kinematics in explosive skill execution: Evidence from field hockey drag flick. Asian J Sports Biomech. 2017;9(1):33–41.

17) Krishnan V. Plyometric training for young male field hockey players. Indian J Phys Educ Sports Sci. 2020;24(1):66–71.

18) Ladru J, Hoekstra J, Elferink-Gemser M. Performance analysis of penalty corner execution in international hockey. Int J Perform Anal Sport. 2023;23(3):321–35. https://doi.org/10.1080/24748668.2023.2187509

19) López de Subijana C, Juárez D, Navarro E. Biomechanical analyses of drag-flick technique in elite female hockey players. Int J Sports Sci Coach. 2010;5(1):23–32.

20) Mathew B. Effect of hockey-specific training program on strength, speed and agility in collegiate hockey players. J Hum Mov Sports Sci. 2024;12(2):95–101.

21) Morris-Binelli A, Gómez R, Ruiz F. Measurement of drag flick speed using radar technology. Sports Biomech. 2021;20(3):354–65. https://doi.org/10.1080/14763141.2019.1687451

22) Morris-Binelli A, Gómez R, Ruiz F. Ball flight characteristics and anticipation in drag flicks. Int J Sports Sci Coach. 2022;17(6):1423–31.

23) Ng L, Tan J, Chua R. Hip–pelvic dissociation and lumbar contribution to drag flick performance in elite hockey players. J Sports Biomech. 2018;17(4):287–96.

24) Palaniappan R. Biomechanical analysis of penalty corner drag flick in field hockey. Int J Phys Educ Sports Health. 2018;5(2):88–92.

25) Rabia S. Relationship between the kinematical factors and the ball velocity of the penalty corner drag-flick in field hockey. J Sports Biomech. 2022;16(2):105–13.

26) Ramírez-Campillo R, Alvarez C, García-Pinillos F, Sánchez-Sánchez J, Yanci J, Castillo D, Moran J. Effects of plyometric training volume and training surface on explosive strength. J Sports Sci. 2024;42(5):601–10. https://doi.org/10.1080/02640414.2024.1834562

27) Reyment CM, Bonis ME, Brown JD. Effects of a four-week plyometric training program on measurements of power in male collegiate hockey players. J Strength Cond Res. 2014;28(9):2579–84.

28) Seitz LB, Haff GG. Factors modulating post-activation potentiation of jump, sprint, throw, and upper-body ballistic performances: A systematic review with meta-analysis. Sports Med. 2016;46(2):231–40. https://doi.org/10.1007/s40279-015-0415-7

29) Singh A, Sharma P, Kumar R. Effect of plyometric training on speed, power and drag flick velocity in elite hockey players. J Sports Sci. 2018;36(11):1290–7.

30) Singh R. Application of Penta Jump test in assessing explosive power of hockey players. Indian J Phys Educ Sport. 2019;19(2):44–9.

31) Slimani M, Chamari K, Miarka B, Del Vecchio FB, Chéour F. Effects of plyometric training on physical performance in team sport athletes: A systematic review and meta-analysis. J Hum Kinet. 2016;53(1):231–47. https://doi.org/10.1515/hukin-2016-0029

32) Thapa R. Integrating PAP and PAPE in French Contrast Training: A scoping review. Strength Cond J. 2024;46(2):41–52.

33) Zhao Y, Wang L, Li X. Effect of French Contrast Training on athletic performance: A meta-analysis. J Strength Cond Res. 2025;39(2):341–52.

34) Barra-Moura A, Nunes JP, Clemente FM. Effects of high- and low-frequency French Contrast Training in soccer players. Res Sports Med. 2024;32(1):45–56.

35) Rebelo AN, Marques MC, Pereira A. Effects of velocity-based complex training on jump and strength endurance in youth athletes. Eur J Sport Sci. 2023;23(2):213–22.

36) Grace J. The role of velocity-based methods in optimizing explosive sports performance. Strength Cond J. 2024;46(3):55–63.

37) Morris-Binelli A, Hoekstra J, Ladru J. Reliability of radar-based ball velocity assessment in elite hockey penalty corners. Int J Perform Anal Sport. 2022;22(4):455–65.

38) Blazevich AJ, Babault N. Post-activation potentiation versus post-activation performance enhancement in humans: Historical perspective, underlying mechanisms, and current issues. Front Physiol. 2019;10:1359. https://doi.org/10.3389/fphys.2019.01359

39) Markovic G, Mikulic P. Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. Sports Med. 2010;40(10):859–95. https://doi.org/10.2165/11318370-000000000-00000

40) Suchomel TJ, Nimphius S, Stone MH. The French Contrast Method: A brief review. Strength Cond J. 2016;38(4):36–43. https://doi.org/10.1519/SSC.0000000000000233

41) Turner AN, Comfort P, Suchomel TJ. Implementing the French Contrast Method: Practical recommendations for coaches. Strength Cond J. 2019;41(1):79–85. https://doi.org/10.1519/SSC.0000000000000415

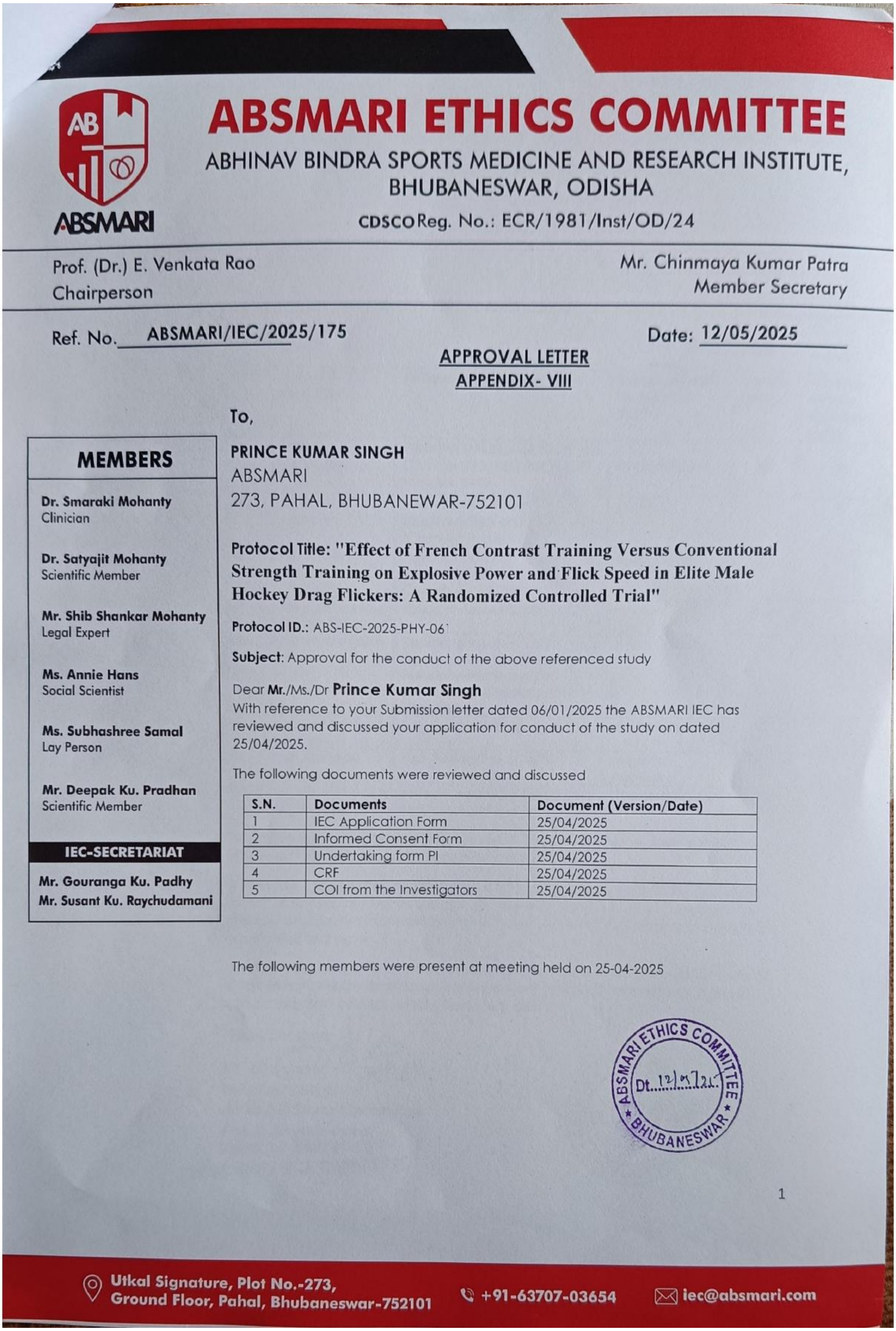
42) Verkhoshansky YV, Siff MC. Supertraining. 6th ed. Michigan: Ultimate Athlete Concepts; 2009.

43) Wilson JM, Duncan NM, Marin PJ, Brown LE, Loenneke JP, Wilson SMC, Jo E, Lowery RP, Ugrinowitsch C. Meta-analysis of postactivation potentiation and power: Effects of conditioning activity, volume, gender, rest periods, and training status. J Strength Cond Res. 2013;27(3):854–9. https://doi.org/10.1519/JSC.0b013e31825c2bdb

44) Beattie K, Kenny IC, Lyons M, Carson BP. The effect of strength training on performance indicators in distance runners. J Strength Cond Res. 2014;28(3):580–90. https://doi.org/10.1519/JSC.0b013e31829b552f

45) Chaouachi A, Manzi V, Chaalali A, Wong DP, Chamari K, Castagna C. Determinant analysis of change-of-direction ability in elite soccer players. J Strength Cond Res. 2014;28(5):1398–406. https://doi.org/10.1519/JSC.0000000000000275

ANNEXURE



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Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/175

Date: 12/05/2025

APPROVAL LETTER
APPENDIX- VIII

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

To,

PRINCE KUMAR SINGH
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: **"Effect of French Contrast Training Versus Conventional Strength Training on Explosive Power and Flick Speed in Elite Male Hockey Drag Flickers: A Randomized Controlled Trial"**

Protocol ID.: ABS-IEC-2025-PHY-061

Subject: Approval for the conduct of the above referenced study

Dear **Mr.**/Ms./Dr **Prince Kumar Singh**
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.

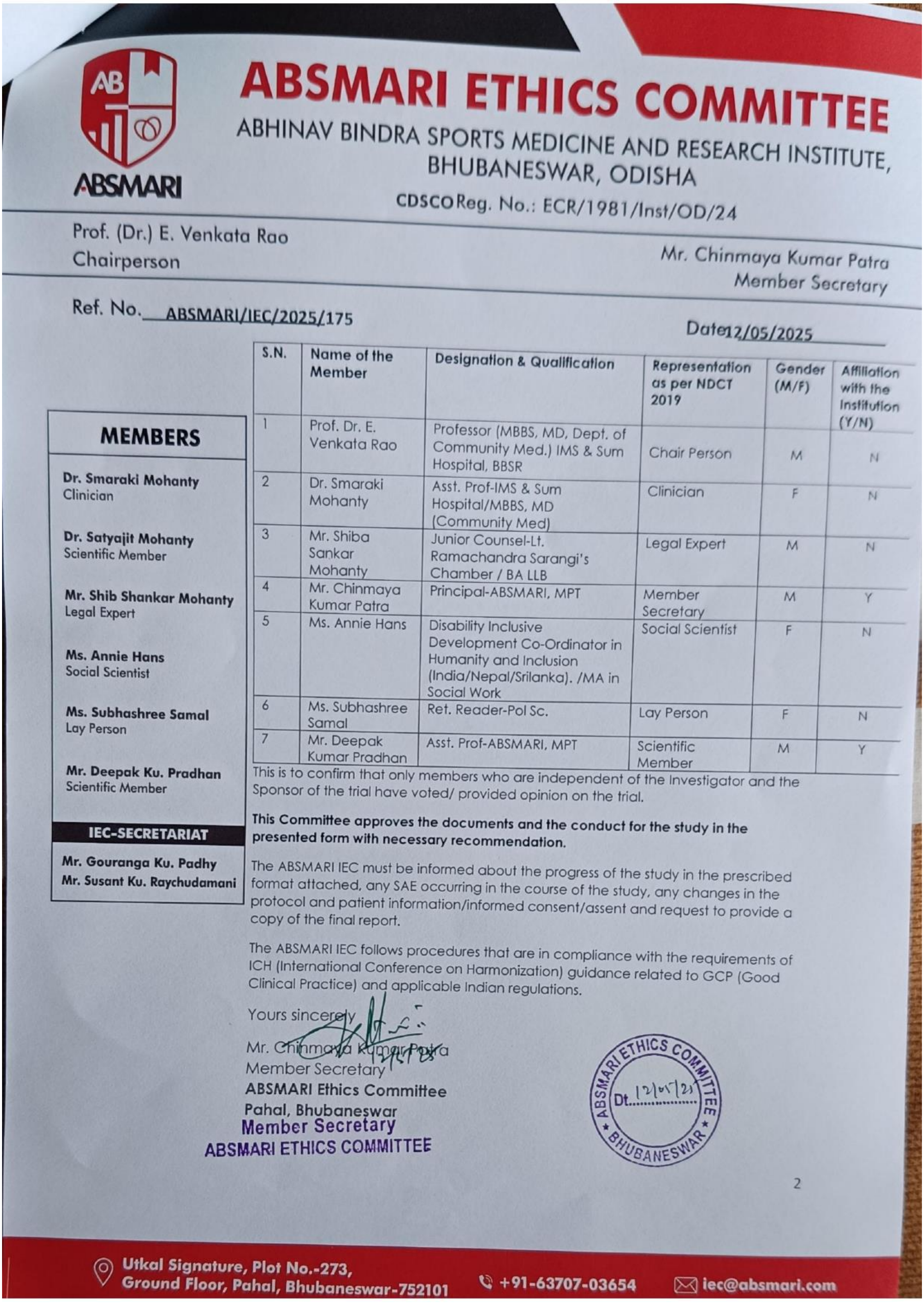
The following documents were reviewed and discussed

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

Dt. 12/5/25

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



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Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/175

Date 12/05/2025

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
4	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
5	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
6	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
7	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

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

This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely

12/5/25

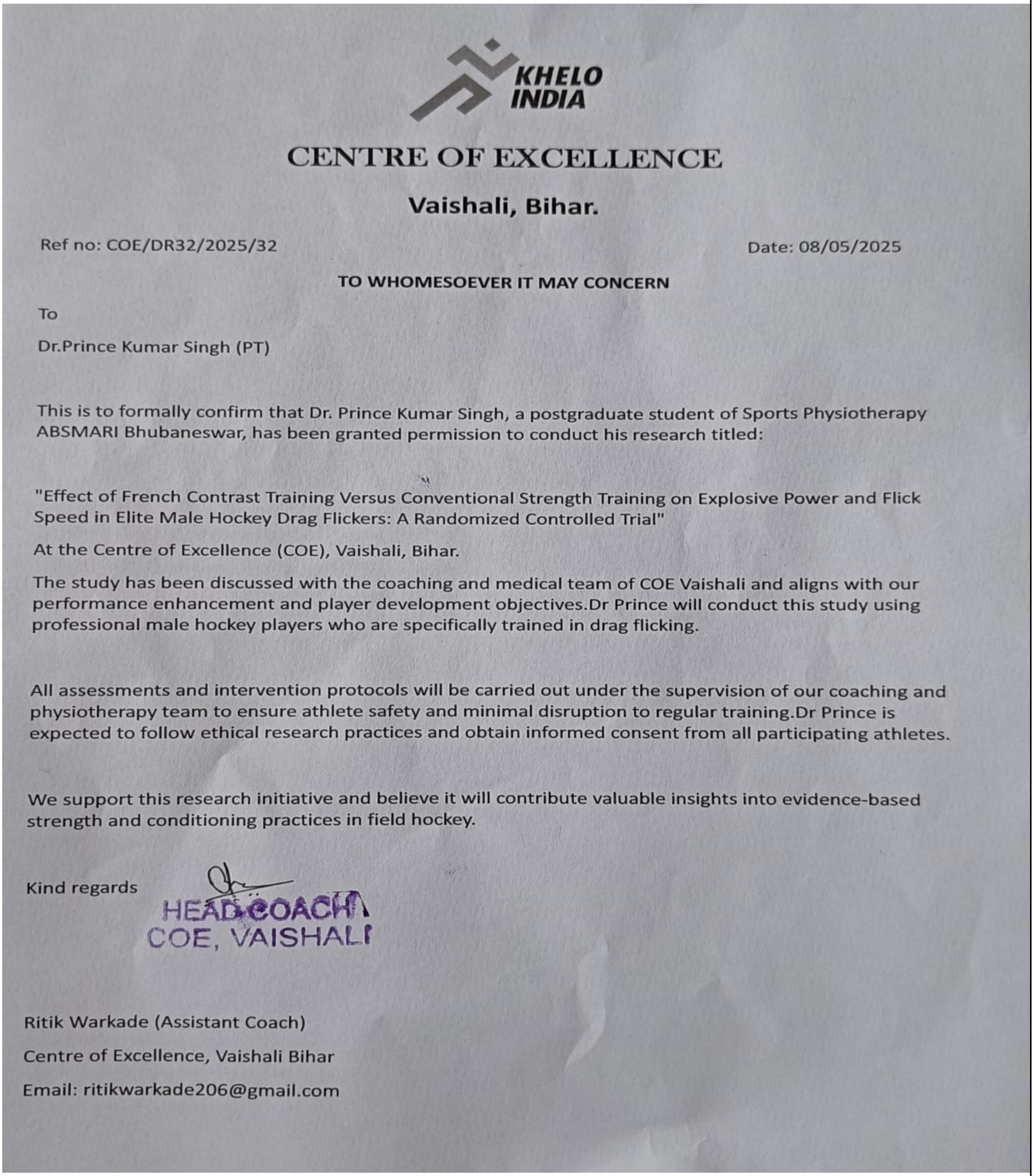
Mr. Chinmaya Kumar Patra
Member Secretary
ABSMARI Ethics Committee
Pahal, Bhubaneswar

Member Secretary
ABSMARI ETHICS COMMITTEE

Dt. 12/05/25

2

Annexure 2



KHELO INDIA

CENTRE OF EXCELLENCE

Vaishali, Bihar.

Ref no: COE/DR32/2025/32

Date: 08/05/2025

TO WHOMESOEVER IT MAY CONCERN

To

Dr.Prince Kumar Singh (PT)

This is to formally confirm that Dr. Prince Kumar Singh, a postgraduate student of Sports Physiotherapy ABSMARI Bhubaneswar, has been granted permission to conduct his research titled:

"Effect of French Contrast Training Versus Conventional Strength Training on Explosive Power and Flick Speed in Elite Male Hockey Drag Flickers: A Randomized Controlled Trial"

At the Centre of Excellence (COE), Vaishali, Bihar.

The study has been discussed with the coaching and medical team of COE Vaishali and aligns with our performance enhancement and player development objectives.Dr Prince will conduct this study using professional male hockey players who are specifically trained in drag flicking.

All assessments and intervention protocols will be carried out under the supervision of our coaching and physiotherapy team to ensure athlete safety and minimal disruption to regular training.Dr Prince is expected to follow ethical research practices and obtain informed consent from all participating athletes.

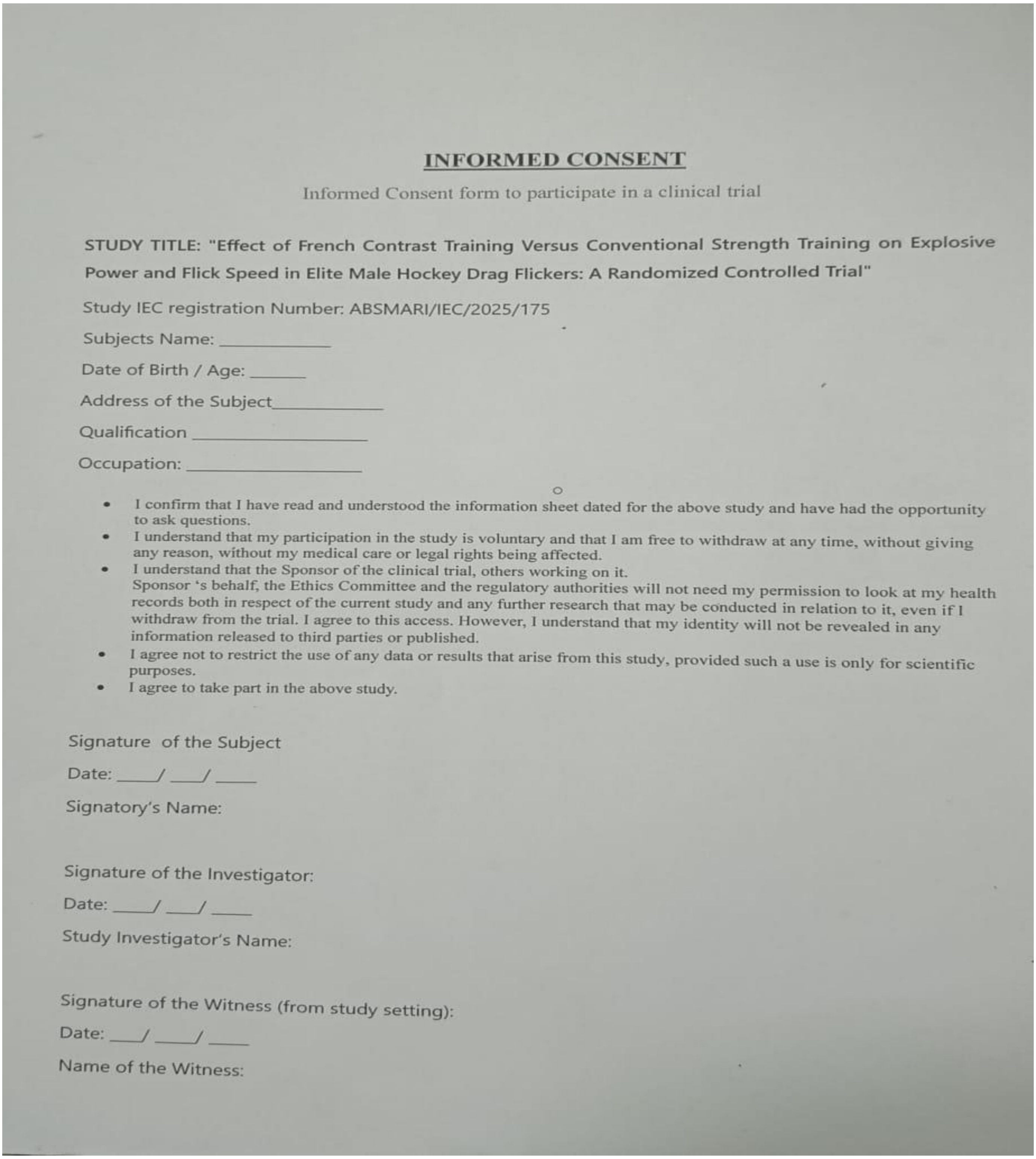
We support this research initiative and believe it will contribute valuable insights into evidence-based strength and conditioning practices in field hockey.

Kind regards

HEAD COACH
COE, VAISHALI

Ritik Warkade (Assistant Coach)
Centre of Excellence, Vaishali Bihar
Email: ritikwarkade206@gmail.com

Annexure 3



INFORMED CONSENT

Informed Consent form to participate in a clinical trial

STUDY TITLE: "Effect of French Contrast Training Versus Conventional Strength Training on Explosive Power and Flick Speed in Elite Male Hockey Drag Flickers: A Randomized Controlled Trial"

Study IEC registration Number: ABSMARI/IEC/2025/175

Subjects Name: ____________

Date of Birth / Age: ______

Address of the Subject____________

Qualification ___________________

Occupation: ___________________

- I confirm that I have read and understood the information sheet dated for the above study and have had the opportunity to ask questions.
- I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.
- I understand that the Sponsor of the clinical trial, others working on it.
  Sponsor 's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.
- I agree not to restrict the use of any data or results that arise from this study, provided such a use is only for scientific purposes.
- I agree to take part in the above study.

Signature of the Subject

Date: ____/ ___/ ____

Signatory's Name:

Signature of the Investigator:

Date: ____/ ___/ ____

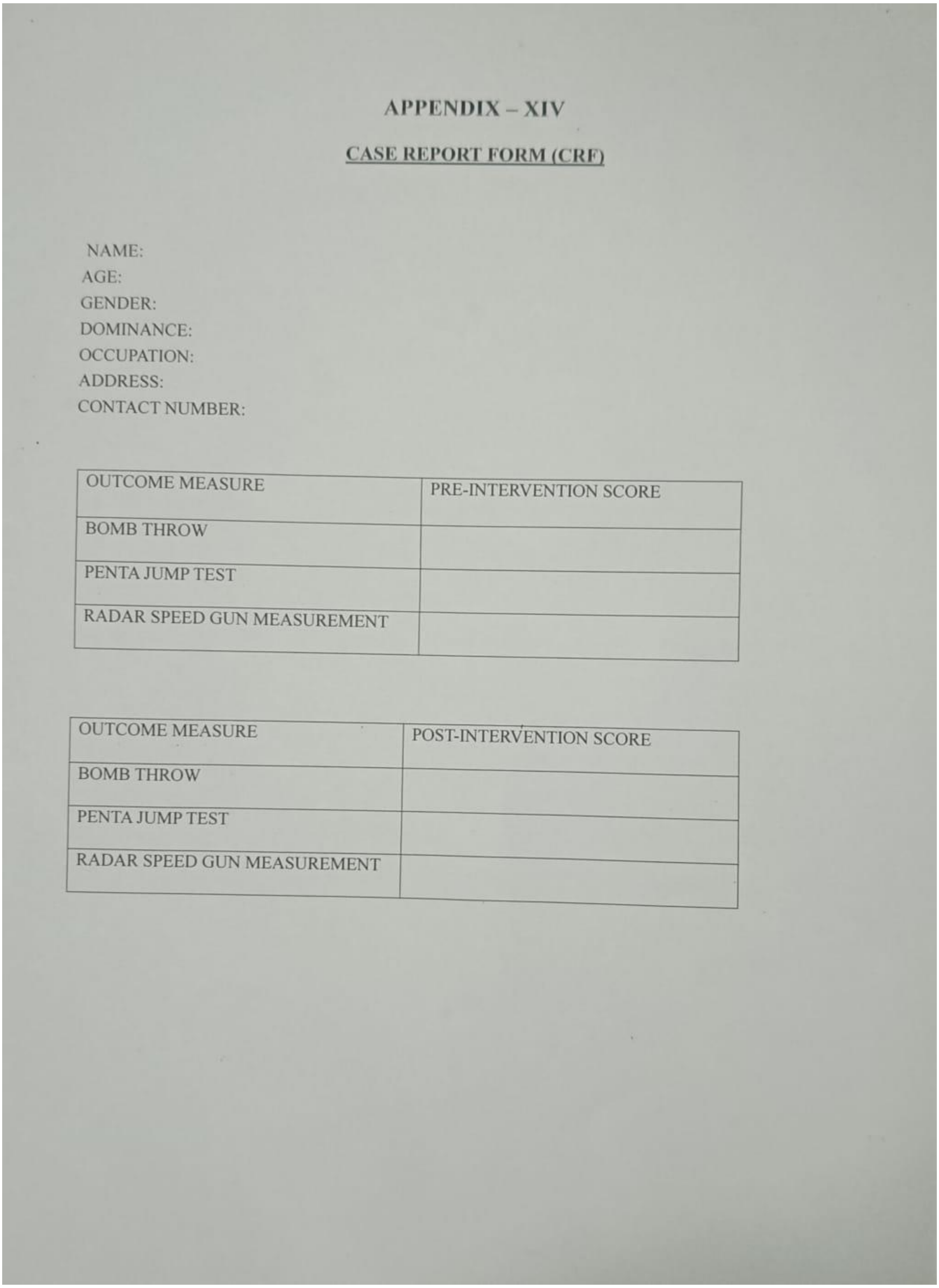
Study Investigator's Name:

Signature of the Witness (from study setting):

Date: ___/ ____/ ____

Name of the Witness:

Annexure 4



APPENDIX – XIV

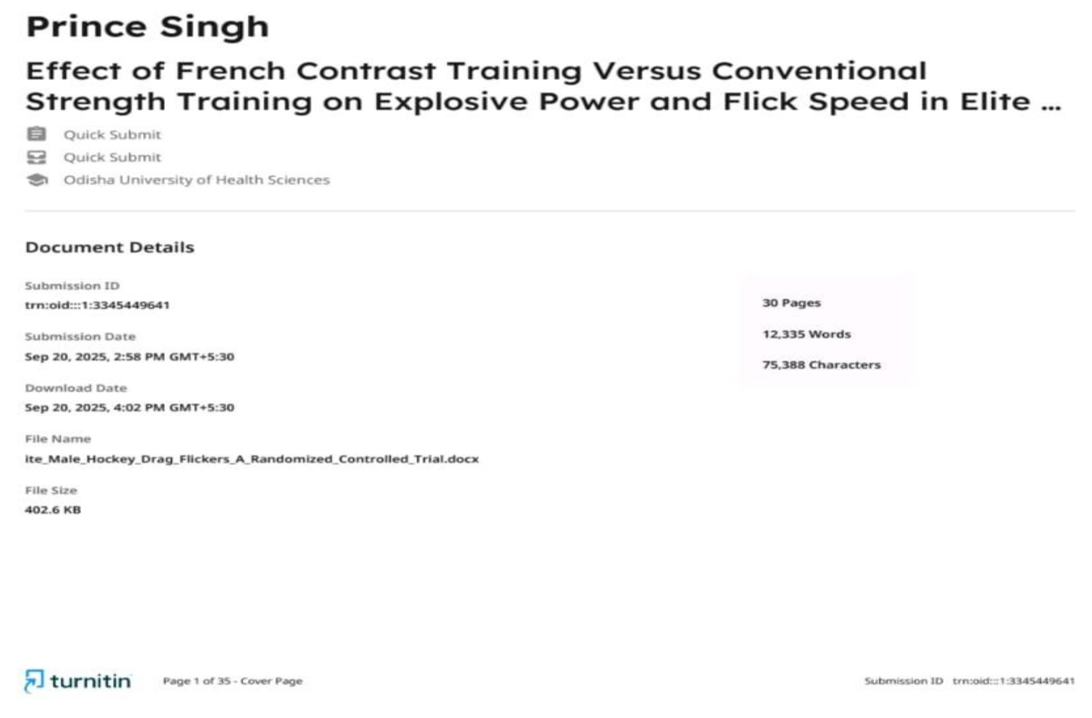
CASE REPORT FORM (CRF)

NAME:
AGE:
GENDER:
DOMINANCE:
OCCUPATION:
ADDRESS:
CONTACT NUMBER:

OUTCOME MEASURE	PRE-INTERVENTION SCORE
BOMB THROW	
PENTA JUMP TEST	
RADAR SPEED GUN MEASUREMENT	

OUTCOME MEASURE	POST-INTERVENTION SCORE
BOMB THROW	
PENTA JUMP TEST	
RADAR SPEED GUN MEASUREMENT	

Annexure 5



Prince Singh

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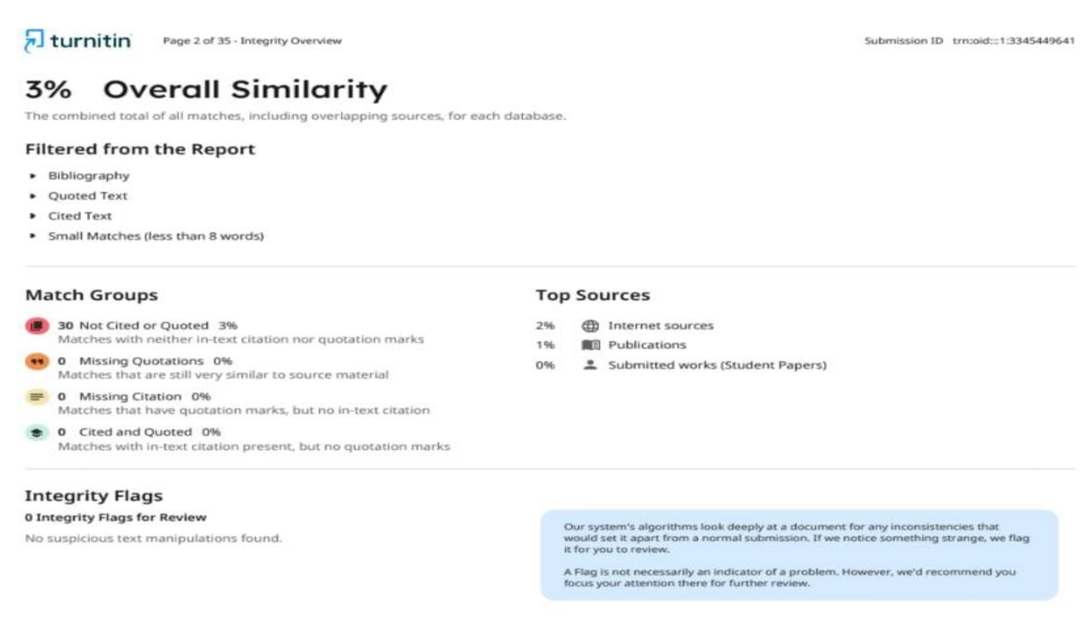

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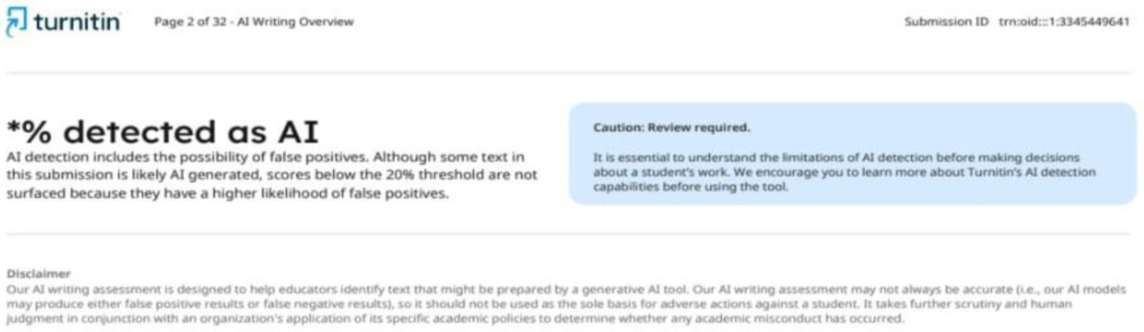

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Our AI writing assessment is designed to help educators identify text that might be prepared by a generative AI tool. Our AI writing assessment may not always be accurate (i.e., our AI models may produce either false positive results or false negative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

Annexure 6

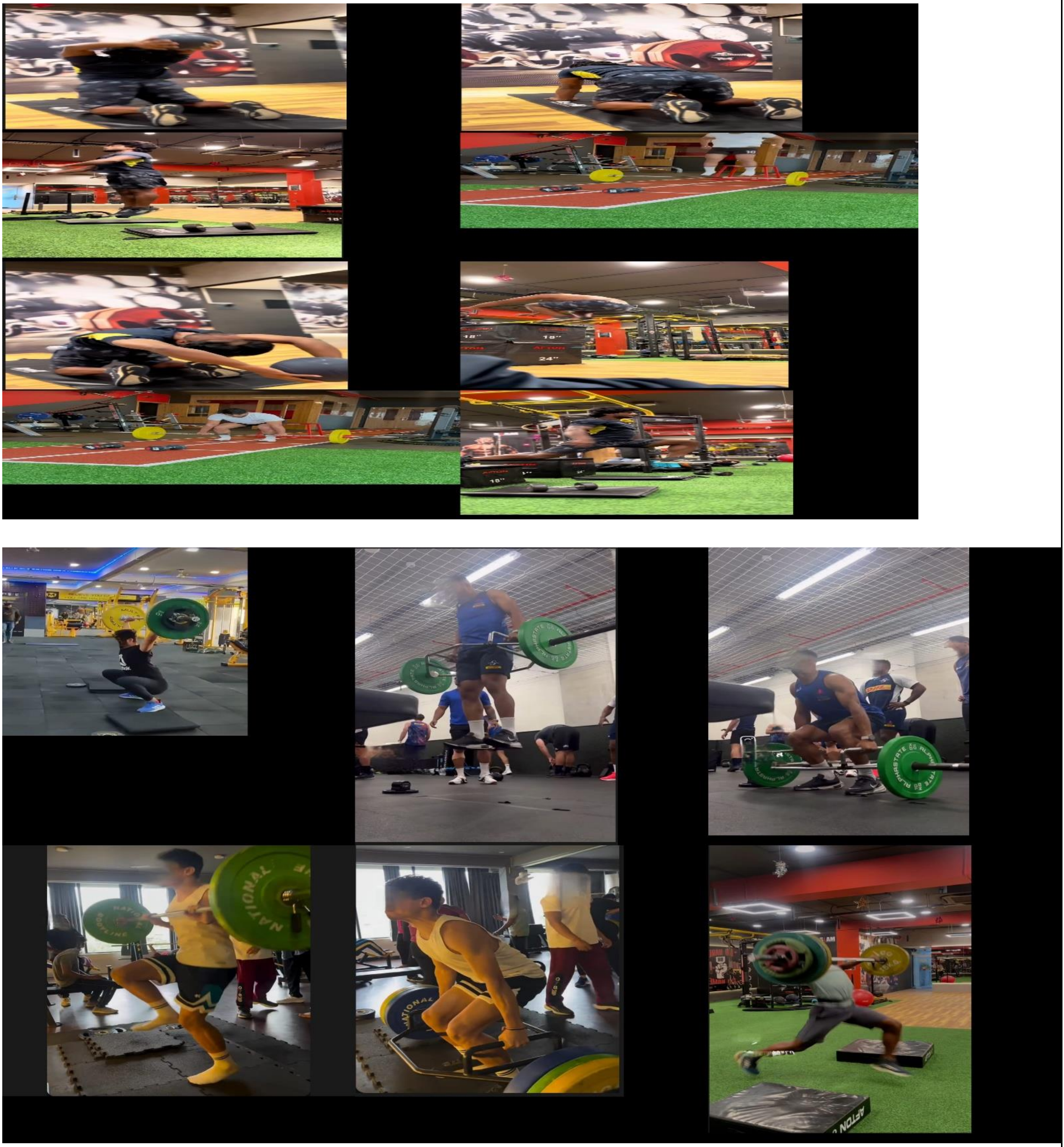
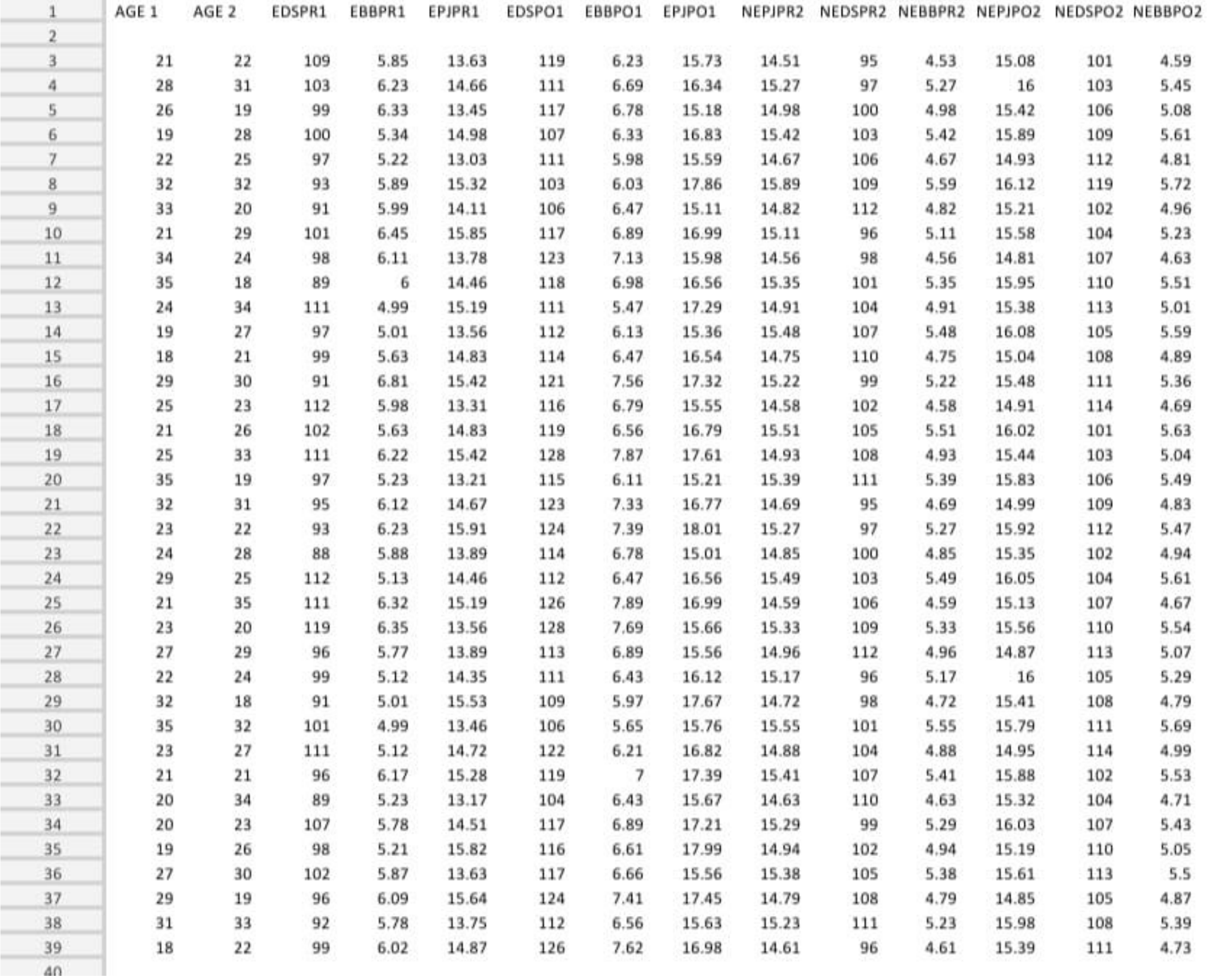


FIG-7 FCM PROTOCOL FEW EXERCISES

Annexure 7



1	AGE 1	AGE 2	EDSPR1	EBBPR1	EPJPR1	EDSPO1	EBBPO1	EPJPO1	NEPJPR2	NEDSPR2	NEBBPR2	NEPJPO2	NEDSPO2	NEBBPO2
2														
3	21	22	109	5.85	13.63	119	6.23	15.73	14.51	95	4.53	15.08	101	4.59
4	28	31	103	6.23	14.66	111	6.69	16.34	15.27	97	5.27	16	103	5.45
5	26	19	99	6.33	13.45	117	6.78	15.18	14.98	100	4.98	15.42	106	5.08
6	19	28	100	5.34	14.98	107	6.33	16.83	15.42	103	5.42	15.89	109	5.61
7	22	25	97	5.22	13.03	111	5.98	15.59	14.67	106	4.67	14.93	112	4.81
8	32	32	93	5.89	15.32	103	6.03	17.86	15.89	109	5.59	16.12	119	5.72
9	33	20	91	5.99	14.11	106	6.47	15.11	14.82	112	4.82	15.21	102	4.96
10	21	29	101	6.45	15.85	117	6.89	16.99	15.11	96	5.11	15.58	104	5.23
11	34	24	98	6.11	13.78	123	7.13	15.98	14.56	98	4.56	14.81	107	4.63
12	35	18	89	6	14.46	118	6.98	16.56	15.35	101	5.35	15.95	110	5.51
13	24	34	111	4.99	15.19	111	5.47	17.29	14.91	104	4.91	15.38	113	5.01
14	19	27	97	5.01	13.56	112	6.13	15.36	15.48	107	5.48	16.08	105	5.59
15	18	21	99	5.63	14.83	114	6.47	16.54	14.75	110	4.75	15.04	108	4.89
16	29	30	91	6.81	15.42	121	7.56	17.32	15.22	99	5.22	15.48	111	5.36
17	25	23	112	5.98	13.31	116	6.79	15.55	14.58	102	4.58	14.91	114	4.69
18	21	26	102	5.63	14.83	119	6.56	16.79	15.51	105	5.51	16.02	101	5.63
19	25	33	111	6.22	15.42	128	7.87	17.61	14.93	108	4.93	15.44	103	5.04
20	35	19	97	5.23	13.21	115	6.11	15.21	15.39	111	5.39	15.83	106	5.49
21	32	31	95	6.12	14.67	123	7.33	16.77	14.69	95	4.69	14.99	109	4.83
22	23	22	93	6.23	15.91	124	7.39	18.01	15.27	97	5.27	15.92	112	5.47
23	24	28	88	5.88	13.89	114	6.78	15.01	14.85	100	4.85	15.35	102	4.94
24	29	25	112	5.13	14.46	112	6.47	16.56	15.49	103	5.49	16.05	104	5.61
25	21	35	111	6.32	15.19	126	7.89	16.99	14.59	106	4.59	15.13	107	4.67
26	23	20	119	6.35	13.56	128	7.69	15.66	15.33	109	5.33	15.56	110	5.54
27	27	29	96	5.77	13.89	113	6.89	15.56	14.96	112	4.96	14.87	113	5.07
28	22	24	99	5.12	14.35	111	6.43	16.12	15.17	96	5.17	16	105	5.29
29	32	18	91	5.01	15.53	109	5.97	17.67	14.72	98	4.72	15.41	108	4.79
30	35	32	101	4.99	13.46	106	5.65	15.76	15.55	101	5.55	15.79	111	5.69
31	23	27	111	5.12	14.72	122	6.21	16.82	14.88	104	4.88	14.95	114	4.99
32	21	21	96	6.17	15.28	119	7	17.39	15.41	107	5.41	15.88	102	5.53
33	20	34	89	5.23	13.17	104	6.43	15.67	14.63	110	4.63	15.32	104	4.71
34	20	23	107	5.78	14.51	117	6.89	17.21	15.29	99	5.29	16.03	107	5.43
35	19	26	98	5.21	15.82	116	6.61	17.99	14.94	102	4.94	15.19	110	5.05
36	27	30	102	5.87	13.63	117	6.66	15.56	15.38	105	5.38	15.61	113	5.5
37	29	19	96	6.09	15.64	124	7.41	17.45	14.79	108	4.79	14.85	105	4.87
38	31	33	92	5.78	13.75	112	6.56	15.63	15.23	111	5.23	15.98	108	5.39
39	18	22	99	6.02	14.87	126	7.62	16.98	14.61	96	4.61	15.39	111	4.73
40														