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# Kinematic Analysis of the Drag Push Technique on Ball Speed in Indoor Hockey

**Salman*, Tono Haryono**

Universitas Pendidikan Indonesia, Indonesia

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## Abstract

This research was aimed to analyze the drag push technique using a 3D kinematic analysis approach. Biomechanical parameters have a significant effect on the drag push technique so that they can be specific recommendations for training the drag push technique. The method used in this research was the quantitative descriptive method. The samples participating in this study were professional hockey players from the Indonesian National men's team (n: 12; age: 21.3 ± 2.5 years; weight: 71.7 ± 5.2 kg; height: 170 ± 2, 4 cm; BMI: 21.2 ± 1.7; competition experience: 4 ± 2.2 years). The instrument used in this research was a High-Speed Camera (Fastecimaging; San Diego, USA) with a shutter speed of 120Hz to record the athlete movements when performing the drag push technique. Radar Speed Gun (Bushnell; Kansas, USA) was used to detect ball speed resulting from the drag push technique. Motion Analysis Software (Frame-DIAS; Fukuoka, Japan) was used to analyze motion kinematics in three dimensions. The collected data were analyzed statistically using descriptive statistics and stepwise linear regression. The results revealed that drag distance and stance width were the dominant variables for optimizing push-in performance of Indonesian Indoor Hockey athletes. This study suggests that maximizing the distance of the foot to the ball at the start of the push-in is important to maximize the distance of the pull and using a combination of simultaneous and sequential segment rotations is beneficial to optimize the ball speed and the drag speed.

✉ Correspondence Address : Jl Setiabudi No.229, Bandung, Jawa Barat 40154
E-mail : aman.emberik@upi.edu

## INTRODUCTION

Indoor hockey is a version of field hockey; it was once a part of winter field hockey training but has now evolved into its own sport under the name "indoor hockey" (Konarski & Strzelczyk, 2009). Similar to field hockey, indoor hockey is a sport that entails two teams consisting of eleven players each, engaging in a competitive play. The players utilize their specialized sticks, commonly referred to as 'hook' sticks, to strike, propel, distribute, and maneuver a small, rigid, typically white ball. The primary objective of the game is to achieve a goal by successfully scoring the ball into the opposing team's designated scoring area (Hardy & Holman, 2018).

High ball speed reduces the goalkeeper's anticipation time to catch or parry the ball (Eskiyecek et al., 2018; Ladru et al., 2019; Ladru et al., 2023), increasing the possibility to score for players who possess the capability to generate high ball speed. Kinematic analysis is critical in developing effective motions; a single indicator change can alter the outcome of a shot. The distance between the ball and the foot, for example, determines the outcome of the ball shot (Gómez et al., 2012). The sequential arrangement of body segments, from proximal to distal, has paramount importance when the objective is to achieve high velocity during the act of throwing or striking a ball with a stick (Putnam, 1993). However, when striving for accuracy, this will be an impediment, therefore the rotation of the body segments will normally rotate concurrently (Allison & Park, n.d.; Kreighbaum & Barthels, 1996).

Drag Push is a well-known and important hockey tactic. This technique can be used by hockey players for short and long-distance passes, penalty execution, and long-distance shooting. Drag Push is used because it produces speed and precision on the ball (Chivers & Elliott, 1987), making it an effective scoring technique (Mosquera et al., 2007; Yusoff et al., 2008). Several previous studies on the biomechanics of the Drag Push technique reported that the angle stick with hand, drag distance, and stance width are the main variables for predicting performance when carrying out the Drag Push technique (Sundar, 2019), and that maximizing drag distance by increasing the distance between the foot and the ball will increase Drag Push performance (Kerr & Ness, 2006). Research by McLaughlin (1997) shows that extending the drag distance with the left foot in front of the ball is significantly linked with the maximum speed of the ball.

Based on the aforementioned research findings, it can be observed that the breadth of the stance and the drag distance are elements that determine the maximum speed of the ball. The faster the ball moves, the more difficult it is for the goalkeeper to react and catch or fend off the ball, increasing the possibility to score. Numerous coaches recommend the Drag Push maneuver into player training regimens due to its demonstrated efficacy in generating scoring opportunities during international championships (Lopez De Subijana, 2010; Hussaein et al., 2012; Ibrahim et al., 2017).

The objective of this study was to examine the factors affecting the execution of the Drag Push technique to develop precise coaching guidelines for the coach of the Indonesian National Hockey Team. The expectation is that shortcomings in the associated kinematic variables would be identified, hence enabling the development of strategies to enhance the proficiency of Indonesian athletes in executing the Drag Push movement technique.

## METHODS

The research employed a quantitative descriptive approach. This method was administered to comprehensively examine the geometric aspects of motion or kinematic variables pertaining to professional hockey players from the Indonesian national men's team during the execution of the Drag Push.

### Participants

The participants included in this study were professional hockey players from the Indonesian National men's team. The sample size consisted of 12 individuals, with an average age of 21.3 ± 2.5 years. The participants had an average weight of 71.7 ± 5.2 kg and an average height of 170 ± 2.4 cm. Their average BMI was 21.2 ± 1.7, and they had an average match experience of 4 ± 2.2 years.

### Sampling Procedures

Players were instructed to carry out the Drag Push movement as if they were in-game; each sample performed the Drag Push movement 5 times. The efficacy of the Drag Push technique was evaluated based on the

velocity and precision of the resulting ball movement. The most successful trial was then analyzed using Kinovea software, with the following variables taken into consideration: stance width, drag distance, foot distance to the ball, drag speed, and ball speed.

Three cameras with 120fps shutter speeds (Panasonic HC-VC 970) were positioned in a perpendicular arrangement. Camera 1 was situated in front of the shooter, at 2 meters. Camera 2 was positioned perpendicularly between the goal and the shooter, at 3 meters. Lastly, camera 3 was placed above the shooter in a perpendicular manner, with a distance of 1 meter (Figure 1).

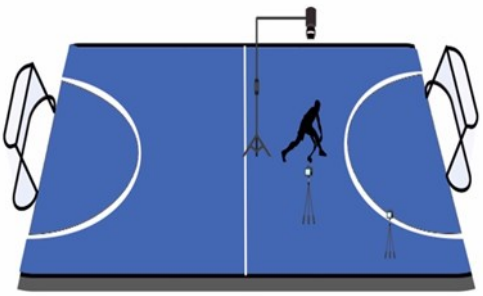

**Figure 1.** Scheme of Data Collection Process

The variables measured in this study were as follows:

1) Stance width: the initial distance between the left foot and right heel during the initiation of the Drag Push movement,
2) Ball-front foot distance: the space between the ball and the heel of the left foot,
3) Drag distance: the linear displacement of the ball upon contact with the stick,
4) Drag time: the duration between the initial contact of the ball with the stick and the subsequent release of the ball,
5) Average drag speed: the ball average speed when it makes contact with the stick, and
6) Ball speed: the ball speed as a result of the Drag Push technique.

### Data Analysis

The mean and standard deviation of the variables of the two groups were calculated. The results were compared using the Independent Sample t-test assumption to determine the disparity in the distribution of variables between the two sample groups. The chosen alpha level for this research was 0.05, as it aligned with the exploratory nature of the study.

## RESULT

Table 1 displays the mean and standard deviation of the kinematic variables observed in National Hockey players.

**Table 1.** Kinematic Variables from Both Sample Groups

| Variable | Mean | Std. Deviation |
|---|---|---|
| Ball Speed (m/s) | 14.02 | ± 1.58 |
| Stance width (m) | 1.15 | ± 1.02 |
| Ball to front foot (m) | 0.87 | ± 0.10 |
| Drag Distance (m) | 1.01 | ± 2.06 |
| Drag Time (s) | 0.42 | ± 0.06 |
| Average Drag Speed (m/s) | 4.02 | ± 1.50 |

The average ball speed was 14.02 ± 1.58m/s. The average stance width was 1.15 ± 1.02m. The distance between the ball and the foot was 0.87 ± 0.30 m. The drag time was 0.42 ± 0.06s, and the average drag speed was 4.02 ± 1.50m/s.

## DISCUSSION

This study discovered that the Ball Speed produced from Drag Push movement by international hockey players (18.1 m/s) was much quicker than that of National hockey players (14.02 m/s), with international players reaching 28% faster than national players. In comparison to prior study, national player stance width was not significantly different from the stance width of female international athletes, specifically measuring 1.00 m (Kaur & Singh, 2019). According to Kerr and Ness (2006), International players have been observed to execute the Drag Push action more effectively than National players due to their utilization of a maximum stance width. This advantage stems from the positive correlation between the stance width and the resulting ball speed generated by the Drag Push movement.

The distance of the left foot to the ball, like the breadth of the stance, is positively connected with the

speed of the ball. It is evident that foot positioning is critical for maximizing the performance of the Drag Push technique to achieve good ball speed and a longer drag distance. Although there is no significant difference in the drag distances between the two groups, it is worth noting that the National group exhibited considerable variability in its drag distance data, with an average value of 1.01 and a standard deviation of 2.06. Previous studies have found a drag time of 0.10 seconds for International Hockey players (Garman, 1977; Kaur & Singh, 2019), while National players exhibit a longer average drag time of 0.42 seconds. This analysis suggests that there is a need for improvement in the backswing skills of National players to reduce the time required to execute Drag Push (Aris and Ibrahim, 2022; Utomo et al., 2019).

Based on the findings derived from this study, three recommendations are proposed. The researcher sought to clarify the research constraints inherent in this study. As the findings were derived exclusively from male athletes aged 18-22 years so it is not relevant if it is used as a reference for female athletes. Additionally, the recommendation being offered may not be applicable to adult male hockey players who often possess higher average strength levels and greater experience. In addition, it should be noted that a sample size that is not excessively large does not yield greater statistical power in the context of data analysis. Notwithstanding these constraints, this study found some differences in the Drag Push movement execution between the International and National player groups. The recommendations acquired can serve as a means of training to enhance the performance of the Drag Push technique, particularly in terms of the ball speed, of Indonesian National players. The subsequent coaching recommendations that have been synthesized encompass:

Stance: the coach should encourage players to take a wide stance. The coach should also focus on the player ability to maximize the space between the front (left) foot and the ball during the initiation of the Drag Push movement. Considering the contribution of body segment movements to reduce the amount of time spent dragging the ball, it is necessary to employ a composite movement pattern, such as a combination of pushing and throwing. The movement begins with simultaneous rotation of the hips and shoulders, followed by simultaneous rotation of the right and left arms (Antonov, 2021).

Explosive drag: the concept of explosive drag entails the necessity of maximizing drag speed, which in turn results in the attainment of maximal ball speed. Players must pull the ball as far as possible in the least amount of time to maximize the drag speed. The efficacy of this operation can be enhanced by optimizing the angle at which the stick is displaced in a perpendicular manner to the Push-in line. Further, because this movement involves a Counter Rotation, the coach must understand the critical significance of the Stretch-Shortening Cycle to effectively optimize the explosive force of the movement. Following the counter-rotation of this segment, the hips and shoulders should rotate at the fastest feasible rate (Kerr & Ness, 2006).

## CONCLUSION

This study demonstrates that the stance width, the distance between the foot and the ball, and the drag push speed are all determining factors for maximum ball speed. The following coaching recommendations are developed as a result of this research to improve the efficacy of the push-in movement technique, namely optimizing the distance of the pull by maximizing the initial distance between the foot and the ball during the push-in, utilizing simultaneous combinations and sequential segment rotations to optimize ball speed and drag push speed, and applying sports science to indoor hockey.

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