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Influence of the Stick Grasping in Sprint and Change of Direction Performance in Elite Youth Rink Hockey Players

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Abstract: This study aimed to investigate the influence of stick grasping on the performance of elite youth rink hockey players in 10 m linear sprints and 180° change of direction (COD) tasks. Forty-nine rink hockey players (age = 18.40 ± 2.12 year; body mass = 73.52 ± 6.02 kg; height = 1.82 ± 0.07 m; BMI = 23.61 ± 1.69; sports experience = 6.42 ± 1.41 years; 4.89 ± 0.68 years' post-peak height velocity) participated in this cross-sectional study. Measurements included 10 m sprint time and COD 180° performance with and without stick grasping. Results revealed non-significant differences when carrying a stick in the 10 m linear sprint (1.90 s ± 0.08 with stick vs. 1.89 s ± 0.08 without stick; $p = 0.71$; $d = 0.05$), neither did COD 180° for the left limb (2.75s ± 0.11 with stick vs. 2.76 s ± 0.11 without stick; $p = 0.91$; $d = 0.02$). However, for the right limb, significantly better performance in COD 180° was found when players held the stick (2.72 s ± 0.11 with stick vs. 2.75 s ± 0.09 without stick; $p = 0.03$; $d = 0.32$). These findings imply that the distinctive biomechanics and requirements of rink hockey, especially the lateral movements inherent in skating, might alleviate the negative impacts associated with implement grasping observed in other sports. This study highlights that stick grasping did not hinder COD ability and may even have a facilitating effect on certain movements, emphasizing the importance of considering sport-specific biomechanics in rink hockey performance analysis.

Keywords: roller hockey; biomechanics; performance enhancement; training specificity

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1. Introduction

Rink hockey, alternatively referred to as roller hockey, quad hockey, or hardball hockey, is a team sport played by two teams, each composed of five players (four players and one goalkeeper). The game unfolds on a rectangular rink measuring 40 m in length and 20 m in width, enclosed by a one-meter high barrier. Participants navigate the playing surface on classic skates equipped with two pairs of parallel wheels, wielding a stick to manipulate a solid, round ball. The physical demands of rink hockey are distinctive, characterized by an intermittent nature featuring brief bursts of high-intensity acceleration and speed. These dynamic sequences typically endure for less than 10 s and involve various unilateral high-intensity actions, including accelerations, tackles, shots, or sudden braking [1].

Among the essential skills in this sport, sprinting and change of direction (COD) ability play a pivotal role in determining an athlete's performance outcomes [2]. These attributes are especially crucial in sports conducted within confined spaces like rink hockey, where rapid accelerations and swift changes of direction can mean the difference between success and a missed opportunity. Moreover, rink hockey players have the added particularity of having to perform these tasks with skates. In this vein, from a biomechanical perspective, rink hockey skating can be dissected into two distinct phases: propulsion and recovery. In the propulsion phase, players generate the force required to move themselves forward by executing a swift and forceful knee extension. This extension propels their forward motion. Simultaneously, during the recovery phase, players retract their legs backward in preparation for the subsequent stride. It is crucial in this phase to keep the leg as close to the ground as possible to minimize any loss of momentum in the skating motion. Moreover, players must execute a knee flexion movement to ready themselves for the impending stride [3]. In the initial strides from a static position, players utilize the front part of the skate (the toe stop) to perform rapid, small steps at a high frequency. This initial burst of activity is succeeded by utilizing the generated momentum to continue gliding on the wheels. As players accumulate momentum and persist in generating strides with the wheels, they integrate frontal and lateral force vectors [3].

In contrast to speed skating, where biomechanics encompass arm positioning (extending arms forward for enhanced aerodynamics and momentum, and maintaining an upright torso for stability and control) [4], rink hockey involves less upper limb movement due to the constraint of the stick grasping [3]. Similar to other hockey modalities and various team sports, such as rugby, lacrosse, or cricket, participants in these sports are obliged to carry essential, yet restrictive, pieces of equipment (e.g., a ball or stick) while executing the sport's task objectives [5]. This aspect can negatively influence players' displacement since the introduction of weights to the body has been documented to influence performance and induce adaptations in sprint technique [6]. For instance, some studies have shown that carrying a rugby ball during a 30 m sprint run can negatively impact the time taken to cover the distance compared to a sprint run performed without the ball [7,8]. In cricket, Callaghan et al. [9] reported that the act of carrying a bat has implications for both arm and leg kinematics during a 17.68 m sprint. This influence can ultimately lead to a reduction in step length and an increase in the time taken when the sprint is initiated from a static start. Similarly, Watkins et al. [10] demonstrated that stick carry led to slower sprint times over 20 m, including the 0–5 m, 5–10 m, 10–15 m, and 15–20 m intervals, in both male and female lacrosse players. These shared biomechanical challenges, such as altered kinematics and increased resistance during sprints, provide a plausible connection between the influences of equipment in the aforementioned sports, and the potential impact of stick grasping in rink hockey.

In this context, despite the recent increase in rink hockey investigations [11,12], the relationship between these factors remains largely unexplored and to the authors' knowledge, no studies analyzing the influence of stick grasping in rink hockey players displacement exist to date. Unlike sports, where athletes may use their hands freely, rink hockey players are constrained by the stick, which introduces a distinctive biomechanical element. Understanding how stick grasping affects sprinting and COD tasks is crucial for optimizing performance strategies specific to rink hockey. Therefore, the main objective of this study was to determine the differences in linear sprint and COD tasks executed with and without stick and study their relationship.

2. Materials and Methods

This study employed a cross-sectional design to assess the differences in sprinting and COD velocity according to the stick grasping in a group of elite youth rink hockey players. To determine the COD and sprint velocity, the 180° COD test and 10 m sprint test were assessed.

2.1. Participants

Forty-nine young elite male rink hockey players were recruited through convenience sampling to participate in this research. The participants in this study were currently part of the pre-selection process for the U-19 national team and were acknowledged as the top-performing players in their league. Table 1 provides an overview of the participants' demographic information, encompassing details such as age, height, mass, body mass index (BMI), sports experience, and years post-peak height velocity. Biological maturation was determined using a non-invasive approach, utilizing a regression equation from Mirwald et al. [13] that incorporated age, body mass, standing height, and sitting height measures. All participants in the study maintained a minimum training frequency of four sessions per week, equivalent to approximately 8 to 12 h weekly, spanning 8–9 months each year. Moreover, they actively engaged in at least one game every weekend throughout the entire season. It is noteworthy that during each training session, players dedicated approximately one hour to specific strength training in the gym with athletic shoes, followed by an hour and a half of on-field practice. This comprehensive training regimen covered both general physical preparation and specific on-field skills, contributing to their athletic development and technical proficiency throughout the season. Exclusion criteria for athletes encompassed the presence of any injury (acute or chronic) or illness during the test period that hindered maximal effort. All sports-related injuries incurred during both matches and training sessions were meticulously documented and tracked using the Osics coding system [14]. Moreover, the goalkeepers were excluded from the analyses because their game performance is not dictated by this type of skating ability. Prior to study participation, written informed consent was secured from all participants. The research design adhered to the guidelines of the Declaration of Helsinki (revised in Fortaleza, Brazil, 2013) and received approval from the local university ethics board (ref. no. 1819005D). Additionally, consent for the study was obtained from the technical departments of the clubs involved.

Table 1. Participants characteristics.

	Mean	**SD**
Age (years)	18.40	2.12
Height (m)	1.82	0.07
Body mass (kg)	73.52	6.02
BMI (kg·m^2)	23.61	2.12
Sports experience (years)	6.42	1.41
Years' post-peak height velocity (years)	4.89	0.68

Key: BMI = body mass index; SD = standard deviation.

2.2. Procedures

One week before the data collection, participants were extensively introduced to all tests and procedures. On the testing day, a standardized warm-up protocol was methodically applied to adequately prepare the participants for subsequent assessments. Initially, all subjects participated in a 15 min warm-up routine wearing sneakers, including continuous moderate-intensity running, joint mobility exercises targeting the trunk, shoulders, and wrists, as well as movements at various speeds on the track and progressive speed changes up to maximum intensity. Following the sneaker warm-up, participants dedicated 10 min to maximal, progressively intense specific activities with skates, involving sprints, directional changes, and acceleration/deceleration. To familiarize the participants with the tests, three practice trials were conducted, each executed at perceived effort levels of 70%, 85%, and 100% of their maximal capacity. A two-minute rest period was allowed between the final practice trial and the initiation of the first test. Both the test order and participant sequence were randomized using a "true random number generator" program to eliminate potential biases.

2.2.1. 180° Change of Direction Speed Test (COD Test)

The evaluation of COD time performance was conducted using timing gates (Witty, Microgate, Bolzano, Italy), positioned at a height of 1.3 m from the ground. This elevation is recommended to minimize the influence of arm movements on the measurements [15]. To replicate specific rink hockey change of direction scenarios [16], the test was carried out while wearing skates. In this assessment, participants were directed to skate forward for a distance of five meters and swiftly return to the starting point, covering a total of ten meters. To execute the test, players were instructed to perform a braking maneuver on one side and then alternate by using the other leg for two separate attempts. A trial was deemed successful if the participant crossed the line with the skate during the COD. In total, each player performed eight attempts: two with a stick and two without for the right leg, and similarly, two with a stick and two without for the left leg. A two-minute rest interval was provided between each attempt. The order of the tests and the sequence of participants were randomized using a "true random number generator" program to mitigate potential biases. For additional analysis, the fastest time recorded from the two attempts for each condition was chosen as the representative measure for each player.

2.2.2. 10 m Linear Sprint

Sprint speed was evaluated using a 10 m sprint test. The start and finish lines were clearly marked with cones. To ensure consistency, the front foot of each player was positioned 0.5 m before the first timing gate. Two sprints were performed by each participant, with a three-minute rest period between each attempt. The total time for each sprint was recorded using photoelectric cells (Witty, Microgate, Bolzano, Italy). The timing gates were situated at a height of 1.3 m from the ground, spaced 1.5 m apart. This specific height was chosen to minimize any interference from arm actions during the measurements, following the recommendations by Yeadon et al. [14]. Each player conducted a total of four attempts, comprising two with a stick and two without. For further analysis, the fastest time obtained from the two sprints was selected as the representative measure of sprint speed for each player.

2.3. Statistical Analysis

Statistical analyses were conducted using JAMOVI® v.2.3.24 software. The data for all variables were presented in terms of mean and standard deviation (SD). The Shapiro–Wilk test was employed to assess the normality of the variables. Additionally, within-session reliability of test measures was evaluated using a two-way random intraclass correlation coefficient (ICC) with absolute agreement (95% confidence intervals). Interpretations for ICC values were categorized as follows: >0.9 = excellent, 0.75–0.9 = good, 0.5–0.75 = moderate, and <0.5 = poor [17]. Additionally, the coefficient of variation (CV) was calculated, and a value of <10% was considered acceptable [18]. The t-Student for related samples test was employed to assess the variations in test performance based on stick grasping. A significance level of $p < 0.05$ was predetermined for all statistical analyses. Additionally, Cohen's d effect sizes (ES) with 95% confidence intervals were computed [19], with the magnitude interpreted as follows: <0.2 = trivial; 0.2–0.6 = small; 0.6–1.2 = moderate; 1.2–2.0 = large; >2.0 = very large [20]. Pearson's correlations were employed to assess the relationship between each test result when performed with and without a stick. Statistical significance was set at $p \leq 0.05$. The magnitudes of correlations were evaluated using Hopkins' scale and interpreted as follows: trivial (0.00–0.09), small (0.10–0.29), moderate (0.30–0.49), large (0.50–0.69), very large (0.70–0.89), nearly perfect (0.90–0.99), and perfect (1.00) [20].

3. Results

Descriptive statistics and reliability measures for all tests are shown in Table 2. All the tests showed good within-session ICC values (≥0.9) and had acceptable consistency with CV values <10%. Results of the paired *t*-tests (Figures 1 and 2) showed a significantly better performance in the COD 180° for the right leg when players grasp the stick ($p = 0.03$;

d = 0.32). There were no significant differences between the stick conditions for the COD 180° for the left leg (p = 0.91; d = 0.02). There was also no difference in performing the 10 m-sprint test without or with a stick (p = 0.71; d = 0.71).

Table 2. Mean test scores and within-session reliability data.

	Mean ± SD	ICC	95% CI	CV (%)	*p* Value	ES
10 m sprint with stick (s)	1.90 ± 0.08	0.93	0.86–0.95	1.33	0.71	0.05 (−0.23–0.34)
10 m sprint without stick (s)	1.89 ± 0.08	0.91	0.85–0.95	1.14		
COD 180° with stick (RL) (s)	2.72 ± 0.11	0.85	0.74–0.92	4.42	0.03	0.32 (0.03–0.61)
COD 180° without stick (RL) (s)	2.75 ± 0.09	0.86	0.76–0.93	4.85		
COD 180° with stick (LL) (s)	2.75 ± 0.11	0.86	0.76–0.93	4.93	0.91	0.02 (−0.30–0.27)
COD 180° without stick (LL) (s)	2.76 ± 0.11	0.89	0.81–0.94	4.89		

Key: ICC = intraclass correlation coefficient; CI = confidence intervals; CV = coefficient of variation; ES = Cohen's *d* effect size; COD = Change direction capacity; RL = Right Limb; LL = Left Limb.

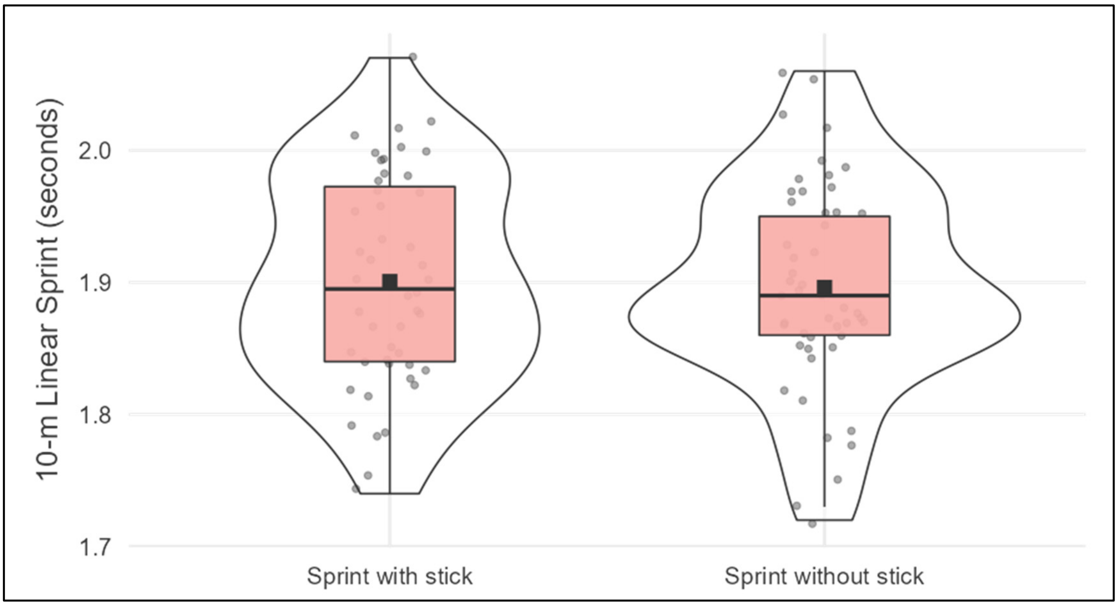

Figure 1. Comparison between the linear sprint performance with the stick and without the stick.

Figure 3 shows the matrix correlation between test performance with players grasping the stick and without. The results showed significant positive correlations for each test when performed with and without stick (r = 0.58 (0.39–1.00); $p < 0.01$ for 10 m sprint; r = 0.62 (0.45–1.00); $p < 0.01$ for COD 180° with the RL; r = 0.55 (0.36–1.00); $p < 0.01$ for COD 180° with the LL).

Finally, Table 3 displays the correlation matrix between the 10 m sprint and COD 180° times according to the grasping stick constraint. The 10 m sprint without stick correlated with all COD 180° times, while the 10 m sprint with stick only correlated with COD 180°.

Table 3. Pearson's r correlations (r) between the linear sprint and COD tasks.

	10 m Sprint with Stick	10 m Sprint without Stick
COD 180° with stick (RL)	**0.40** *	**0.40** **
COD 180° with stick (LL)	0.17	**0.41** **
COD 180° without stick (RL)	0.24	**0.60** **
COD 180° without stick (LL)	0.28	**0.48** **

Key: * ($p < 0.05$); ** ($p < 0.01$); The bold shows the significant correlations.

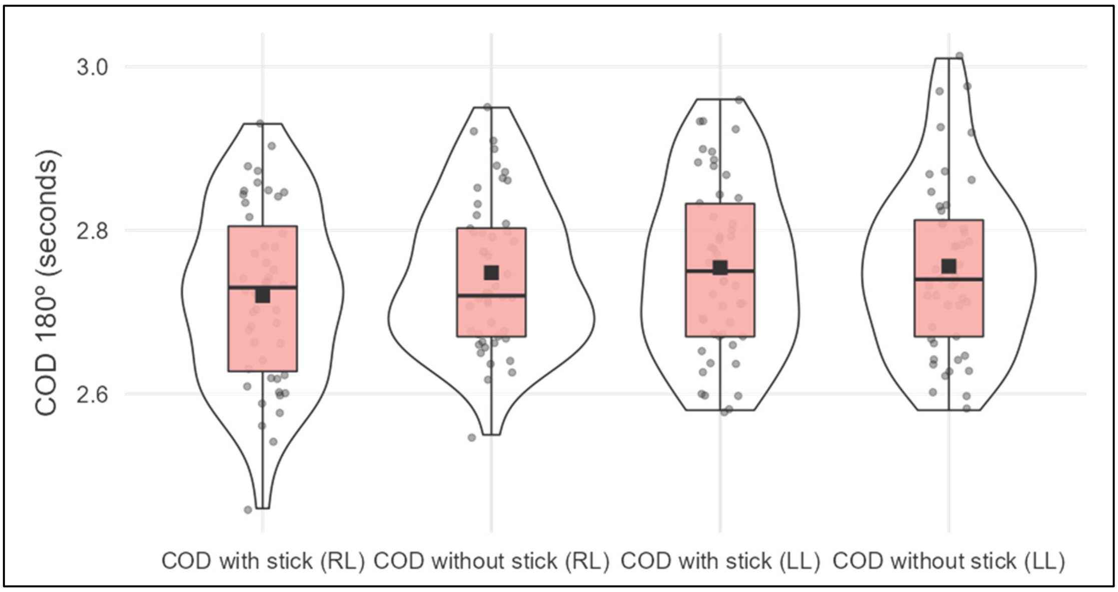

Figure 2. Comparison between the 180° COD performance with the stick and without the stick for the right limb (RD) and the left limb (LL).

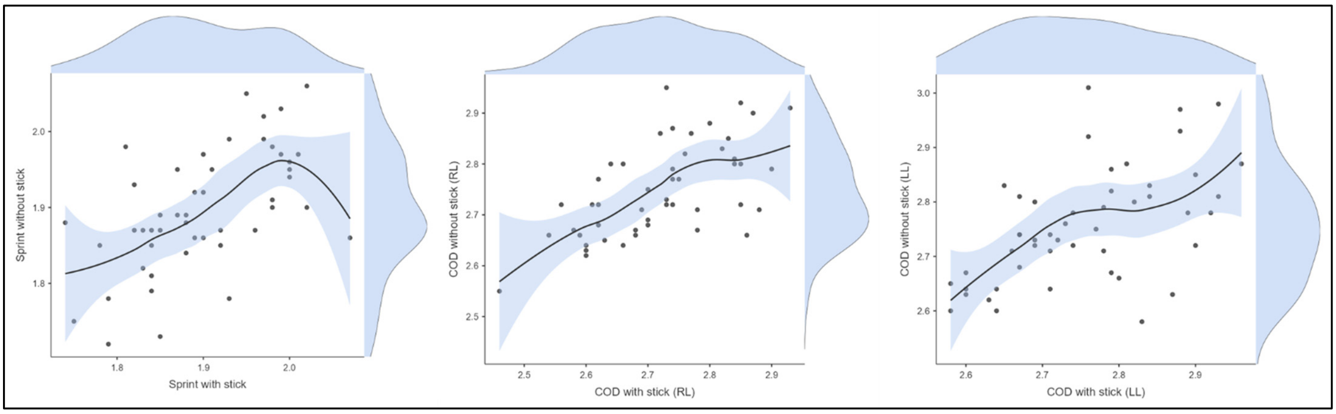

Figure 3. Matrix correlation between tests performance with stick and without stick.

4. Discussion

This study aimed to assess and identify differences in 10 m linear sprint and COD 180° performance with and without the constraint of carrying a rink hockey stick. The key findings indicate non-significant differences in the 10 m linear sprint and COD 180° for the left limb. However, significant differences in COD 180° for the right limb were observed, demonstrating improved performance when players executed the test with the stick.

The study sample size was drawn from a very specific context, which limits the generalizability of the results. Nonetheless, there are still some notable findings. Firstly, this study provided descriptive data for elite youth rink hockey players, which is limited in the scientific literature. Comparing the present results with scientific literature, Arboix-Alió et al. [21] reported 2.83 s ± 0.20 and 2.77 s ± 0.06 [22] for the COD 180° in a sample of non-professional players.

The analysis of COD indicated a noteworthy enhancement with a small effect size (d = 0.32) in the performance of COD 180° for the right limb when players held the stick, while no significant differences were observed for the COD 180° performance for the left limb. This discovery implies that grasping the stick did not adversely impact COD ability and, in fact, might have a facilitating effect on specific COD movements. The possible explanation for the stick not adversely impacting COD ability and even facilitating certain movements could be attributed to the specific biomechanics of rink hockey [23]. The sport requires rapid and precise changes in direction, and players executing these movements on skates might integrate the stick more seamlessly into their motor patterns [24]. The lateral nature of displacement in rink hockey, as opposed to the primarily frontal displacement in running, may allow players to use the stick effectively in COD tasks without compromising performance. Furthermore, carrying a stick showed non-significant differences for the 10 m sprint time with a trivial effect size (d = 0.05).

Although no data on rink hockey sport has been found, our results are in contrast with Lockie et al. [25], who reported significant differences between the 0–10 m sprint interval without a stick compared to with a stick (p = 0.02; but this had a small effect (d = 0.25) in collegiate female lacrosse players. Similarly, Watkins et al. [10], observed that carrying a stick led to a slower 20 m sprint performance among both male and female collegiate lacrosse players. Callaghan et al. [9] also reported analogous findings in male cricketers, noting that carrying a cricket bat in the dominant hand during sprinting led to a reduction in shoulder and elbow range of motion. Consequently, this limitation in motion contributed to decreased hip flexion and, subsequently, a diminished step length within the initial 5 m of a 17.68 m sprint [9].

The lack of significant differences in the 10 m sprint time when carrying a stick among rink hockey players could be attributed to the specific biomechanics and demands unique to rink hockey compared to the aforementioned sports. This is primarily due to the mode of displacement on skates. In contrast to running, where the predominant movement is frontal, skating in rink hockey introduces lateral movements as players glide on the wheels of their skates [3]. This lateral displacement requires a different set of motor patterns and muscle activations compared to running. The biomechanics of stick-carrying during sprinting on skates might be more seamlessly integrated into the players' movement patterns due to the inherent lateral nature of their displacement [3]. Additionally, the weight distribution and design of the hockey stick used in rink hockey may be optimized for performance on skates. Players may have learned to handle the stick in a way that minimizes interference with their skating mechanics, ensuring efficient propulsion and agility. These sport-specific factors likely contribute to the contrasting results observed in rink hockey compared to lacrosse and cricket studies, emphasizing the importance of considering the biomechanics associated with the mode of displacement in each sport.

Finally, the significant positive correlations between test performances with and without the stick suggest a consistent individual influence of stick grasping on both sprint and COD abilities. Interestingly, while the 10 m sprint without a stick correlated with all COD 180° times, the 10 m sprint with stick only correlated with COD 180°, indicating a more specific relationship between stick usage and COD performance.

While providing valuable insights, it is important to acknowledge certain limitations in this study. Firstly, the restricted sample size may limit the representativeness of the findings and the extent to which they can be extrapolated to broader player demographics or varying skill levels. Elite youth male players constitute a specific subset of the rink hockey population, and their characteristics and performance may differ from those of female players, adult players, or players at different skill levels. Moreover, the impact of sample size on the study's statistical power and interpretability of the results should be emphasized. Consequently, the observed influence of stick grasping should be interpreted with caution, and future studies with larger sample sizes can provide a more robust assessment of these associations. Secondly, the cross-sectional design used hinders the establishment of causal relationships, and measurements were confined to a specific point in time (end-season). Given the potential influence of season timing [26,27], particularly in youth athletes [28], longitudinal studies would be beneficial. Furthermore, this study exclusively evaluated timing in COD and linear sprint performance, overlooking other influential factors like players' skating technique or biomechanics. More comprehensive investigations that encompass a broader range of variables would contribute to a more holistic understanding of sprint and COD performance in rink hockey players.

5. Conclusions

In conclusion, this study shed light on the influence of stick grasping on linear sprint and COD 180° performance in elite youth rink hockey players and provided descriptive data for these abilities' performance. The results revealed significant improvements in COD 180° for the right limb when players held the stick, suggesting a potential facilitating effect on specific COD movements. The use of task- and sport-specific sprint drills, such as performing sprint protocols while carrying a hockey stick, may improve the specificity of training in field sports by allowing an explicit replication of the mechanical demands of the skills underpinning superior performance within the sport.

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Data Availability Statement: The data presented in this study are available on reasonable request from the corresponding author.

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References

1. Yagüe, P.L.; Del Valle, M.E.; Egocheaga, J.; Linnamo, V.; Fernández, A. The competitive demands of elite male rink hockey. *Biol. Sport* **2013**, *30*, 195–199. [CrossRef]
2. Fernández, D.; Cadefau, J.A.; Serra, N.; Carmona, G. The distribution of different intensity demanding scenarios in elite rink hockey players using an electronic performance tracking system. *PLoS ONE* **2023**, *18*, e0282788. [CrossRef] [PubMed]
3. Riverola, R. *Hockey Patines: Preparación Física*; Segura, R., Ed.; Alto Rendimiento: Alcoy, Spain, 2009.
4. Astudillo-Sarabia, C.F.; Moscoso-García, R.F.; Barrachina-Fernández, G. Análisis biomecánico de la técnica de salida de patinaje de velocidad. *Cienciamatria* **2022**, *8*, 1103–1130. [CrossRef]
5. Wdowski, M.M.; Gittoes, M.J.R. Kinematic adaptations in sprint acceleration performances without and with the constraint of holding a field hockey stick. *Sport. Biomech.* **2013**, *12*, 143–153. [CrossRef]
6. Alcaraz, P.E.; Palao, J.M.; Elvira, J.L.L.; Linthorne, N.P. Effects of Three Types of Resisted Sprint Training Devices on the Kinematics of Sprinting at Maximum Velocity. *J. Strength Cond. Res.* **2008**, *22*, 890–897. [CrossRef] [PubMed]
7. Grant, S.; Oommen, G.; McColl, G.; Taylor, J.; Watkins, L.; Friel, N.; Watt, I.; McLean, D. The effect of ball carrying method on sprint speed in rugby union football players. *J. Sports Sci.* **2003**, *21*, 1009–1015. [CrossRef]
8. Walsh, M.; Young, B.; Hill, B.; Kittredge, K.; Horn, T. The effect of ball-carrying technique and experience on sprinting in rugby union. *J. Sports Sci.* **2007**, *25*, 185–192. [CrossRef] [PubMed]
9. Callaghan, S.J.; Lockie, R.G.; Jeffriess, M.D. The acceleration kinematics of cricket-specific starts when completing a quick single. *Sport. Technol.* **2014**, *7*, 39–51. [CrossRef]
10. Watkins, C.; Brown, L.; Wong, M.; Barillas, S.; Bartolini, J.; Munger, C. Stick carry decreases sprint speed in collegiate lacrosse players. In Proceedings of the 39th National Strength and Conditioning Association National Conference and Exhibition, New Orleans, LA, USA, 6–9 July 2016.
11. Arboix-Alió, J.; Buscà, B.; Peña, J.; Aguilera-Castells, J.; Miró, A.; Fort-Vanmeerhaeghe, A.; Trabal, G. Situational and Game Variables in Rink Hockey: A Systematic Review. *Apunt. Educ. Física y Deport.* **2023**, *2*, 22–35. [CrossRef]
12. Ferraz, A.; Valente-Dos-Santos, J.; Sarmento, H.; Duarte-Mendes, P.; Travassos, B. A Review of Players' Characterization and Game Performance on Male Rink-Hockey. *Int. J. Environ. Res. Public Health* **2020**, *17*, 4259. [CrossRef]
13. Mirwald, R.L.; Baxter-Jones, A.D.G.; Bailey, D.A.; Beunen, G.P. An assessment of maturity from anthropometric measurements. *Med. Sci. Sports Exerc.* **2002**, *34*, 689–694. [CrossRef]
14. Rae, K.; Orchard, J. The Orchard Sports Injury Classification System (OSICS) Version 10. *Clin. J. Sport Med.* **2007**, *17*, 201–204. [CrossRef]
15. Yeadon, M.; Kato, T.; Kerwin, D. Measuring running speed using photocells. *J. Sports Sci.* **1999**, *17*, 249–257. [CrossRef]

16. Arboix-Alió, J.; Aguilera-Castells, J.; Ferrándiz, C. Resistencia Aeróbica en Hockey Patines: Análisis Comparativo del Rendimiento Deportivo Efectuado con y sin Patines. *Red Rev. Entren. Deport.* **2016**, *31*, 3–11.
17. Koo, T.K.; Li, M.Y. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J. Chiropr. Med.* **2016**, *15*, 155–163. [CrossRef]
18. Cormack, S.J.; Newton, R.U.; McGuigan, M.R.; Doyle, T.L.A. Reliability of Measures Obtained During Single and Repeated Countermovement Jumps. *Int. J. Sports Physiol. Perform.* **2008**, *3*, 131–144. [CrossRef]
19. Cohen, J. *Statistical Power Analysis for Behavioural Science*; Lawrence Erlbaum: Mahwah, NJ, USA, 1988.
20. Hopkins, W.G.; Marshall, S.W.; Batterham, A.M.; Hanin, J. Progressive Statistics for Studies in Sports Medicine and Exercise Science. *Med. Sci. Sport. Exerc.* **2009**, *41*, 3–13. [CrossRef] [PubMed]
21. Arboix-Alió, J.; Aguilera-Castells, J.; Rey-Abella, F.; Buscà, B.; Fort-Vanmeerhaeghe, A. Asimetrías neuromusculares entre miembros inferiores en jugadores de hockey sobre patines. *RICYDE. Rev. Int. Cienc. Deport.* **2018**, *14*, 358–373. [CrossRef]
22. Arboix-Alió, J.; Buscà, B.; Busquets, A.; Aguilera-Castells, J.; de Pablo, B.; Montalvo, A.M.; Fort-Vanmeerhaeghe, A. Relationship between Inter-Limb Asymmetries and Physical Performance in Rink Hockey Players. *Symmetry* **2020**, *12*, 2035. [CrossRef]
23. Yagüe, P.L.; del Valle, M.E.; Egocheaga, J.; Fernández, A. Correlación entre la fuerza explosiva y la capacidad de aceleración y aceleración-desaceleración en jugadores de hockey sobre patines. *Red Rev. Entren. Deport.* **2009**, *23*, 13–20.
24. Fernández, D.; Varo, F.; Carmona, G.; Reche, X. Quantification of external load of elite rink hockey players in official matches. *J. Sports Med. Phys. Fitness* **2020**, *60*, 1520–1525. [CrossRef]
25. Lockie, R.; Birminagham-Babauta, S.; Stokes, J.; Liu, T.; Risso Fabrice, G.; Lazar, A.; Giuliano, D.V.; Orjalo Ashley, J.; Moreno, M.R.; Stage, A. An Analysis of Collegiate Club-Sport Female Lacrosse Players: Sport-Specific Field Test Performance and the Influence of Stick Carry on Speed. *Int. J. Exerc. Sci.* **2018**, *11*, 269–280.
26. Bishop, C.; Read, P.; Bromley, T.; Brazier, J.; Jarvis, P.; Chavda, S.; Turner, A. The Association Between Interlimb Asymmetry and Athletic Performance Tasks: A Season-Long Study in Elite Academy Soccer Players. *J. Strength Cond. Res.* **2020**, *36*, 787–795. [CrossRef] [PubMed]
27. Bishop, C.; Read, P.; Chavda, S.; Jarvis, P.; Brazier, J.; Bromley, T.; Turner, A. Magnitude or Direction? Seasonal Variation of Interlimb Asymmetry in Elite Academy Soccer Players. *J. Strength Cond. Res.* **2020**, *36*, 1031–1037. [CrossRef] [PubMed]
28. Fort-Vanmeerhaeghe, A.; Bishop, C.; Buscà, B.; Vicens-Bordas, J.; Arboix-Alió, J. Seasonal variation of inter-limb jumping asymmetries in youth team-sport athletes. *J. Sports Sci.* **2021**, *39*, 2850–2858. [CrossRef]