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Comparative Analysis of Activity Profiles in Division I Female Field Hockey Athletes: Before and after Game Time Modifications

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Abstract: Collegiate field hockey in the United States underwent a game format change in 2019, moving from two halves to four quarters to align with international play. The purpose of this study is to report physical activity profiles for US Collegiate Division I female field hockey athletes in the game format of four quarters and compare activity pre- and post-rule change. Activity profiles of a US Collegiate Division I female field hockey team were recorded using a Polar Pro Sensor. Fifteen regular season games from 2018 were analyzed from 21 players, and fifteen regular season games from 2019 were analyzed from 20 players. Absolute and relative activity profile data, including total distance, maximum velocity, low-speed and high-speed running, and number of surges for the team and positional difference, were compared across the two seasons. While an increase in the number of substitutions as well as a decrease in match time was noted, overall, the change in format had minimal impact on player performance profiles, including total time played, distance traveled, and maximum velocity. The results suggest the change in format did not alter the physical activity profiles for midfielders or forwards but did change for defenders. Implications for performance that existed before the rule change can be seen as consistent going forward.

Keywords: field hockey; Division I; activity profile; GPS

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1. Introduction

For coaches and training staff to develop efficient and effective practices and training programs, it is useful to understand the physical activity levels for their competitions. In this context, field hockey is an open-skill team-based game that consists of intermittent bursts of high-intensity running followed by periods of low-intensity running [1–3]. Physical activity profiles are known to vary across player positions [2,4–6]. Most research has focused on international levels of play [1,7–9]. Within the last ten years, advances in global positioning system (GPS) technology have allowed for accurate distance monitoring of players during games [10,11], and rule changes have been implemented first at the international level and, more recently, at other levels that impact the timing of the game.

Field hockey is played with ten field players and one goalie. Field players typically are delineated as forwards, midfielders and defenders, often with 3–4 of each on the field at one time, varying by team formation. The International Federation of Hockey (FIH) governs and regulates the sport of field hockey. Current FIH rules state matches are four 15 min quarters, with 2 min separating quarters 1 and 2 and quarters 3 and 4, and a 5-min halftime between quarters 2 and 3 [12]. The game clock stops between the time a penalty corner has been awarded and the start of the penalty corner. Prior to 2015, FIH tournament regulation rules stated matches were two 35 min halves with a 10-min halftime and a continuous game clock [13].

The National Collegiate Athletic Association (NCAA) governs and regulates collegiate sports in the United States of America. The NCAA, in some cases, modifies rules for sports in comparison to international or professional rules. Collegiate field hockey follows FIH rules with some modifications. Prior to the 2019–2020 season, all collegiate matches were played with two 35 min halves and a 10-min halftime with a continuous clock [14]. For the 2019–2020 season, this modification was removed, and matches were played with four 15 min quarters, with 2 min separating quarters 1 and 2 and quarters 3 and 4 and a 10-min halftime between quarters 2 and 3 [15]. Further, the game clock now stops between the awarding of a penalty corner and the start of the penalty corner, but not for a controlled amount of time. The game clock also stops for goals both before and after the rule change, as well as at officially designated times such as those resulting from a player injury. The primary rationale for changing the collegiate match format to four quarters was to resemble all international play.

Most studies on elite field hockey players consisted of games with two halves [1,5,16,17]. Gabbett [1] reported elite women field hockey defenders traveled an average of 6643 ± 1618 m, midfielders 6931 ± 1882 m, and forwards 6154 ± 271 m, though no statistical comparison between those were made. Macutkiewic and Sunderland [17] compared distances between positions and found both defenders (6170 ± 977 m) and midfielders (5626 ± 787 m) covered a significantly greater distance during a match compared with forwards (4700 ± 918 m). In both studies, the distance reported was not relative to the time each player spent on the field. Numerous studies have noted defenders spend more time on the field compared with forwards [3,17–19]. Vinson et al. standardized relative distance to playing time for female hockey players competing in the England Hockey Premier League, finding defenders (99.77 ± 4.36 m·min^{-1}) covered less relative distance than midfielders (117.20 ± 4.36 m·min^{-1}) [16]. While showing a similar trend, these values are slightly lower than elite international female field hockey players, where defenders covered an average relative distance of 114 ± 7 m·min^{-1}, midfielders 129 ± 5 m·min^{-1}, and forwards 131 ± 10 m·min^{-1} [5]. One study, at the professional level, compared activity profiles before and after the game format change and found the relative distance for all field players increased playing four quarters, but positional comparisons were similar before and after the rule change [18]. Examining the match in quarters, McGuinness et al. [5] also saw the trend of defenders covering the highest absolute distance (5181 ± 607 m) and the forwards the lowest absolute distance (4549 ± 546 m), but when examining the relative distance, forwards were the highest (142.2 ± 17.1 m·min^{-1}) and the defenders were the lowest (115.1 ± 13.5 m·min^{-1}).

Collegiate team organization, training, and play in the United States are distinctly different from international-level teams. In college, athletes typically play 1–2 games per week over a 10–11 week season. NCAA athletics are organized within three collegiate exclusive divisions, with Division I being the highest competitive level for collegiate play. Many international tournaments take place over 8–12 days, with 5–6 games played during the short time period [20,21]. Practice schedules are also different. The NCAA limits practice time during the competitive playing season to 20 h per week [22]. In addition to practices and games, student-athletes must balance classes and other collegiate-related stresses. To our knowledge, only one study has examined activity profiles in collegiate female field hockey athletes and was conducted before moving to the four-quarter format [3]. Sixty-eight players from six different Division I universities were monitored for one regular season game. Similar to international players, forwards played less time than defenders and defenders covered less relative distance compared with both midfielders and forwards. Defenders also had significantly more distance in low-intensity running compared with forwards.

The change in game format introduces more short-term recovery periods resulting from the break between quarters. This change can potentially lead to increased levels of high-intensity running. Understanding how this change affects activity profiles is important for coaches to structure their training appropriately. Activity profiles for collegiate field

hockey athletes only exist for the game format of two halves. Therefore, the purpose of this study is to report activity profiles for Division I female field hockey athletes in the game format of four quarters. Additionally, this research will compare activity profiles in the two different game formats, including differences between positions. This research can provide a basis for further informed training at the collegiate level, including similarities and differences across player positions. We hypothesize that the change in rules will allow for increased high-intensity running and sprinting, in particular across forwards and midfielders, and the number of substitutions will increase.

2. Materials and Methods

2.1. Subjects

A total of 27 distinct players from a single Division I women's field hockey team were included in this study. For the 2018 season, 21 players were included (average age 19.4 years; forward = 6, midfield = 10, defense = 6; note one player switched from midfield to defense partway through the season). For the 2019 season, 20 players were included (average age 19.3 years; forward = 5, midfield = 8, defense = 7). Fourteen athletes played in both seasons. Only field players were included in the study. All players provided informed consent, and the study was approved by the university's institutional review board. In both seasons, the team was ranked in the top half of their conference, thus making the conference postseason tournament, though it did not make it to the NCAA tournament either year.

2.2. Match Data

Fifteen regular season games from 2018 were analyzed with a total of 257 match analyses. Fifteen regular season games from 2019 were analyzed with a total of 241 match analyses. Data is available in supplementary material. During the 2018 season, the match was played in two 35 min halves. During the 2019 season, the match was played in four 15 min quarters. All players wore the Polar Pro Sensor (Polar Electro Inc., Bethpage, NY, USA) for each game. Only data from players who had activity data for all time they were present on the field during a particular game were included in the full dataset. While care was taken throughout each game, occasionally, technical issues with the sensors themselves, sensor connectivity, or disconnection from the user based on environmental conditions or body positioning led to data interruption. The start and stop times for each match were verified via video. Match time (MT, min) is the total time in minutes of the game. The total time (TT, min) represents the amount of time a player spends in the game. For the 2018 season, total time was the amount of time that elapsed on the game clock during which the player was on the field. Because the game clock stopped for penalty corners in 2019 and not 2018, the total time for the 2019 season was the amount of time that elapsed on the game clock during which the player was on the field plus the amount of time the player was on the field with the clock stopped between the awarding and starting of a penalty corner. Penalty corner time was verified via video. TT for each player was calculated and verified with a combination of substitution sheets, play-by-play sports information provided by the host university of each game, video, and GPS data. Numbers of substitutions were calculated using the same combination of information as TT. A substitution is noted any time one player is added to the game while another leaves, including changes that occurred at halftime or other stoppages. To assess the impact of the clock stopping during penalty corners in 2019, the average number of penalty corners was calculated along with the average penalty corner time. In 2018, the time of penalty corners and their duration within each game were not recorded because their time contribution to the game was included in the match time because the clock did not stop for penalty corners.

2.3. GPS Equipment

Each athlete wore a GPS unit with a MEMS motion sensor for each game. The GPS was sampled at 10 Hz, and the motion sensor, including the accelerometer, gyroscope,

and magnetometer, was sampled at 200 Hz. The sensor was 36 mm × 68 mm × 13 mm with a mass of 39 g. The sensor was attached to each player using a strap around the chest, positioned as recommended by Polar Pro instructions. The GPS unit communicates wirelessly via Bluetooth to an iPad located on the sidelines. Players wore the GPS unit through the duration of their warm-up routine, allowing the units to be running for at least 30 min before data used for this study were recorded.

2.4. GPS Analyses

GPS data were downloaded via the Polar Team Pro web interface. Total distance (TD, m) is the total distance traveled by the players as measured by the GPS unit. Low-speed running (LSR, m) is the distance traveled while the player's velocity is <10.99 km/h. High-speed running (HSR, m) is the distance traveled while the player's velocity is >11.00 km/h. The maximum velocity (MV, m/s), in addition to the number of surges (S, #), defined as the number of efforts above 19.01 km/h, was recorded for each player for each game. In order to determine relative values to allow for comparisons between positions irrespective of time spent on the field, the TT for each player for each game was determined. Then, the TD, LSR, HSR, and S for each player for each game were divided by the corresponding time for that game, with the resulting averages of those values reported as the relative values. Relative substitutions were determined by dividing the number of substitutions by match time.

2.5. Statistical Analyses

Prior to analysis, outliers were removed from the data (4% of available data). For maximum velocity, data above 10 m/s were removed as this is more than 10% higher than the fastest player's sprinting speed. T-tests were performed to determine the effect of year on game time and differences in attacking versus defensive penalty corner times. A two-way mixed-effects analysis of variance was used to determine the effect of year, position, and their interaction on all other dependent measures. The players were treated as a random effect to account for repeated measures within each season. Effect size, partial eta squared (η^2), was calculated with the interpretation small ($\eta^2 = 0.01$), medium ($\eta^2 = 0.06$), and large ($\eta^2 = 0.14$) [23,24]. Post hoc analysis was completed with Tukey's HSD. All statistical analyses were completed in JMP Pro 12 (Cary, NC, USA) with significance set at $p < 0.05$ for all tests.

3. Results

The absolute and relative performance metrics for all players in the 2018 and 2019 seasons are shown in Table 1, independent of position. Table 2 shows the absolute and relative performance metrics across positions, independent of year. Table 3 shows absolute values, and Table 4 shows relative values across positions across years.

Table 1. Team values (mean ± standard deviation) for 2018 (two halves) and 2019 (four quarters). * = game year significance ($p < 0.05$). SUB = # of substitutions, MT = match time, TT = total playing time, TD = total distance, LSR = low-speed running, HSR = high-speed running, MV = maximum velocity, S = # of surges.

	2018	2019
Absolute		
SUB (#)	54.2 ± 4.3	60.3 ± 7.2 *
MT (min)	75.3 ± 1.5	70.1 ± 3.2 *
TT (min)	40.0 ± 15.5	38.0 ± 13.9
TD (m)	4795.1 ± 1453.0	4562.5 ± 1337.4
LSR (m)	2617.5 ± 992.3	2498.2 ± 874.3
HSR (m)	1944.8 ± 625.4	1846.0 ± 583.3
MV (m/s)	7.1 ± 0.8	7.1 ± 0.8
S (#)	16.3 ± 6.7	14.2 ± 6.5

Table 1. *Cont.*

	2018	2019
Relative		
SUB (#·min^{-1})	0.72 ± 0.06	0.87 ± 0.11 *
TD (m·min^{-1})	124.5 ± 18.1	124.2 ± 17.5
LSR (m·min^{-1})	66.0 ± 7.3	66.8 ± 7.9
HSR (m·min^{-1})	52.1 ± 14.5	51.1 ± 13.2
S (#·min^{-1})	0.4 ± 0.2	0.4 ± 0.2 *

Table 2. Defense, midfield, and forward values averaged across both years (mean ± standard deviation), * = positional significance ($p < 0.05$). SUB = # of substitutions, MT = match time, TT = total playing time, TD = total distance, LSR = low-speed running, HSR = high-speed running, MV = maximum velocity, S = # of surges.

	Defender	Midfielder	Forward
Absolute			
SUB (#)	7.5 ± 4.0	22.8 ± 2.9	28.1 ± 3.5 *
TT (min)	48.6 ± 21.7	36.0 ± 10.5	35.7 ± 8.9 *
TD (m)	4964.4 ± 1900.1	4643.4 ± 1291.1	4518.8 ± 1020.9 *
LSR (m)	3153.5 ± 1351.3	2371.2 ± 721.1	2361.6 ± 544.5 *
HSR (m)	1544.5 ± 546.7	2057.8 ± 616.8	1947.3 ± 523.8
MV (m/s)	7.0 ± 0.8	7.1 ± 0.8	7.3 ± 0.8
S (#)	12.3 ± 5.4	15.7 ± 6.7	17.1 ± 6.8 *
Relative			
SUB (#·min^{-1})	0.11 ± 0.1	0.31 ± 0.0	0.39 ± 0.0 *
TD (m·min^{-1})	108.3 ± 17.5	130.5 ± 15.0	128.3 ± 13.8 *
LSR (m·min^{-1})	66.2 ± 7.2	66.0 ± 7.9	67.0 ± 7.6
HSR (m·min^{-1})	35.5 ± 11.1	58.0 ± 10.7	55.2 ± 9.3 *
S (#·min^{-1})	0.3 ± 0.1	0.5 ± 0.2	0.5 ± 0.2 *

Table 3. Absolute values (mean ± standard deviation) for defense, midfield, and forwards in 2018 and 2019. SUB = # of substitutions, MT = match time, TT = total playing time, TD = total distance, LSR = low-speed running, HSR = high-speed running, MV = maximum velocity, S = # of surges. ‡ indicates significance between years within the position.

	Defender		Midfielder		Forward	
	2018	2019	2018	2019	2018	2019
SUB (#)	4.0 ± 1.8	10.1 ± 3.0 ‡	28.9 ± 2.6	27.4 ± 4.1	22.5 ± 2.5	22.9 ± 3.3
TT (min)	54.6 ± 22.4	43.5 ± 19.9	36.8 ± 10.4	35.2 ± 10.7	34.7 ± 8.7	36.9 ± 9.1
TD (m)	5347.4 ± 2000.4	4639.4 ± 1761.2	4753.1 ± 1312.1	4523.3 ± 1263.0	4494.6 ± 1082.3	4548.4 ± 947.1
LSR (m)	3478.6 ± 1420.7	2877.8 ± 1234.2	2447.4 ± 732.5	2287.7 ± 702.4	2286.3 ± 550.6	2453.8 ± 526.1
HSR (m)	1567.1 ± 559.2	1525.4 ± 539.5 ‡	2092.9 ± 631.3	2019.3 ± 601.3	1994.0 ± 562.3	1890.1 ± 470.0
MV (m/s)	7.0 ± 0.5	7.1 ± 0.9	7.2 ± 0.8	7.0 ± 0.8	7.3 ± 0.8	7.2 ± 0.8
S (#)	12.9 ± 6.1	11.8 ± 4.7	16.4 ± 6.6	14.9 ± 6.7	18.5 ± 6.4	15.5 ± 6.9

Table 4. Relative values (mean ± standard deviation) for defense, midfield, and forwards in 2018 and 2019. SUB = # of substitutions, TD = total distance, LSR = low-speed running, HSR = high-speed running, S = # of surges. ‡ indicates significance between years within the position.

	Defender		Midfielder		Forward	
	2018	2019	2018	2019	2018	2019
SUB (#·min^{-1})	0.05 ± 0.03	0.14 ± 0.05 ‡	0.38 ± 0.04	0.39 ± 0.06	0.30 ± 0.03	0.33 ± 0.05
TD (m·min^{-1})	103.2 ± 16.2	112.6 ± 17.4	130.3 ± 13.4	130.6 ± 16.7	130.7 ± 14.1	125.5 ± 13.1
LSR (m·min^{-1})	64.3 ± 5.9	67.9 ± 7.7	66.5 ± 7.7	65.5 ± 8.1	66.5 ± 7.5	67.7 ± 7.7

Table 4. *Cont.*

	Defender		Midfielder		Forward	
	2018	2019	2018	2019	2018	2019
HSR ($m \cdot min^{-1}$)	32.0 ± 10.4	38.5 ± 10.8 ‡	57.6 ± 10.3	58.4 ± 11.0	57.8 ± 8.8	52.1 ± 9.1
S ($\# \cdot min^{-1}$)	0.3 ± 0.1	0.3 ± 0.1	0.5 ± 0.2	0.4 ± 0.2	0.5 ± 0.2	0.4 ± 0.2 ‡

3.1. Absolute Differences

MT significantly decreased when moving to the four-quarter format from two halves ($p < 0.001$, $\eta^2 = 0.522$). On average, MT is 5.2 min less in 2019 compared with 2018. In 2019, the average penalty corner time was 41.4 ± 8.3 s, with an average of 10.5 ± 4.1 penalty corners per game.

Overall, the four-quarter format has more substitutions than two halves ($p = 0.0133$, $\eta^2 = 0.075$), with an average of six more substitutions occurring per game. Midfielders are substituted more compared with forwards, who are substituted more than defenders ($p < 0.001$, $\eta^2 = 0.890$). The interaction effect ($p < 0.001$, $\eta^2 = 0.029$) shows defenders subbed more often in 2019 compared with 2018, with midfielders and forwards having no differences between years. The number of substitutions across positions is consistent with the typical rotation for the team, where seven players commonly rotated among four midfield positions, five players commonly rotated among three forward positions, and defenders were rotated sparingly, with three to four players typically being rotated among three positions.

There is no significant main effect for the year ($p = 0.288$, $\eta^2 = 0.016$) on TT. There is a main effect of positions where defenders played significantly longer than forwards and midfielders ($p < 0.001$, $\eta^2 = 0.151$). There is no interaction effect for TT ($p = 0.606$, $\eta^2 = 0.029$).

For TD, there is no significant main effect for the year ($p = 0.288$, $\eta^2 = 0.011$). There is a significant main effect of position as defenders had a higher TD traveled compared with forwards and midfielders ($p < 0.001$, $\eta^2 = 0.017$). There is no interaction effect for TD ($p = 0.229$, $\eta^2 = 0.010$).

There is no main effect of year for LSR ($p = 0.405$, $\eta^2 = 0.012$) or HSR ($p = 0.233$, $\eta^2 = 0.003$). There is a main effect of position as defenders covered more distance in LSR compared with both forwards and midfielders ($p < 0.001$, $\eta^2 = 0.141$). There is no positional difference in HSR ($p = 0.054$, $\eta^2 = 0.114$). There is no interaction effect in LSR ($p = 0.706$, $\eta^2 = 0.023$). There is an interaction effect in HSR for defenders in 2019 compared with defenders in 2018 ($p < 0.001$, $\eta^2 = 0.000$).

There is no significant main effect for the year ($p = 0.472$, $\eta^2 = 0.000$) or position ($p = 0.481$, $\eta^2 = 0.013$), nor an interaction ($p = 0.270$, $\eta^2 = 0.004$) for MV. There is no main effect of year for the number of surges ($p = 0.243$, $\eta^2 = 0.020$). There is a main effect of position for the number of surges ($p = 0.010$, $\eta^2 = 0.072$), with forwards completing more surges per game than midfielders. There is an interaction effect ($p = 0.011$, $\eta^2 = 0.004$), with forwards in 2018 having more surges than defenders across both years; however, the focus of the current study is comparing positions within a year or comparing the same positions across years.

3.2. Relative Differences

There is a main effect of position ($p < 0.001$, $\eta^2 = 0.891$), year ($p < 0.001$, $\eta^2 = 0.208$), and an interaction ($p = 0.001$, $\eta^2 = 0.150$) for substitutions per minute. Similar to absolute numbers, midfielders were substituted at a higher rate than forwards, who were subbed at a higher rate than defenders. The substitution rate was higher in 2019 than in 2018. The interaction effect shows defenders were substituted more often in 2019 compared with 2018.

For relative TD, there is no effect for the year ($p = 0.636$, $\eta^2 = 0.002$). There is a main effect of position as relative TD was significantly greater for midfielders compared with

forwards who were higher than defenders ($p < 0.001$, $\eta^2 = 0.272$). There is no interaction effect ($p = 0.266$, $\eta^2 = 0.031$). There is a main effect for the year ($p = 0.003$, $\eta^2 = 0.007$), position ($p = 0.033$, $\eta^2 = 0.175$), and an interaction ($p = 0.029$, $\eta^2 = 0.032$) for surges per minute. The number of relative surges was higher in 2018 than in 2019. Forwards have a significantly higher number of surges per minute compared with defenders. The forwards in 2018 had a higher number of relative surges compared with 2019.

There is no significant main effect for the year ($p = 0.459$, $\eta^2 = 0.007$) or position ($p = 0.497$, $\eta^2 = 0.004$), nor an interaction effect ($p = 0.296$, $\eta^2 = 0.015$) on relative LSR. There is no main effect for the year ($p = 0.556$, $\eta^2 = 0.000$), but there is a main effect of position ($p < 0.001$, $\eta^2 = 0.459$) with midfielders and forwards being higher than defenders on relative HSR. There also is an interaction effect ($p = 0.002$, $\eta^2 = 0.027$), with forwards in 2018 having a higher relative HSR than forwards in 2019.

4. Discussion

This is the first study to examine the impact of the format change from two halves to four quarters, along with the rule change of stopping the clock for penalty corners in collegiate women's field hockey athletes. Therefore, this also is the first study to report activity profiles of Division I college athletes with the current timing system. While an increase in the number of substitutions as well as a decrease in match time was noted, overall, the change in format had minimal impact on player performance profiles and specifically on player's TD, LSR, HSR, MV, and relative measures. One notable implication resulting from this overall minimal impact is that this study demonstrates most work related to player training and performance remains valid despite the rule changes. Also, while the games were shorter in the new format, the lack of player activity change implies coaches are able to play their top athletes to a similar degree while not degrading their overall performance while lessening the amount of time the subbed athletes might play.

A prior study examined the same format change in elite female athletes at the international level [18]. A similar significant decrease in match time was observed. To allow a direct comparison of activity levels per time on the field before and after the rule change and to compare to international play, the time on the field used for 2019 included the duration of penalty corners. In international competition, the clock is stopped for 40 s for penalty corners, whereas, after the format change in Division I college field hockey, the referees control the restart of the game with the insertion of the penalty corners. The average penalty corner time in 2019 reported in this study (41.4 ± 8.3 s) is comparable to the 40 s required stoppage time in international play. The match time difference across years in this study is approximately 5 min shorter in 2019 compared with 2018, which is a result of a 10 min shorter game, but 6 more minutes for average penalty corner stoppage, and 1 min less on average with no time outs, with all other referee and goal stoppages of the clock being approximately equal. As seen from the standard deviation for match time in 2019 being twice that of 2018, the variability is because the number of penalty corners fluctuates.

Considering the results changing across years, both overall and for specific positions, comparisons can be made to a similar study, which also noted a higher number of substitutions after the rule change in elite athletes, both in an absolute and relative sense [18]. This increase in substitutions in both studies could be a result of substitutions that occur during breaks between periods. After the rule change, there were four periods with three breaks rather than two periods with one break. This allowed for more natural opportunities to perform substitutions outside the active run of play. Substitutions during breaks are easier to perform for athletes primarily playing on the opposite side of the field from the bench or in key positions related to defending the goal. Performing a substitution during active play requires a player in a key location to be absent for a period of time. Substituting during breaks eliminates this concern. Such a substitution during play at the elite level may be easier to perform than at the collegiate level, thus explaining the increase in substitutions for defenders in this study. This variation in substitutions approach across format change

for defenders relative to those of elite athletes also helps to explain the increased HSR for defenders in this work after the rule change. The rule change did not have a noted impact on substitutions for forwards or midfielders.

While this study showed a change in relative HSR for forwards before and after the rule change, a similar difference was not seen in prior research at the elite level [18]. One difference between the two studies is the prior study did not include player data if they fell below a set threshold in playing minutes. The average relative HSR for forwards can be impacted measurably by players who play a shorter number of minutes having a higher or lower relative HSR. Therefore, a direct comparison with past research on this metric is not feasible. Past research had, on average, higher TT and TD for midfielders and forwards but lower relative TD in both game formats compared with the current study [18]. In a separate study of elite female athletes' activity profiles in the two halves format, the athletes played higher minutes in midfield and forward, had higher TD, and relative TD was similar for all positions except for defenders compared with the current study [19]. In the four-quarter format, elite female athletes had similar TT, higher TD in defenders, and higher relative TD for forwards compared with the current study [5]. Maximum velocity in the current study is slightly higher than in previous studies [5,18]. Similar to past studies, the forwards and midfielders also covered more absolute distance at higher speeds than the defenders [3,5,17].

To our knowledge, only one prior study has examined activity profiles in Division I field hockey athletes, and this study was conducted prior to the game format change [3]. When comparing positional differences, consistent with past research, defenders spent the most amount of time on the field relative to forwards and midfielders [3]. Similarly, the relative distance traveled was higher for forwards and midfielders than it was for defenders, and midfielders covered more distance in HSR and had a higher relative HSR compared with other positions [3]. Another similarity between the studies saw midfielders covered more total distance in medium (8.1–16.0 km/h) and high (16.1–20.0 km/h) speed running compared with forwards [3]. Comparing the numerical values for Vescovi and Frayne [3] with this study shows some differences; however, direct numerical comparison between the two studies is not appropriate due to differences in methods. The prior work only included data from a fixed number (ten starting players and up to five substitutes) of players and not the whole team. For example, past research showed higher playing time, higher distance traveled, and a lower relative distance in comparison with this study, with each of these results being consistent with a limited number of athletes who participated the most during the game being monitored [3]. The number of substitutions also was not reported, which could impact these numerical differences. Finally, the rotation scheme used by a team will impact not only the number of substitutions but also the other metrics. For example, if four players rotated across three forward positions, the average playing time and other absolute performance metrics should be higher than if six players rotated across those same three forward positions. Importantly, the number of substitutions can be the same in those two cases, or they could be different.

There are several limitations to this study. First, results should be taken contextually. Only one team was recorded, and the results may not be extrapolated to other collegiate field hockey teams. This study should be expanded to include multiple teams from different athletic conferences. The GPS units used in this study did not record time spent in each speed zone. Therefore, the relative HSR and LSR presented in this study may not be the same as other studies that calculated the relative HSR and LSR as time spent in HSR and LSR. Additionally, past studies do not use the same range for low-speed and high-speed running, making it hard to compare across studies [5,17,18]. Finally, comparisons to past research were difficult due to previously stated unclear methods or differences in methodology.

5. Conclusions

Match time decreased as a result of the rule change, and the amount of time used for each penalty corner was similar to the fixed time used in the professional game. Overall, the results suggest the change in format did not alter the physical activity profiles for midfielder or forwards but did change for defenders, showing an increase in both substitutions and relative HSR. Coaches may want to increase high-intensity bouts of training in defenders compared to the pre-rule change. The change in game format also increased the number of substitutions, allowing for more players to rotate on the field. Other absolute and relative measures, including TD, LSR, and HSR, were consistent before and after the rule change; therefore, implications for performance that existed before the rule change can be seen as consistent going forward.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app14156674/s1.

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