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SPRINT AND DISTANCE ZONE ANALYSIS BY POSITION OF DIVISION I WOMEN'S LACROSSE

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ABSTRACT

Sprint zones are measured by the number of sprints conducted in zones 1 through 5 (Sprint 1 - Sprint 5) and the distance traveled in each zone (Dist 1 - Dist 5). Zones are determined by percentage of maximum sprint speed (1<60%, 2=60-69%, 3=70-79%, 4=80-89%, 5≥90%). The purpose of this study was to compare sprint zones and speed by position in Division I women's lacrosse during practices and games. Players (n=13) wore a vest with microtechnology (global positioning unit and heart rate monitor) to track movement and speed during 9 games and 41 practices. Players included four attackers, four midfielders, and five defenders. There were no main effect differences between training and games (p=0.288), or by an interaction with position (p=0.396). Univariate analyses showed differences between training and games for average speed (p<0.001) max speed (p=0.021), Sprint 1 (p<0.001), Sprint 2 (p<0.001), Sprint 3 (p<0.001), Sprint 4 (p<0.001), Sprint 5 (p=0.031), Dist 1 (p<0.001), Dist 2 (p<0.001), Dist 3 (p=0.001), and Dist 5 (p=0.003). All variables were higher in games than training except Sprint 5 and Dist 5 where training was higher. For the interaction between activity type and position there was a difference in Sprint 4 (p=0.032) and Sprint 2 (p=0.046), with attackers logging higher values during practice in Sprint 5 and Dist 5. There was a mismatch in sprint demands between training and games, with a greater game demand for efforts in zones 1-4 in games for all positions. These data indicate no need to train differently by position, but coaches and support staff can utilize this information to alter the structure of training to meet the demands of the game.

Keywords: athlete monitoring, team sports, external load

INTRODUCTION

Lacrosse is a physically demanding game comprised of multiple accelerations and decelerations, changes in direction, and large volumes of running (1,2). The sport consists of four positions (attack, midfield, defense, and goalie), each sharing some responsibilities but also having distinct roles (3). Recently, the game of lacrosse has grown in popularity, especially within the National

Collegiate Athletic association (NCAA) (1,4). With the increase specifically in women's lacrosse, there is a greater need for coaches and support staff to know the physical capacity of the female players they train and the demands of the game (5). Few papers have highlighted the internal (e.g., heart rate and ratings of perceived exertion) and external workload (e.g., distance, sprints, accelerations, decelerations) demands of training and games in women's lacrosse (1,6–10), with only one study providing an analysis of the high-intensity sprint demands of women's international play (6).

Speed is measured in sport with the use of wearable devices that typically include a global positioning system (GPS), accelerometer, magnetometer, and gyroscope. Studies have shown that these units are accurate and reliable when assessing movement of athletes at lower speeds over increased distances (11,12), and that reliability is improved with increased sampling rates (13). Wearable microtechnology also allows for an in-depth analysis of speed by classifying data into six activity bands that are known as sprint zones (14). Sprint zones are measured by the number of sprints conducted and distance moved in zones 1 through 5. Each zone is determined by a percentage of an athlete's maximum sprint speed (MSS), with sprint zone 1 <60% MSS, sprint zone 2 60-69% MSS, sprint zone 3 70-79% MSS, sprint zone 4 80-89% MSS, and sprint zone 5 ≥90% MSS.

Game profiles in Division I women's collegiate lacrosse determined that, on average, players traveled 4733-5422 ± 2294-2304 m per game (1,15), of which 656 ± 446 m occurred at high-intensity speeds and reached a maximum speed of 24.1 ± 2.6 km/h (1). Midfielders were found to run the greatest distance at high-intensity speeds in games. A separate analysis of speed, agility, and power in collegiate lacrosse athletes showed no differences between the positions in their agility and speed, indicating that the athletes were all similarly trained (3). In international women's play, it was determined that defenders performed more sprints (14 ± 2) and traveled farther in sprint zones 2-5 (zone 2: 1041.3 ± 47.1 m; zone 3: 1073.2 ± 126.1 m; zone 4: 638.5 ± 282.1 m; zone 5: 248.3 ± 42.7 m) (6). In this same study, midfield was shown to travel the most distance in speed zone 1 (1194 ± 143.7 m). Sprint zones in this study were determined by absolute speeds (zone 1: 7.0 $km \cdot h^{-1}$, zone 2: 7.0–11 $km \cdot h^{-1}$, zone 3: 11.0–15.0 $km \cdot h^{-1}$, zone 4: 15.0–19.0 $km \cdot h^{-1}$, zone 5: >19.0 $km \cdot h^{-1}$) and were not relative to the athlete's sprint capability. Collectively, these studies indicate that differences among positions exist in women's lacrosse.

To date, only three studies have provided workload context of a game profile for women's lacrosse (1,6,15). These studies provide a glimpse of the sprinting demands within international and collegiate game play and indicate that these demands are different by level of play and by position. Hauer et al. presented sprint zone information for international play, but this type of play operates under different rules than collegiate lacrosse (6). Devine et al. provided a concept of workload for collegiate lacrosse during games but did not provide information for sprint zones (1). The purpose of this study was to compare positional sprint and speed demands in Division I women's lacrosse during practice and games. These data add to the small body of research in training load demands for women's lacrosse, and help coaches have a better understanding of how to train their athletes.

METHODS

This study was a prospective observational study design. Participants were

Division I lacrosse athletes and data were collected during the 2019-2020 season. Athletes wore microtechnology during each practice and games to evaluate workload. The system utilized provides a myriad of internal and external workload data, but speed and sprint-related data were specifically used for the present analyses.

Participants

Participants were included in this study if they were members of the varsity women's lacrosse team. Participants were excluded if they were not eligible for play as determined by a healthcare professional, played fewer than 50% of the games during the competitive season, or were removed from the team. Twenty-seven athletes were consented for study participation, but data for only 13 athletes were included in the present study based upon the aforementioned criteria. Of the 13 athletes, there were four attackers, four midfielders, and five defenders. Participants were given ample opportunity to ask questions prior to the study as well as completed written informed consent. The study followed all FERPA guidelines and was approved by the institutional review board.

Data collection

Sprint data were collected for athletes during training and games using VX Sport microtechnology (Wellington, New Zealand) containing a wearable GPS unit (10 Hz) and heart rate monitor (2.4 GHz). VX Sport units have been previously demonstrated to provide accurate evaluations of external and internal load metrics (12,16). Units were turned on outside and distributed prior to each practice and games, and players used the same unit for the entire year. Satellite connections were ensured prior to the start of training sessions and games. After training and games, the units were collected and data were uploaded into the VX Sport Training software. The data were trimmed and split to remove any downtime before and after practice, to categorize specific drills, and remove other down times such as water breaks and halftime.

The sprint variables were measured depending on each athlete's maximum sprint speed (MSS). MSS was measured at the beginning of each training season (in September and January) with a 20-meter fly-in sprint followed by at 30-meter full effort sprint. Athletes completed the sprint effort three times with at least two minutes of recovery between each effort. The maximum speed attained during the three efforts according to the VX Sport unit was used as the athlete's MSS. Sprint zone repetitions (Sprint 1-Sprint 5) and distance run (Dist 1-Dist 5) were determined as a percentage of the players' MSS: Sprint 1 was equal to <60% MSS, Sprint 2 was 60-69%, Sprint 3 was 70-79%, Sprint 4 was 80-89%, and Sprint 5 was >90%. Speed data retrieved from the VX Sport Training Tool included all sprint zone data, player maximum speed in a session, and player average speed in a session.

Data analysis

SPSS version 25.0 (IBM, Chicago, IL) was used for all statistical analyses. Mean sprint zone data were tabulated for each athlete for training and games. A Shapiro-Wilks test was used to determine data normality. Data were determined to be normally distributed, thus parametric analyses were used. A repeated measures analysis of variance (RM-ANOVA) was used to compare sprint zone variables by type of activity (training vs games) and by position (attackers, midfielders, and defenders). Univariate analyses and Fisher's least significant differences (LSD) post-hoc analyses were used to tease out specific differences in sprint variables by activity type and position. Partial

eta-squared (η^2) effect sizes were calculated to determine the magnitude of differences. Effect sizes were interpreted as small (.02), moderate (.13), and large (.26) (17).

RESULTS

The competitive season was ended prematurely due to the COVID-19 pandemic. Thus, analyses included nine competitive intercollegiate games with 117 individual athlete files and 41 training sessions with 533 individual athlete files, totaling 650 athlete evaluations used to evaluate the sprint zone demands.

There were no main effect differences between training and games (Lambda (10,1) = 6.939, p = 0.288, partial η^2 = .986), or by an interaction with position (Lambda (20,2) = 1.933, p = 0.396, partial η^2 = .951). Univariate analyses showed differences between training and games for Sprint 1-3 (p < 0.001, partial η^2 = .818-.903), Sprint 5 (p = 0.031, partial η^2 = .387), Dist 1-3 (p ≤ 0.001, partial η^2 = .652 - .895), and Dist 5 (p = 0.003, partial η^2 = .611). These data are shown in Figure 1 A-F. Sprint 1-3 and Dist 1-3 demonstrated higher values in games than training; Sprint 5 and Dist 5 demonstrated lower values in games than training. All effect sizes were large.

Positional analyses, also shown in Figure 1, indicated a difference between positions for Sprint 2 (p = 0.010, partial η^2 = .601459) and Sprint 3 (p = .051, partial η^2 = .449), with attackers logging higher values than midfielders (p = .014-.037) and defenders (p = .004-.028). There was also a difference by position for Dist 2 (p = .029, η^2 = .509), with attackers logging higher Dist 2 than defenders (p = .010). Table 1 shows mean speed and maximum speeds reached during by position during training and games. Univariate analyses showed that games required a higher average speed (p < 0.001, partial η^2 = .754) and maximum speed (p = 0.021, partial η^2 = .428) than training. There were no differences by position. Again, all effect sizes are interpreted as large.

Table 1: Descriptive game statistics for each position presented as mean ± standard deviation. * indicates a difference between training and games (p < .05).

	Average Speed (km/h)		**Maximum Speed (km/h)**	
	Training	Games	Training	Games
Attackers	2.29 ± 0.13	3.01 ± 0.33	25.53 ± 0.65	26.39 ± 1.11
Midfielders	2.27 ± 0.07	2.79 ± 0.83	26.51 ± 1.1	26.82 ± 1.61
Defenders	2.08 ± 0.19	2.93 ± 0.17	25.31 ± 0.79	25.93 ± 0.15
Total	2.20 ± 0.17*	2.91 ± 0.47	25.74 ± 0.96*	26.35 ± 1.35

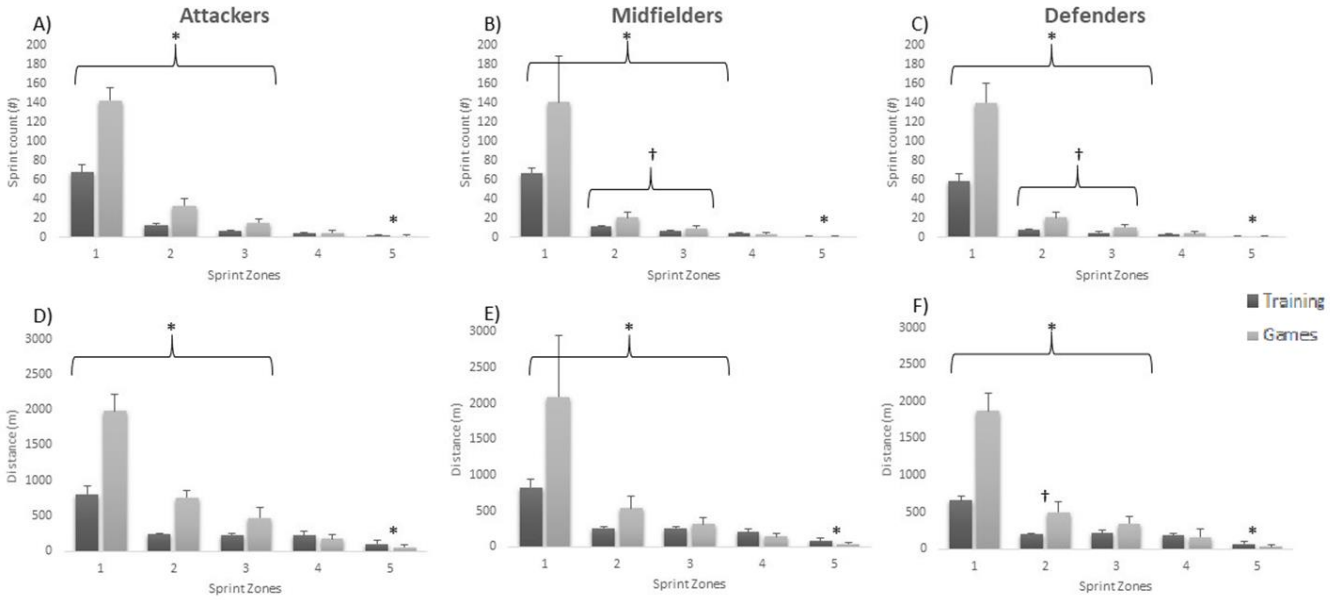

Figure 1: means for each sprint zone by position are shown in A) attackers, C) midfielders, and E) defenders. Distance traveled within each sprint zone are shown in B) attackers, D) midfielders, and F) defenders. * indicates a difference ($p < 0.05$) between training and games. † indicates differences from attackers ($p < .05$).

DISCUSSION

The aim of this study was to compare sprint zones and speed by position in Division I women's lacrosse during practices and games. Differences were shown between training and games for Sprint 1-3, Sprint 5, Dist 1-3, and Dist 5. Sprint and Dist 1-3 demonstrated higher values in games than training and Sprint and Dist 5 demonstrated lower values in games than training. Games also required a higher average speed and maximum speed than training. Among positions, attackers logged higher values than midfielders and defenders for sprint efforts and distance in zones 2 and 3.

When comparing game play to training, there was a difference in most sprint and distance zones most likely due to less down time during game play. During training, players are going through drills at different paces and have more down time discussing what needs to be improved upon and allowing for repetitions of reserve players. Participants included in the present study were only players that contributed in more than 50% of the games played, thus fewer reserve players were included in the analyses. The more time spent in sprint zones 1-3 in games is possibly due to a more dire need to follow the play of the game and stay on top of the task at hand. The greater number of repetitions and distance in Sprint 5 in training was due to purposeful conditioning sessions aimed at improving speed.

The present study indicated that attackers logged higher sprint efforts in zones 2 and 3 and distance in zone 2 than other positions. These data disagree with previous literature in collegiate women's lacrosse showing higher sprint efforts and high-speed distance for midfielders during games (1). Data from the current study also indicated greater maximum speed during games for all positions compared to the collegiate players

in the study by Devine et al. (1). Evaluation of international play has shown that defenders covered a greater total distance than other positions but around a third of this distance was in zone 1 (6). For the present study, defenders logged less distance than attackers. In collegiate game play, defenders usually to stay within a certain area of the field resulting in less distance run. Hamlett et al. showed that defenders in collegiate play had a great deal of sprint starts with less sprint distance run compared to attackers and midfielders (15). This was attributed to the reactionary nature of defending. Because there is so little data available for women's lacrosse and each study has only focused on one team at a time, it is difficult to assess if these are true differences or differences related to varied team strategies, players, and style of play.

A major limitation of this study was COVID-19 cancelling most of the 2020 competitive season, allowing data collection from only nine games. More games would have allowed potentially allowed an analysis of sprint patterns depending upon the opponent and throughout the season. Due to the nature of lacrosse game play, playing time was not tracked for these data. Evaluating these data per minute of play time for each athlete would help provide more relative context to the sprint load.

CONCLUSIONS

The data did not indicate a need to train differently by position. However, there was a significant mismatch between training and games for four of the five zones. These data provide useful information for lacrosse coaches and conditioning coaches in planning training to match the sprint-related workload of games. Lacrosse coaches may implement sideline sprint training for players when they are not participating in a drill during practice. This sideline training should be conducted with a lacrosse stick and being mindful of positions needing to mimic either attacking or defending sprint efforts. This sideline training may help supplement the needed sprint efforts and distance in training to match and better prepare for the sprint workload demands of a game.

Conflict of interest declaration

The authors have no conflict of interests.

Ethics

Institutional Review Board approval was obtained for the study procedure. The study conformed to the provisions of the Declaration of Helsinki.

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