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An evaluation of drill volumes in Division I women's lacrosse

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Abstract

Introduction. **Monitoring athletes using microtechnology allows for coaches to observe how athletes respond to the physiological demands of training.** Aim of Study. **The aim of this study was to determine differences in intensities and demand by training mode and position in women's collegiate lacrosse athletes.** Material and Methods. **Global positioning systems and heart rate monitors were worn by 27 athletes to gather training volume metrics, including: distance rate, maximum speed distance, high-intensity distance (HID), sprint efforts, accelerations, decelerations, and sprint distance. All data were organized into drill classifications: stickwork (SW), small-sided games (SSG), skill-specific drills (SSD), and simulated game play (SGP). All training metrics, except distance rate and maximum speed, were analyzed per minute spent in the drill to control for time. The drill database consisted of 99 days of training, which included three drills for SW, four drills for SSD, five drills for SSG, and five drills for SGP.** Results. **There was no difference in training workload by position (p = 0.414), but there was a difference in workload by drill type (p < 0.001), and an interaction between drill type and position (p = 0.031). For distance and accelerations, SSD was less than all other types of drills (p < 0.001 for all), and SSD had fewer decelerations than SSG (p = 0.011). SW drills registered less HID and fewer decelerations than all other types of drills (p < 0.001), and fewer sprint repetitions, accelerations, and less sprint distance than SSG (p = 0.001-0.011) and SGP (p = 0.001--0.013).** Conclusions. **Coaches can use this information to provide more specific training for each position and to manage the training volume of their athletes. Drill intensities can also be compared to game intensities to provide more specific training for games.**

KEYWORDS: team sports, athlete monitoring, training volume.

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Introduction

Managing athlete training volume, which is the amount of physical activity an individual performs, is becoming increasingly more common throughout the collegiate sports world. Athlete monitoring utilizes wearable technology, global positioning systems (GPS) and heart rate (HR) monitors alongside self-reporting measures to provide insight to how athlete respond to stress [1, 8, 10]. External load data is collected through GPS technology that tracks player movement patterns, helping the sports medicine and coaching world improve performance outcomes [8]. HR monitors along with self-reporting measures, such as rating of perceived exertion (RPE), are used to monitor internal load [1, 10]. Obtaining training data over the course of a season allows acute to chronic workload ratio, which shows activity levels of one week (acute) divided by previous weeks (chronic), for any one metric to be determined and can help to prevent any sudden changes in training volume [10]. Balancing the intensity of the demands put on athletes is vital for preventing exhaustion and reducing the risk of injury [10]. This new standard practice for maximizing player performance is a constant struggle, as coaches must balance the total training volume with an athlete's capabilities to reduce the risk of injury while also preventing detraining. Monitoring training intensity is also a critical component to the process of creating an individualized periodization focused training plan [10]. Having the ability to quantify training load for various exercises and drills using a single term would be very useful in overall ease of program understanding and administration. Understanding the intensity of each practice drill assists coaches and clinicians in making decisions towards managing the workload of athletes, ensuring safe and productive practice sessions.

Literature surrounding women's lacrosse has investigated the external load of games, evaluated positional differences in speed, sprint, and distance, assessed external load metrics and game performance, and classified drills according to their intensity [6, 7]. Previous literature also has shown weekly variations in training loads in collegiate athletes, with game scheduling heavily influencing training load [5]. This information has assisted coaches in developing in-game strategies as well as managing training volume that meet the position specific demands of games. Alphin et al. [1] classified 56 unique lacrosse practice drills into low, moderate, and high intensity for the team collectively, but there were variations in these classifications based on player position. These drills were classified based primarily on internal and speed variables. Similarly, load differences have been identified based upon different types of training, with large and small sided game drills resulting in the greatest percentage of workload followed by aerobic conditioning drills [8]. It was also discovered that tactical drills had higher intensity levels while technical skills required greater total distance [8]. This suggests that team focused drills (i.e., running set plays) produce greater intensity levels over drills that focus on important individual skills (i.e., footwork, passing). Alphin et al. [1] and Kupperman et al. [8] showed similar results suggesting that most high intensity drills were team-oriented; however, there was also more skill specific drills included in high intensity. Classifying various workloads helps teams to become the best versions of themselves during games and practices. In lacrosse, there is variation among different drills with many of the conditioning and team drills categorized as high intensity, small-sided games categorized as moderate intensity, and drills related to stick work and individual skills categorized as low intensity [1]. However, these categories were only conducted with two internal load variables – training impulse and average heart rate – and average speed. Knowing which drills are more demanding in external load for the team and each position is vital to create a successful training plan. This is significant for developing training plans distinct to the intensity and recovery needs of the team, as well as managing injury risk.

Aim of Study

This study aimed to compare the different drill classifications used in women's collegiate lacrosse by external load and position. These data may be used by coaches to understand the specific mechanical demand of a drill type on a position player and thereby provide insight into managing the training volume of the athlete.

Material and Methods

Study design and participants

The study was an observational study where 27 (10 attackers, 11 midfielders, 6 defenders) Division I collegiate female lacrosse players participated. Individuals on the university varsity lacrosse team were eligible to participate in the study. Participants were excluded if they removed themselves from the team, were not approved for play by a healthcare provider, or were ineligible by the National Collegiate Athletic Association. Dependent variables included: distance rate, maximum speed distance, high-intensity distance (HID), sprint efforts, accelerations, decelerations, and sprint distance obtained from the GPS units worn by the athletes. The independent variables were the type of drill completed and the athletes' position. This study was approved by the university Institutional Review Board and all participants completed an informed consent prior to study participation.

Evaluation

VX Sport vests, GPS devices, and heart rate monitors (Wellington, New Zealand) were assigned to each athlete. GPS devices were activated at the beginning of practices and attached to the vest in addition to the heart rate monitor. Participants carried out training as recommended by their coaches. GPS metrics and heart rate were recorded in each practice session with various drills. At the end of each session the devices were collected, turned off, and stored. Data was uploaded from the devices using the VX Sport training tool, and each session was trimmed to exclude inactive times. Sessions were further split into separate drills based on what was accomplished in each practice according to pre-training plans and confirmed with coaches following training. Furthermore, scrimmages were divided into two categories: warm--up and scrimmage with inactivity and halftime being excluded from the data. Each individual athlete's maximum sprint speed was determined during the first week of the training season through a 20 m fly-in followed by a 30 m maximum effort sprint. The test was completed three times with a 2-minute rest between each bout. The maximum speed recorded was used to determine thresholds for external load variables. Total distance, HID, sprint distance, sprint repetitions, accelerations, and decelerations were used as metrics during data collection. Total distance is the distance traveled (m) for the duration of the segment, regardless of speed. HID is the distance travelled at speeds >60% of maximum sprint speed. Sprint distance is the total distance travelled for all five speed zones, while sprint repetitions is the total number of sprints completed in each speed zone. Accelerations and decelerations were determined by a change in acceleration more than $\pm 3\ m \cdot s^{-2}$. These metrics were selected to align with previous literature in lacrosse [2, 3, 6, 9].

Drills were classified into four specific types including: stickwork (SW), skill-specific drills (SSD), small-sided games (SSG), and simulated game play (SGP). SW drills mainly focused on the stick mechanics of passing, catching, cradling, and picking up ground balls to help players perform the simpler aspects of the game under pressure. SSD prioritized skills that not every position might need for example, draw controls, shooting mechanics, or clears. SSG drills consist of altered formats of play, such as adjusting the number of players or the rules, where coaches can focus on specific tactics. SGP drills assist players in practicing under the pressure of game situations and often tries to simulate the intensity of competitions. The drill database consisted of 99 days of training, which included three different drills for SW, four drills for SSD, five drills for SSG, and five drills for SGP. Variables were divided by the amount of time spent training in each drill to control for this variation.

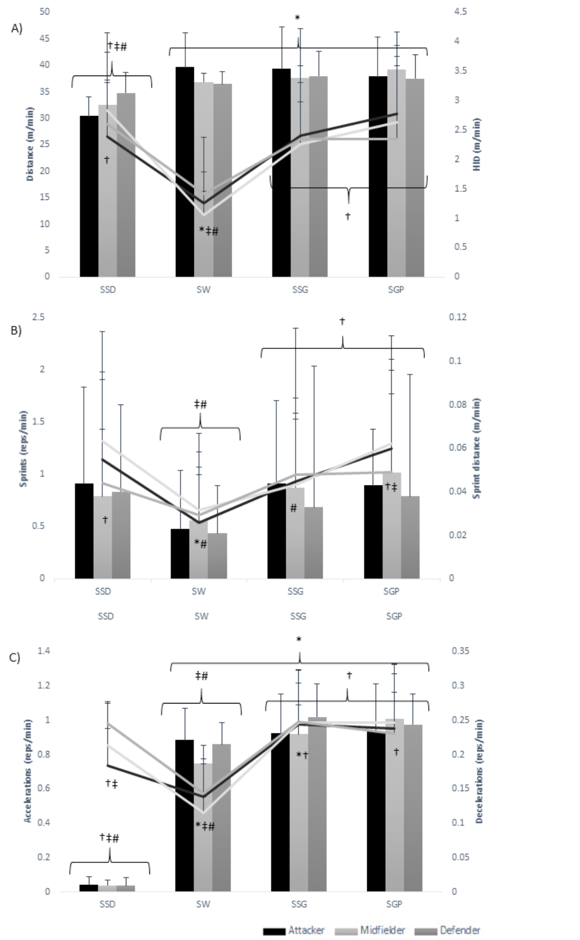
Statistical analysis

Data were organized by drill class and workload per minute of the drill were calculated. The mean of each metric per minute of play was calculated for each athlete for each drill type. Thus, an athlete's data consisted of several means, one for each drill type, for each training metric evaluated.

Data were determined to be normally distributed via a Shapiro–Wilks test. A 4 × 3 repeated measures analysis of variance (RM-ANOVA) was used to evaluate differences in training volume by type of drill (SW, SSD, SSG, SGP) and by position (attacker, midfielder, or defender). If there was a significant main effect, univariate analyses were used to determine differences between drill types for specific metrics, and an LSD post-hoc analysis was used to determine differences by position. Partial eta squared effect sizes (ES) were calculated to determine the magnitude of difference. ES were interpreted as small (0.01), moderate (0.06), and large (0.14) [4]. All analyses were conducted using SPSS, version 27 (Chicago, IL) and an alpha level of 0.05 was used to determine significance.

Results

The RM-ANOVA indicated that there was no difference in training workload by position (*Lambda*(14,36) = 1.071,



* represents a difference from SSD ($p < 0.05$), † represents a difference from SW ($p < 0.05$), ‡ represents a difference from SSG ($p < 0.05$), # represents a difference from SGP ($p < 0.05$)

Figure 1. Means and standard deviations by position for each drill type for A) distance represented in the bars and HID represented by the lines, B) sprint repetitions represented in the bars and sprint distance represented by lines, and C) accelerations represented in bars and decelerations represented by lines

p = 0.414, ES = 0.294, large). There was a difference by drill type (*Lambda*(28,325) = 100.454, p < 0.001, ES = = 0.870, large), and there was a main effect interaction between drill type and position (*Lambda*(56,490) = = 1.415, p = 0.031, ES = 0.109, moderate). By drill type, univariate tests showed differences in distance (p < 0.001, ES = 0.959, large), HID (p < 0.001, ES = 0.948, large), sprint repetitions (p < 0.001, ES = 0.852, large), sprint distance (p < 0.001, ES = 0.862, large), accelerations (p < 0.001, ES = 0.908, large), and decelerations (p < 0.001, ES = 0.752, large). Univariate analyses did not show a difference in any of the training metrics for the interaction between drill type and position [distance (p = 0.129, ES = 0.124, moderate), HID (p = 0.909, ES = 0.010, moderate), sprint repetitions (p = 0.470, ES = 0.064, moderate), sprint distance (p = 0.556, ES = 0.050, small), accelerations (p = 0.438, ES = 0.076, moderate), and decelerations (p = 0.306, ES = 0.093, moderate)].

Figure 1 A-C shows the comparisons for each training metric by drill type. For distance, SSD was less than all other types of drills (p < 0.001 for all). SW drills registered less HID than all other types of drills (p < 0.001). For sprint repetitions, SW was less than SSG (p = 0.011) and SGP (p = 0.005). For sprint distance, SW was less than SSD (p = 0.001) and SGP (p < 0.001). SSG was also less than SGP (p = 0.009). For accelerations, SSD was less than all other drills types (p < 0.001), SW was less than SSG and SGP (p < 0.001 and p = 0.013, respectively). For decelerations, SW was less than all other drills (p < 0.001) and SSD was less than SSG (p = 0.011).

Discussion

This study aimed to determine differences in workload by training mode and position in women's collegiate lacrosse athletes. Results indicated differences in training load by drill type as well as an interaction between drill type and position. Differences were found for all workload variables (distance, HID, sprint repetitions, sprint distance, accelerations, and decelerations) by drill type. There was no difference for any variable between drill type and position. Overall, SW was the drill mode with the lowest workload demand per minute, logging less HID, sprints repetitions, sprint distance, and decelerations than the other drills. SSD was the drill mode that logged the least amount of total distance.

This study compliments previous work by Alphin et al. [1] that classified various drills performed in training by a collegiate women's lacrosse team into low, moderate, and high intensity. SW presented with the lowest overall workload for athletes in this study with Alphin et al. [1] having similar findings as SW related drills were reported in the low intensity category. Bunn et al. [2] indicated that athletes' average HR was 77% of heart rate max during SW drills, likely due to the steadier state nature of these drills rather than high-intensity efforts. The nature of these drills often requires low intensity jogs or walking coupled with changes of direction at a moderate speed, which results in greater total distance and explains the higher number of accelerations (seen in Figure 1C) despite low HID and sprint distance. This contrasted with Kupperman et al. [8] that provided drill information in women's collegiate soccer, who found technical skills (similar to SW) showed the lowest overall distance. A likely explanation is differences in the two sports as technical skills in lacrosse (passing, cradling, etc.) includes being able to execute during movement, while technical skills in soccer (passing, crossing, heading) can be performed with less overall north/south and east/west movement across the field for each player. For the present study SSD showed the lowest total distance however, had comparative HID, sprint repetitions, and sprint distance to SGP. SSD provides the opportunity for athletes to progress through the stages of skill acquisition and include frequent repetitions to try and achieve autonomous skill mastery. These drills are often performed with a partner or on smaller scales trying to mimic the flow of gameplay while allowing for learning and retention, with the psychological aspect of trying to learn/improve skills possibly resulting in slower paced starts. This is a possible explanation as to why these drills were low in accelerations but performed at intensity levels comparative to SGP. These results agree with Alphin et al. [1] as most partner or goal-oriented drills were in the moderate and high intensity classifications.

Similar to Kupperman et al. [8], SSG was comparative to SGP (or large-sided games) for volume related metrics (total distance, sprint repetitions, accelerations, and decelerations) but presented lower for intensity related metrics (HID and sprint distance) which aligns with Alphin et al. [1]. SSG is a controlled combination of SGP and SSD drills that still allow for training in team tactics. For example, SSD may focus strictly on a defender receiving a clear pass from the goalie while SSG may have the goal of four defensive players clearing the ball into the offensive zone in less than ten seconds while facing pressure from four opposing players. This can result in high volume but slightly lower intensity as the team is trying to focus on the specific tactical issue at hand. For SGP, the greatest overall workload was seen as it was slightly higher than SSG for every variable except decelerations and comparative to SSD for HID. These results specifically were not surprising as SGP drills try to mimic almost every aspect of competitive gameplay allowing the team to apply what they have learned, on a skill based and tactile level, to game-like competition. Alphin et al. [1] reported drills focusing on transition, clears, and gameplay involving five or more players in the moderate and high-intensity categories, which aligns with the findings from this study regarding SGP. Similarly, Kupperman et al. [8] reported large--sided games with the greatest distance and distance/minute. Coaches often use SGP to help set an aerobic base while putting athletes under the pressure of game scenarios, and these findings are indicative of that.

When compared to external game demands of in--conference games (IC) and out-of-conference games (OC) in women's collegiate lacrosse, these findings reveal that drill demands are less than that of game play [9]. Total distance (IC 145.54 m/min PT; OC 100.78 m/min PT), HID (IC 10.85 m/min PT; OC 7.82 m/min PT) high-intensity sprints (IC 0.12 num/min PT; OC 0.09 num/min PT), accelerations (IC 4.41 num/min PT; OC 3.57 num/min PT), and decelerations (IC 1.01 num/min PT; OC 0.74 num/min PT) for games are all greater than the values for every drill type. Although this may not be true to every team, a possible explanation for this is significantly lower intra-squad competition on the team monitored compared to the competitive level of games. Lower intra-squad competition levels will result in slower paced drills, specifically SGP, that lack urgency in every play [9]. This could be caused by a large skill gap between key players and bench players with some athletes having the mindset that positions have already been taken, creating no need to show their capabilities in practice. Nevertheless, management of training volume could also play a role in these drills not matching the demands of game play.

This study was not without its limitations. One study limitation was that these data were collected from one team. Teams from other divisions or levels of play may have slight variations in how they run certain types of drills and the athletes may have varied levels in intensities and load that they are capable of. Due to the variety of these drills, this study did not include anaerobic conditioning drills in analysis. Although coaches often calculate the volume for these drills to maintain player fitness, intensity levels cannot be calculated accurately as players could potentially not give 100% of effort due to exhaustion. It is recommended for future research to consider including conditioning drills in analyses. Lastly, this study did not differentiate between starters and non-starters in the analysis, but evaluated general player drill load. Understanding the differences between these players in time spent in a drill and load of the drill would be beneficial in managing specific player workloads.

Conclusion

Drill classifications provide insight into the workload and efficiency of training that athletes are receiving. Greater drill intensities can challenge athletes to perform better, but may also increase the risk of injury when not properly managed. Drills of lesser intensities can help prepare athletes for an intense training session, but may also reduce the fitness and performance capabilities of an athlete when utilized too frequently. These data can help coaches formulate a well-balanced training regimen that can improve, challenge, and nourish a team to a successful competitive season. Continuously monitoring athletes across a season will be of great benefit when coupled with these findings as coaches can recognize when athletes need lighter or higher intensity practices to maintain fitness levels. Coaches can use these data to make more informed decisions for selecting drills based upon the type of training needed and the volume and intensity goals they have set for the practice or specific athletes. When lighter practices are needed, coaches may be more apt to choose drills from SW and SSD training modes and select options from SGP when higher intensity efforts are wanted.

Conflict of Interests

The authors declare no conflict of interest.

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