Descriptive characteristics of NCAA Division I women lacrosse players

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KEYWORDS
Sports performance; Speed; Aerobic capacity

Summary  The purpose of this investigation was to describe anthropometric and physical performance characteristics of Division I college female lacrosse players. An additional aim of the study was to examine positional differences in this sample of athletes. Eighty-four university lacrosse players (age = 19.8 \pm 1.1 years; height = 168.3 \pm 5.9 cm; body mass = 64.7 \pm 6.9 kg) volunteered to participate and were evaluated at the end of their off-season. Test items included standing height, body mass, linear sprint speed (9.14–36.58 m), agility (pro-agility and Illinois), countermovement jump height and the 20 Meter Shuttle Run Test (MSRT). Standing height was different between positions, pairwise comparisons indicating that attackers were taller than defenders ($p = 0.029$). No other dependent variable differed between positions. Homogeneity between positions for women's lacrosse players indicates that the tests used do not have a high discriminatory value or could reflect the lack of development of positional specificity due to relatively minimal playing experience by participants. Although positional distinctions were not observed in this study, quartiles and ranges provide evidence that performance in female lacrosse players varies markedly.

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Introduction

Lacrosse was first played by North American Indians during the 15th century and was later adopted by Canada and America during the 1600–1700s. Lacrosse continued to grow in the United States during the 1900s and in 1971 and 1982 the National Collegiate Athletic Association (NCAA) held the first men’s and women’s championships, respectively. According to U.S. Lacrosse (the governing body of lacrosse) participation has increased by approximately 20% for youth, high school and college players since 2001.\textsuperscript{1} In fact, over 240 colleges and 450 high schools currently sponsor women’s varsity programs with a projected growth of about 25% in the near future.\textsuperscript{1} Despite its tradition and history as well as its increasing popularity only one study exists describing the physiological needs...
of lacrosse and one other detailing performance variables for male club players. To date no reports exist which describe performance at any level of play (e.g., youth, high school and professional) for women participating in lacrosse.

A number of field tests are often used to evaluate physical performance which include linear sprint speed, agility, vertical or horizontal jumping and aerobic capacity. The assessment of physical performance is commonly used to identify talent, monitor training interventions and observe normal growth and development patterns. Other sports similar to lacrosse, such as soccer, have used various anthropometric measures and physical performance tests to differentiate between levels of play as well as classify positional differences for male soccer players. Specifically, it has been reported that keepers and defenders are taller and have greater body mass compared to midfielders and forwards. On the other hand, midfielders have the highest aerobic capacity, supporting the notion that athletes playing that position cover the most distance during the course of a match. It has also been reported that vertical jumping ability is greater in forwards and defensemen compared to midfielders, which may be the result of these positions being involved in more frequent high intensity efforts. Recently, our group found differences between positions for university women soccer players on several performance variables. Therefore, it would be of interest to examine physical performance in female lacrosse players to determine if similar relationships exist.

While both are intermittent field sports and have similar positional identities (e.g., forwards/attacks and defenders), distinct differences between soccer and lacrosse exist. Therefore, the main purpose of this study was to describe anthropometric and physical performance characteristics of NCAA Division I college female lacrosse players. In addition, positional comparisons were made to examine if distinctions could be identified. Finally, quartiles and ranges were determined in an effort to begin creating normative standards from this sample.

**Methods and procedures**

Eighty-four NCAA Division I university athletes volunteered to participate in the study. The athletes were fully informed of all experimental procedures before giving their consent. The investigation was conducted in accordance with the Declaration of Helsinki. The testing battery was performed at the end of each team’s off-season and completed between 08:00 and 12:00 h. No strenuous exercise was performed 24 h prior to testing. Height and body mass were measured by staff at each of the participating institutions within 48 h of the performance testing date. A standardized warm-up of 10—15 min was performed that included jogging, shuffling, sprinting and dynamic stretching exercises. Performance was assessed in the following order: linear sprint speed, countermovement jump (CMJ), agility and 20 Meter Shuttle Run Test (MSRT). A minimum of three minutes of rest was provided between test trials to reduce the likelihood of fatigue.

Linear sprint speed was evaluated over 36.6 m. Infrared sensors (Brower Timing, Utah) were positioned at the start line and at 9.1, 18.3, 27.4 and 36.6 m at a height of approximately 1.0 m. Subjects stood at the start line and began when ready. The athletes were instructed to run at maximal speed through the final pair of sensors. Timing started when the laser of the starting gate was broken (i.e., first movement). If there was a differences greater than 0.1 s between the first two trials, then a third trial was performed. When three trials were required the two closest times were recorded and the best score used for analysis. The intraclass correlation coefficient (ICC) ranged between 0.87 and 0.98 for the four sprint speed distances.

Countermovement jump height was determined using an electronic timing mat (Just Jump System, Probotics Inc.). Subjects began from a standing position, performed a crouching action followed immediately by a jump for maximal height. Hands remained on the hips for the entire movement to eliminate any influence of arm swing. This system determines flight time which is converted to jump height using the following equation: $\frac{1}{2}gt^2$ (where $g$ is the acceleration due to gravity and $t$ is the air time). Performance using a timing mat can be influenced by body position during flight, therefore the subjects were instructed and carefully observed to maintain straight legs while airborne. If the knees were bent or raised the score was discarded and the subject was given another attempt following a rest period. Jump technique was demonstrated to each subject, followed by two sub-maximal attempts. Two maximal trials were then completed. If there was a difference greater than 2.54 cm between the first two trials then a third was performed. When three trials were required the two closest jump heights were recorded and the best score used for analysis. The ICC was 0.98 for CMJ performance.

Agility was examined using a modified version of the Illinois and pro-agility tests (Figs. 1 and 2). Identical starting procedures as the sprint speed tests were used. For the Illinois test timing gates were
placed at the start and finish lines at a height of 0.30 m. It was believed that the original version of the Illinois may be heavily influenced by the ability to sprint quickly over short distances instead of measuring the ability to change directions. Therefore, two of the four 9.2 m linear sprints were omitted from the original protocol. Athletes sprinted 9.2 m, turned to weave down and back through the center line of cones and finished with another sprint (9.2 m) across the finish line. The pro-agility was modified by using a flying start to incorporate the use of the timing gates, which were placed at the center cone at a height of approximately 1.0 m. Athletes sprinted from the starting point to the other end cone (9.2 m), touched the ground with one hand, changed direction, sprinted back to the start line, again touched the ground with one hand, made a final change of direction to sprint through the finish line at the center cone (4.6 m). If a difference greater than 0.2 and 0.1 s was observed for the Illinois or pro-agility tests, respectively, then a third trial was performed. When three trials were required the two closest times were recorded and the best score used for analysis. The ICC was 0.98 and 0.94 for the Illinois and pro-agility tests, respectively.

Aerobic capacity was evaluated using an incremental 20 MSRT (CD version).\textsuperscript{10,11} Athletes ran along the 20 m course being paced by an audible beep, which became progressively more frequent until they reached volitional fatigue. Standard instructions were given\textsuperscript{12} and verbal encouragement provided to obtain a maximal effort. The test was terminated when an athlete failed to reach two consecutive end lines. The level and final successful shuttle completed was recorded as the score and later used to estimate aerobic capacity using the table provided with the CD.\textsuperscript{11}

Statistical analysis. SPSS Version 11.0 (SPSS Inc., Chicago) was used for all statistical procedures. Results are reported as mean±S.D. A one-way ANOVA was used to examine if differences exist between four positions: forwards, midfielders, defenders and keepers. When a significant F-ratio was found, Gabriel post hoc analysis was used.
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Table 1  Subject characteristics

<table>
<thead>
<tr>
<th>Position</th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Body mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attack (n=31)</td>
<td>19.7 ± 1.2</td>
<td>170.2 ± 6.2</td>
<td>66.5 ± 5.9</td>
</tr>
<tr>
<td>Midfield (n=24)</td>
<td>19.8 ± 1.1</td>
<td>169.3 ± 6.1</td>
<td>62.9 ± 5.3</td>
</tr>
<tr>
<td>Defender (n=18)</td>
<td>19.9 ± 1.3</td>
<td>165.5 ± 3.9</td>
<td>63.4 ± 6.4</td>
</tr>
<tr>
<td>Keeper (n=11)</td>
<td>19.6 ± 1.2</td>
<td>165.5 ± 4.8</td>
<td>68.2 ± 11.5</td>
</tr>
<tr>
<td>Total (n=84)</td>
<td>19.8 ± 1.1</td>
<td>168.3 ± 5.9</td>
<td>64.7 ± 6.9</td>
</tr>
</tbody>
</table>

a n = 58. One participating team would not allow body mass measurements.
† Taller compared to defenders (p = 0.029).

Results

Descriptive data are included in Table 1. No differences were observed between positions for age or body mass, however a difference was found for height, F(3, 83) = 3.96, p = 0.01. Pairwise comparisons indicated that attackers were taller than defenders (p = 0.029). The mean difference between attackers and keepers was identical (4.75 cm) compared to attackers and defenders, however it did not reach statistical significance (p = 0.08).

Table 2 displays the results of the 20 MSRT and the corresponding estimated aerobic capacity. Estimated aerobic capacity for this sample was 46.8 ± 4.4 ml kg⁻¹ min⁻¹ with a range of 33.3–57.6 ml kg⁻¹ min⁻¹ for the entire group. No significant differences were observed between positions for estimated aerobic capacity, F(3, 83) = 1.29, p = 0.29.

Linear sprint times are shown in Table 3. All positions performed similarly for each 9.14 m split, F(3, 83) < 1.53, p > 0.21. No differences were observed between positions for countermovement jump F(3,
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\[ t = 0.841, \ p = 0.48 \] or either agility test, \( F(3, 83) \leq 1.43, \ p \geq 0.24 \) (Table 4).

**Discussion**

To the authors’ knowledge this is the first attempt to identify anthropometric and physical performance characteristics for female lacrosse players. The testing battery used in the current study assessed linear sprint speed, agility, CMJ and aerobic capacity. Each of these physiological qualities is important to various extents for successful performance in a multifactorial sport like lacrosse. It is unclear if any single quality is more important than another for a particular position since the current findings do not reveal any type of positional specificity. However, marked variability in the entire sample (Table 5), as well as within each position (data not shown), was observed for all of the dependent variables indicating a wide range of anthropometric characteristics and physical performance for women’s college lacrosse players.

Lacrosse games are played with two halves lasting 25—30 min each, however no direct evidence exists indicating the degree of importance for aerobic capacity. Williams and Reilly\(^{13}\) have indicated that aerobic power plays a significant role in successful soccer performance, with ranges reported between 41 and 58 ml kg\(^{-1}\) min\(^{-1}\) for elite female players.\(^{12,14,15}\) In addition, Hoare and Warr\(^{16}\) provided a range between 30 and 47 ml kg\(^{-1}\) min\(^{-1}\) for high school age females selected to participate in a talent identification developmental program. The aerobic capacity of the current sample was 46.8 ml kg\(^{-1}\) min\(^{-1}\) (Table 2), which falls on the low end of the elite range and the high end of the high school players, but is comparable to college soccer players (48.6 ml kg\(^{-1}\) min\(^{-1}\)).\(^{9}\) These differences in aerobic capacity between women participating in lacrosse and soccer could be due to several factors. First, the additional playing time during soccer (90 min versus 50—60 min) could have a cumulative effect on increasing aerobic capacity. Considering youth lacrosse leagues are just beginning to gain popularity, it is plausible that collegiate soccer players have more playing time and consequently greater aerobic capacity because of accumulating larger amounts of running during younger ages. Second, the physical demands of lacrosse may differ from soccer. In a recent review, Stolen et al.\(^{17}\) reported that soccer players can cover up to 12,000 m during a game and perform short sprints lasting 2—4 s every 90 s. Data from Plisk\(^{2}\) indicates that 60 or more bouts of work of 29 s or less are performed per game. However, Plisk’s paper examined the men’s game and cannot be directly applied to the women’s game. Lastly, differences could be the result of training program design (i.e., strength and conditioning) for college athletes. Because the duration of play and the rules of the game are different between soccer and lacrosse, sports performance professionals at the collegiate level may focus on developing stationary sprint speed and agility more so than aerobic capacity.

Linear sprint speed is considered an essential element for successful performance in sports requiring athletes to guard an opposing player or to become open to receive a pass. Oftentimes sprints begin while the athlete is already moving (e.g., walking or jogging), however frequent stops occur during a lacrosse game where all players must become stationary. Therefore, initiating fast sprint speeds over short distances (e.g., up to 36.6 m) is common. While the results did not reach statistical significance the keepers and attack were 0.13—0.14 and 0.11—0.12 s slower compared to defenders and midfielders, respectively, for the

**Table 5** Interquartile ranges for anthropometric and performance characteristics

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<tr>
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<th>Quartiles</th>
<th>Range</th>
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<tr>
<td></td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.1</td>
<td>167.6</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>60.4</td>
<td>64.3</td>
</tr>
<tr>
<td>Aerobic capacity (ml kg(^{-1}) min(^{-1}))</td>
<td>43.3</td>
<td>47.1</td>
</tr>
<tr>
<td>9.1 m sprint (s)</td>
<td>2.06</td>
<td>1.98</td>
</tr>
<tr>
<td>18.3 m sprint (s)</td>
<td>3.48</td>
<td>3.36</td>
</tr>
<tr>
<td>27.4 m sprint (s)</td>
<td>4.80</td>
<td>4.66</td>
</tr>
<tr>
<td>36.6 m sprint (s)</td>
<td>6.16</td>
<td>5.97</td>
</tr>
<tr>
<td>Countermovement jump (cm)</td>
<td>35.8</td>
<td>40.1</td>
</tr>
<tr>
<td>Illinois (s)</td>
<td>10.82</td>
<td>10.36</td>
</tr>
<tr>
<td>Pro-agility (s)</td>
<td>5.15</td>
<td>4.99</td>
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</table>
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36.6 m distance (Table 3). This may have practical consequences as a defender is attempting to cover an opposing offensive player or conversely when an offensive player is attempting to maintain distance from a defender during a breakaway. A slower defender will allow an offensive player more freedom to become open, whereas a slower attacker will be caught during a breakaway and forego a potential scoring opportunity. The individual split times from the current sample appear to be in line with data reported from other women’s sports (e.g., soccer and field hockey), however the distances assessed are slightly longer (e.g., 40 m versus 36.6 m and 20 m versus 18.3 m) and so a direct comparison between studies is limited.

Lacrosse is unique because different positions are restricted to certain parts of the field. For example, only seven offensive and eight defensive players are permitted beyond the restraining line, which is located 27.4 m from each goal line. When in this area athletes perform multiple changes of direction in an attempt to create or block shots, so the ability to decelerate and re-accelerate (i.e., agility) is extremely important. We used two tests to evaluate agility performance, however neither showed the ability to discriminate between positions. New rules allow any four players to remain back behind the restraining line, so continuous rotations are implemented depending on game strategy or even fatigue. This overlap of player responsibilities may cause positional distinctions to become blurred and could be a reason for the lack of discrimination for performance scores on the agility tests (Table 4). Plisk’s report of the men’s game showed the ability to discriminate between offensive and defensive players (10.49 and 10.51 s, respectively). However standing height was different between positions.

Percentiles are used to provide a ranking for an individual score within a comparable distribution. Using the data collected from this sample of collegiate female lacrosse players, quartiles were generated for each dependent variable (Table 5). Sports performance professionals can now determine specific limitations in performance on an individual basis for other Division I female lacrosse players. Subsequent training regimens can then be designed to focus on improving identified weaknesses and enhance overall athletic performance.

Not be implemented for an entire team, but rather athletes should be grouped and trained according to identified limits.

Performance testing is often used for talent identification within or between groups of athletes. Scores can be used to distinguish between elite and non-elite players or between starters and non-starters within a team. Until additional performance data is gathered on other levels of play (e.g., youth, high school and elite) it will remain unclear if the tests used in this study can be used to discriminate between female lacrosse players. In addition, at the collegiate level lacrosse allows a significant amount of substitutions during a game and so it may be difficult to determine differences based on starter and non-starter classifications. Future research should focus on movement analysis to quantify playing time and activity profiles.

A limitation for this study is that no identification of training status was obtained before testing. All participants were free from injury, however various training regimens were most likely followed by each participating team. Nevertheless, since all of the teams were involved in strength and conditioning programs and data collection occurred at the end of the off-season training cycle, it was speculated that all participating athletes demonstrated peak performance. Within the constraints of these limitations the findings in the current study indicate little positional variations for Division I female lacrosse players. The homogeneity of this sample prevents extrapolation of these findings to other levels of play and requires further research to determine if positional differences exist for youth, high school and elite level players.

Practical implications

- Physical performance could not identify positional differences in college female lacrosse players, however standing height was different between positions.
- Training regimens should focus on specific performance limitations that can be identified using the percentile rankings.

References