International Journal of EXERCISE SCIENCE

Original Research

An Analysis of Collegiate Club-Sport Female Lacrosse Players: Sport-Specific Field Test Performance and the Influence of Stick Carry on Speed

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ABSTRACT

International Journal of Exercise Science 11(4): 269-280, 2018. Lacrosse is a field-based, intermittent sport that requires players to use a stick with a shaft and mesh pocket to manipulate the ball. However, there has been limited analysis of the characteristics of collegiate club-sport players, and whether stick carry influences the sprinting speed of lacrosse players. As a result, this study investigated the field test characteristics of collegiate club-sport female lacrosse players, and the effects of stick carry on linear and change-of-direction speed. Nine players (seven field players, two goalkeepers) volunteered for this study and completed: vertical jump and standing broad jump; 30-meter (m) sprint (0-5, 0-10, and 0-30 m intervals) and modified T-test without and with a stick; and the Yo-Yo Intermittent Recovery Test. Magnitude-based inference analyses via effect sizes (*d*) compared the field players and goalkeepers. Data was pooled for the 30-m sprint and modified T-test to examine the effect of stick carry via paired samples t-tests ($p<0.05$) and effect sizes. Field players performed better in most field tests ($d=0.93$-2.45), although goalkeepers generated greater vertical jump power ($d=2.01$). With regards to the effects of stick carry, there was a significant difference between the faster 0-5 m sprint interval without a stick compared to with a stick ($p=0.02$), but this had a small effect ($d=0.25$). There were no differences between the other sprint intervals and modified T-test ($p=0.08$-0.39; $d=0.06$-0.19). When contextualized with comparisons to other female collegiate athletes, the results indicated limitations in training exposure for collegiate club-sport lacrosse players. Furthermore, stick carry generally did not affect speed.

KEY WORDS: Leg power, linear and change-of-direction speed, Yo-Yo Intermittent Recovery Test Level 1, college athletes, women, lacrosse stick

INTRODUCTION

Lacrosse is a unique sport that requires players to use of a stick which has a shaft and mesh pocket to manipulate the ball. Sharing similar demands to many other field-based invasion team sports, lacrosse is characterized by intermittent high-intensity activity, direction changes, collisions, and high demands on aerobic and anaerobic capacity (8, 12, 25, 29). There are four main positions in lacrosse, including the three field playing positions (attackers, midfielders, and defenders), and goalkeeper. Several studies have noted the increasing popularity of lacrosse, particularly for females (12, 30, 31). However, when compared to other popular field-based team sports for females such as soccer and field hockey, there has been much less research conducted on lacrosse players (8, 12, 31). This has implications on the best practice that can be adopted for training and developing female lacrosse players.

Physiological testing of athletes is an essential tool for coaches and sport scientists, and is necessary for determining the characteristics of female lacrosse players. Indeed, the results drawn from sport-specific tests can aid coaches in developing optimal training programs, as well as providing objective feedback to the individual player (11, 26). Due to the demands of the sport, a testing battery for lacrosse should include assessments of leg power, linear and change-of-direction (COD) speed, and sport-specific fitness (10). While there is some available data on collegiate female lacrosse players in the scientific literature, there are certain limitations with what is available.

Enemark-Miller et al. (8) provided descriptive data for Division I female collegiate lacrosse players, which included measures of leg power (vertical jump [VJ]), aerobic capacity (maximal oxygen consumption derived from a treadmill test and a one-mile run), and speed over 91.44 meters (m; 100 yards) and 188.82 m (200 yards). Given the nature of lacrosse, where match-play features frequent accelerations, decelerations, and direction changes (25), sprints over distances of 91.44-188.82 m could be considered as not being sport-specific. Vescovi et al. (30) also analyzed Division I female collegiate lacrosse players. The assessments used by Vescovi et al. (30) included a 36.6-m sprint, VJ, pro-agility shuttle and Illinois agility shuttle, and the multi-stage fitness test to provide a field-based measure of aerobic capacity. However, due to the intermittent nature of most team sports, there has been a shift towards using intermittent maximal running tests such as the Yo-Yo Intermittent Recovery Test (YYIRT) (15). A maximal running assessment such as this could be more specific for female lacrosse players than tests such as a one-mile run or multi-stage fitness test. Hoffman et al. (12) utilized laboratory-based assessments of maximal aerobic and anaerobic capacity, in addition to the 36.6-m sprint and pro-agility shuttle to assess Division III female players. As a further test of COD speed, Hoffman et al. (12) also used the T-test, which involved sprints, side-shuffles, and back pedaling over distances of 9 m. However, Sassi et al. (27) designed a modified T-test, which uses shorter distances over 5 m. Although the modified T-test was initially designed for soccer, it has also been adopted for the assessment of female team sport athletes (24), and should have application for lacrosse players as well. Further to this, Steinhagen et al. (29) stated that research is required on collegiate club-sport athletes, as they often lack the physical skills, coaching, and appropriately prescribed training programs that are available at the higher college competition levels. Additionally, given that previous research has indicated conflicting findings as to whether there are positional differences in certain physiological capacities for lacrosse players (12, 25, 30), this is also worthy of further investigation in the specific collegiate club-sport population.

As noted earlier, lacrosse players are required to carry a stick during a game in order to manipulate the ball. The stick could influence the linear and COD speed of female players. As an example from cricket, Callaghan et al. (4) found that carrying a bat in male cricketers can affect arm and leg kinematics during a 17.68-m sprint, which can ultimately contribute to reduction in step length and increases in time when the sprint is initiated from a static start. There has been some analyses of the effects of stick carry in lacrosse players. Watkins et al. (32) demonstrated that stick carry led to slower sprint times over 20 m, including the 0-5 m, 5-10 m, 10-15 m, and 15-20 m intervals, in both male and female lacrosse players. In contrast to this, Wong et al. (33) found that stick carry did not lead to slower pro-agility test times in male and female lacrosse players. However, in both studies (32, 33), the males wore full protective equipment, including pads, gloves, and helmet. With regards to the linear speed results from Watkins et al. (32), it could have been the equipment that influenced the slower sprint test times. Protective equipment for both American football players (shoulder pads, game pants with hip, tail-bone, thigh, and knee pads, and helmet) (2) and cricketers (leg pads and gloves) (4) led to changes in sprint kinematics and the time taken to cover 36.6 m and 17.68 m, respectively. Research should investigate whether stick carry influences linear and COD speed specifically in female players.

Therefore, this study investigated collegiate club-sport female lacrosse players from one university team. There were three goals for this initial exploratory analysis; first, to describe the physiological characteristics as measured by sport-specific field tests of collegiate club-sport female lacrosse players. Second, to ascertain whether there were meaningful differences in these tests between field players and goalkeepers. The third and final goal was to determine whether stick carry influenced linear and COD speed. Subjects were assessed in typical field sport assessments, including the VJ and standing broad jump (SBJ); the 30-m sprint, including the 0-5 m, 0-10 m, and 0-30 m intervals, both with and without a stick; the modified T-test both with and without a stick; and the YYIRT1. It was hypothesized that field players would perform better in the field tests, and that stick carry would lead to slower times in the 20-m sprint and modified T-test.

METHODS

Participants

Nine collegiate club-sport women's lacrosse players (age=21.43±2.57 years; height=1.62±0.07 m; body mass=69.08±17.35 kilograms [kg]) were recruited for this study. The sample included two goalkeepers and seven field players, and is similar in size to previous analyses of female collegiate club-sport (23) and general team sport (24) athletes. G*Power software (v3.1.9.2, Universität Kiel, Germany) was used post hoc to calculate that the sample of 9 for a matched pairs t-test analysis meant data could be interpreted with a moderate effect of 0.75 (13), and power of 0.7 when significance was 0.05 (9). Participants were recruited if they: were a member of the university's women's lacrosse team; above 18 years of age; had a lacrosse training history of two sessions per week or more that extended over the previous 12 months; were currently completing training of three hours or more per week for lacrosse; and did not have any medical contraindications. All participants were familiar with the tests performed in this study. The procedures were approved by the institutional ethics committee. Participants received an explanation of the research, and written informed consent was obtained.

Protocol

One testing session was utilized for this study, similar to methods adopted by Lockie et al. (23). The participant's age, height, and body mass were recorded at the start of the session. Participants refrained from intensive lower-body exercise in the day prior to testing, and consumed water as required throughout the session. A dynamic warm-up was completed by all participants prior to testing, which consisted of 10 minutes of jogging at a self-selected pace, 10 minutes of dynamic stretching, followed by practice jumps and sprints over the test distances. For both the jump and speed tests, 2-3 minutes recovery was provided between trials. Participants were tested outdoors in one session on a grass field in the evening at the university. The VJ and SBJ were completed first, followed by the 30-m sprint trials, modified T-test trials, and YYIRT Level 1 (YYIRT1). Participants wore their own cleats for all tests.

Vertical Jump (VJ): The VJ was performed as described by Lockie et al. (24). Each subject completed two trials, with the best trial analyzed. Peak power from the VJ was also calculated for the best trial by using the equation from Sayers et al. (28): Peak Power (watts; w) = (60.7·VJ height [cm]) + (45.3 ·body mass [kg]) - 2055.

Standing Broad Jump (SBJ): The SBJ was performed according to methods previously described in the literature (23, 24). Two trials were completed, with the best trial used for analysis.

30-m Sprint: 30-m sprint time was recorded by a timing lights system (Fusion Sports, Sumner Park, Australia), and followed methods outlined by Lockie et al. (20) and Lockie et al. (23). Four trials were completed by each participant. The first two trials were completed without a lacrosse stick, while the second two trials were completed with a stick carried in the dominant hand (4, 5, 17). Participants carried the stick that they used during a lacrosse game, were instructed to carry the stick in their dominant hand throughout the sprint, and to carry the stick in a manner that would allow them to run the fastest. The fastest trial for the sprints without and with the stick were used for analysis.

Modified T-Test: As stated, a modified T-test with shorter distances was used in this study (24, 27). Markers were positioned as shown in Figure 1, with a start line identified by tape on the floor, and one, 1.2-m high, 2 m wide timing gate (Fusion Sports, Sumner Park, Australia). The modified T-test was performed as described by Lockie et al. (24). Four trials were completed; two without the lacrosse stick, and two with the stick. As for the 30-m sprint, the stick was carried in the dominant hand throughout the trial (4, 5, 17), in a manner that would allow the participant to complete the modified T-test as quickly as possible. Within each pair (without and with a stick) of trials, one trial was completed with movement initiation at the middle marker to the left, and one with movement initiation to the right (7, 19). The order of the left or right movement initiation trials was randomized amongst the sample. The fastest modified T-test trial without and with the stick was utilized for analysis.

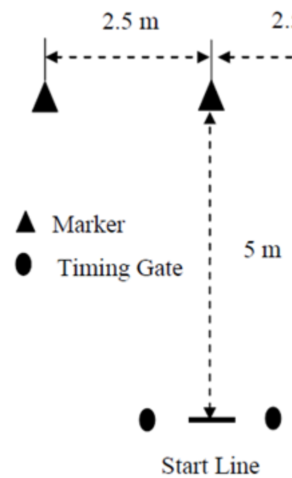

Figure 1. Modified T-test design. m = meters.

Statistical Analysis
Means±standard deviations (SD) were calculated, and data distribution was checked with Q-Q plots. Due to the sample size, effect sizes (*d*) were used for magnitude-based inference analysis to derive differences between the field players and goalkeepers, where the difference between the means was divided by the pooled SD (6). Buchheit (3) has noted the importance of calculating the magnitude of differences, as this can have greater application for coaches and sport scientists. The *d* strength was defined as per parameters outlined by Hopkins (13). Data for all participants (n=9) was pooled to compare differences in the 30-m sprint and modified T-test performed with and without a stick. Paired samples t-tests were used for these calculations, with significance set at $p < 0.05$. Effect sizes were also calculated for these comparisons. Statistical analyses were processed using the Statistics Package for Social Sciences (Version 24; IBM Corporation, New York, USA), and Microsoft Excel (Microsoft Corporation™, Redmond, Washington, USA).

RESULTS

The field test performance data for the field players and goalkeepers are shown in Table 1. There were moderate effects for age (goalkeepers were older) and height (field players were taller). Goalkeepers generated greater VJ power when compared to the field players, which had a very large effect. Field players had a superior SBJ (large effect), faster performance in all sprint intervals (all large effects), the Modified T-test without (moderate effect) and with (large effect) a stick, and covered a greater distance in the YYIRT1 (very large effect).

The pooled speed test data for the comparisons between performance without or with a lacrosse stick is shown in Figure 2. Participants were significantly faster in the 0-5 m interval without a stick compared to when they carried the stick (p=0.02), although the effect was small (d=0.25). There were no significant differences between the stick conditions for the 0-10 m (p=0.08; d=0.19) and 0-30 m (p=0.39; d=0.06) intervals. There was also no difference to performing the modified T-test without or with a stick (p=0.37; d=0.16).

Table 1. Performance data (mean±SD) for the vertical jump (VJ), standing broad jump (SBJ), 30-meter (m) sprint (0-5 m, 0-10 m, and 0-30 m intervals) without and with a stick, modified T-test without and with a stick, and Yo-Yo Intermittent Recovery Test Level 1 (YYIRT1) distance in collegiate club-sport female lacrosse players. m = meters; kg = kilograms; cm = centimeters; w = watts; s = seconds; *d* = effect size.

	Position Players (n=7)	Goalkeepers (n=2)	*d*	*d* strength
Age (years)	20.80±2.78	23.00±1.41	1.00	Moderate
Height (m)	1.63±0.08	1.59±0.01	0.70	Moderate
Body Mass (kg)	61.77±10.81	94.67±4.94	3.91	Very Large
VJ Height (cm)	40.82±5.36	38.74±8.08	0.30	Small
VJ Power (w)	3220.76±639.57	4584.54±714.49	2.01	Very Large
SBJ (m)	1.54±0.21	1.22±0.16	1.71	Large
0-5 m without stick (s)	1.231±0.111	1.361±0.017	1.64	Large
0-10 m without stick (s)	2.204±0.200	2.458±0.033	1.77	Large
0-30 m without stick (s)	5.667±0.664	6.618±0.241	1.90	Large
0-5 m with stick (s)	1.252±0.120	1.415±0.030	1.86	Large
0-10 m with stick (s)	2.234±0.229	2.533±0.095	1.71	Large
0-30 m with stick (s)	5.686±0.774	6.729±0.293	1.78	Large
Modified T-test without stick (s)	8.226±0.625	8.672±0.271	0.93	Moderate
Modified T-test with stick (s)	8.259±0.681	8.982±0.330	1.35	Large
YYIRT1 (m)	376.00±171.11	80.00±0.00	2.45	Very Large

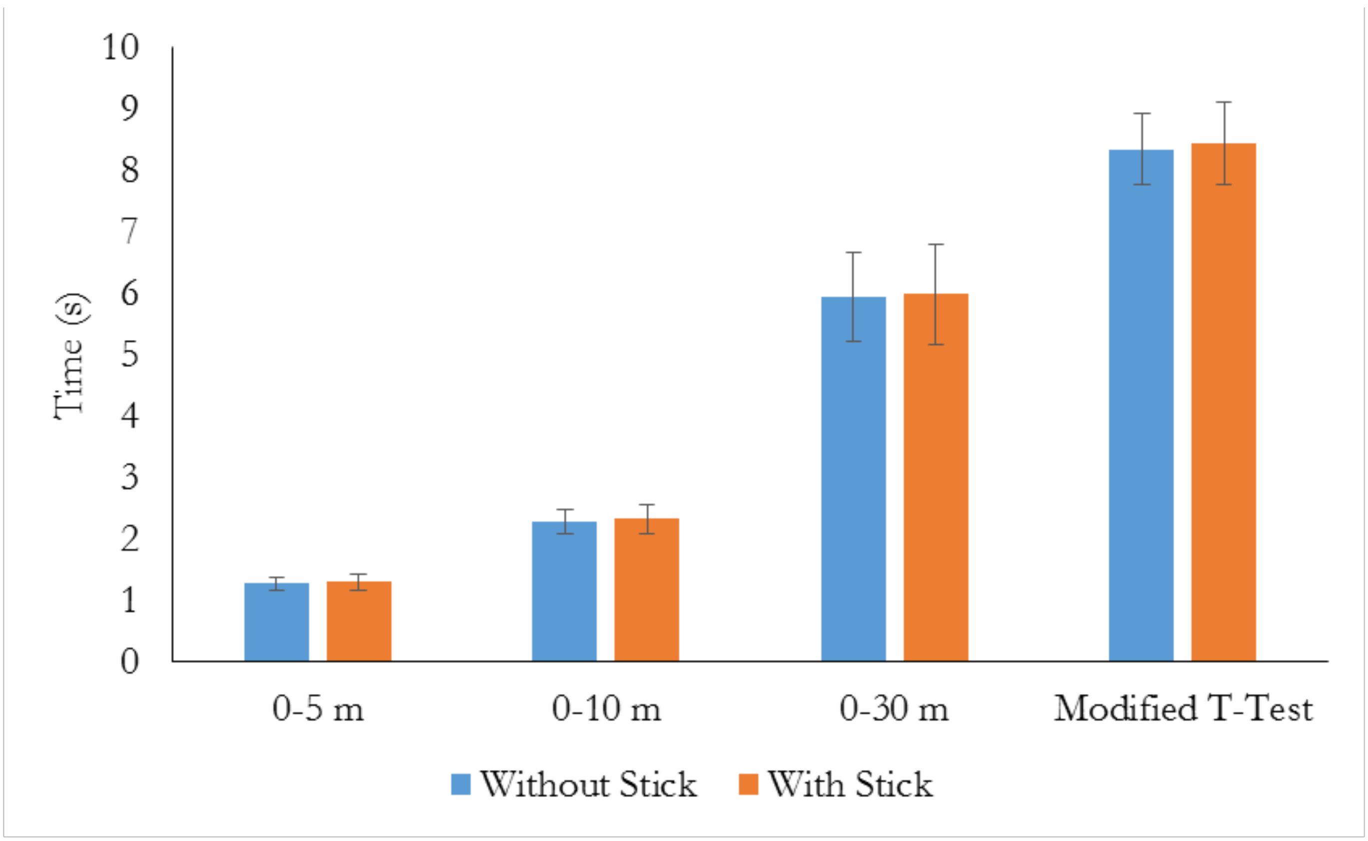

Figure 2. Times for the 0-5 meter (m), 0-10 m, and 0-30 m sprint intervals from a 30-m sprint, and modified T-test, completed without or with a stick in collegiate club-sport female lacrosse players (n=9).

DISCUSSION

This study provided an initial exploratory analysis of collegiate club-sport female lacrosse players. The study sample size was small (n=9), and was drawn from one collegiate club lacrosse team, which limits the generalizability of the results. Nonetheless, there are still some notable findings. Firstly, this study provided descriptive data for collegiate club-sport female lacrosse players, which limited in the scientific literature. The field players also tended to perform better in the field tests when compared to the goalkeepers. In addition to this, the use of the lacrosse stick did not appear to significantly affect linear and COD speed in female lacrosse players. However, the results also demonstrated that compared to higher-level collegiate athletes, the lacrosse players from this study performed poorer in most field tests. This provides further credence to the issues associated with collegiate club sports, in that players do not receive exposure to the coaching and training available to higher-level collegiate athletes (29). The results from the current study have implications for those coaches and trainers who work with club-sport collegiate athletes and female lacrosse players.

Leg power is an important physiological characteristic for lacrosse players (8, 10, 12). The VJ recorded by the participants in this study was less than that for the Division I players assessed by Enemark-Miller et al. (8), but superior to the Division III players evaluated by Hoffman et al. (12). The field players in this study had a VJ of 40.82±5.36 cm, while the goalkeepers achieved a mark of 38.74±8.08 cm. Enemark-Miller et al. (8) recorded a VJ of 44.0±6.2 cm using similar methods to that from this study. Hoffman et al. (12), who also used methods similar to this study, chronicled VJ heights of 36.3±5.6 cm, 38.1±5.6 cm, 37.6±7.1 cm, for Division III attackers, defenders, and midfielders, respectively. VJ power was also calculated in this study, which has not been documented previously for female lacrosse players in the literature. Body mass has a great influence on the power generated in the VJ (28). For example, in an analysis of junior college male football players, Lockie et al. (19) found that the linemen (who were the heaviest players) generated the greatest VJ power when compared to all other position groups. This highlights why the goalkeepers, who were heavier than the field players, generated greater VJ power in this study. Nevertheless, despite the limitations associated with physiological development for collegiate club-sport athletes (29), the results from this study demonstrated that female club-sport lacrosse players can achieve a VJ superior to that of Division III players.

The SBJ provides a specific measure of horizontal power. Power in this plane has been related to superior sprint acceleration performance (16, 21, 22), which provides an indication of its importance for lacrosse players. The current study was the first to present SBJ data for female lacrosse players. Field players achieved a SBJ of 1.54±0.21 m, while goalkeepers attained a SBJ of 1.22±0.16 m. The participants from this study performed poorer than female Division I soccer players (median value=1.94 m) (20), Division III soccer players (1.85±0.15 m) (14), and recreational team sport athletes, which included soccer, netball, basketball, and softball players (1.79±0.17 m) (24). Although limited by the sample size, the results from this study suggest that horizontal power is a capacity that could be improved in collegiate club-sport female lacrosse players.

Lacrosse features constant accelerations, decelerations, and direction changes (8, 12, 25, 29). This highlights the importance of linear and COD speed. This is the first study to measure 0-5 m, 0-10 m, and 0-30 m sprint and modified T-test performance in collegiate female lacrosse players, despite the clear applications of these assessments for this sport. When considering the sprints without a stick, there were large effects in the 30-m sprint intervals when comparing field players and goalkeepers, with field players being faster. Field players were also faster in the modified T-test. This could be expected, as time-motion analyses of Australian male lacrosse players has shown the high demands placed during on these capacities during match-play (25). However, previous research has suggested that linear sprint performance, in this instance speed over 0-9.1 m, 0-18.3 m, 0-27.4 m, and 0-36.6 m, did not differentiate between positions in Division I collegiate female lacrosse players (30). This may also be further evidence of the issues identified by Steinhagen et al. (29) in that collegiate club-sport athletes do not have the access to coaching and training that Division I athletes may have, which Vescovi et al. (30) noted could have contributed to the heterogeneity of their sample. A limitation of this study was that the sample size precluded a more detailed analysis of between-position differences of female collegiate club-sport lacrosse players. This is an avenue for future research.

As this was the first study to measure 30-m sprint and modified T-test performance in female lacrosse players, there is limited context for comparison with other participants from this sport. However, the participants from this study were clearly slower than Division I collegiate female soccer players, with Lockie et al. (18) finding 0-5 m, 0-10 m, and 0-30 m sprint times of 1.15±0.04 s, 1.98±0.05 s, and 4.73±0.13 s, respectively. The participants from this study were also slower than female recreational team sport athletes in the 0-5 m sprint interval (1.156±0.043 s), 0-10 m sprint interval (1.986±0.165 s), and modified T-test (~6.598 s) (24). Collegiate club-sport athletes generally do not received the coaching and training prescriptions available to other collegiate athletes (29), and this could have an impact on capacities such as linear and COD speed.

The YYIRT1 provides a measure of aerobic capacity, with contributions from the anaerobic energy systems (15). This was the first study to provide YYIRT1 data for female lacrosse players from any level of play. However, the YYIRT1 performance by both the field players and goalkeepers in this study was relatively poor, and as an example, far below that achieved by collegiate female soccer players (1666.7±473.0 m) (18). Although it would be expected that goalkeepers would perform poorer in a test such as the YYIRT1 when compared to field players due to different movement demands in match-play (25), the scores achieved by both groups was still less than optimal. Vescovi et al. (30) acknowledged that no direct evidence exists indicating the level of importance that aerobic capacity has upon lacrosse performance. The shorter durations of lacrosse matches (two 25-30 minute halves) compared to other team sports such as soccer (two 45-minute halves and field hockey (two 35-minute halves) could also impact the relative importance of aerobic capacity. Collegiate lacrosse also features a high amount of player substitutions (30), which could further diminish the importance of aerobic capacity for these players. Nonetheless, the results from this study suggest the club-sport female lacrosse players should perform more high-intensity running training that could be reflected in improved performance in a test such as the YYIRT1. This would be notable, as improved performance in this test has been related to greater distance covered during soccer matches in male players (1).

Carrying a stick led to a significant increase in 0-5 m time; however, the effect was small (*d*=0.25). This result supports the findings of Watkins et al. (32), who found that stick carry led to a slower 20-m sprint performance in male and female collegiate lacrosse players. Callaghan et al. (4) documented that in male cricketers, carrying a cricket bat in the dominant hand when sprinting reduced the range of motion at the shoulder and elbow. This in turn led to reductions in hip flexion, which would have contributed to the reduced step length found by Callaghan et al. (4) in the first 5 m of a 17.68-m sprint. Despite this, the results from this study also showed that there were no significant effects of stick carry on 0-10 m and 0-30 m sprint times. The bat carried by the participants in the study by Callaghan et al. (4) was 1.2 kg, which was the same as the bat used by Lockie et al. (17) in a cricket speed testing analysis. However, the mass distribution of a cricket bat is away from the handle, and it is from the handle where cricketers must carry the bat when sprinting (4, 5, 17). Although women's lacrosse sticks can have a mass ranging from approximately 1-2 kg, the shafts are longer and the weight is more evenly distributed than that for a cricket bat. Furthermore, when carrying the lacrosse stick in the current study, participants tended to hold the stick around the midpoint of the shaft. This would reduce the influence of the stick on sprint kinematics, as the weight distribution of the implement would be better than that experienced by cricketers from the afore-mentioned research (4, 5, 17). This highlights why the results from this study suggested minimal impacts to linear speed when the participants carried the lacrosse stick.

Furthermore, the results from this study also suggested that carrying a stick did not affect performance in the modified T-test. This supports the findings of Wong et al. (33), who found carrying a stick did not affect pro-agility shuttle performance in male and female collegiate club-sport lacrosse players. Wong et al. (33) suggested that coordination adaptations between the upper- and lower-body was primarily responsible for limiting the effects of stick carry on COD speed. As for the 30-m sprint, participants also tended to hold the stick around the shaft's midpoint during the modified T-test, which would have been a technique used to reduce the impact the stick would have on COD capabilities. Collectively, the results from this study suggest that for collegiate club-sport female lacrosse players, carrying a stick should not have a significant impact on linear and COD speed as measured by a 30-m sprint and modified T-test, respectively.

There are several limitations for this study that should be acknowledged. Firstly, the sample size was small, which as stated, limits the generalizability of the results. In addition to this, the sample size precluded a more detailed comparison between position groups. Future research should use a larger sample of female lacrosse players to make positional comparisons between tests such as the YYIRT1, which requires further analysis in lacrosse players. The sample was also drawn from the one collegiate squad, so the results may only be specific to this team. However, the data still provides descriptive information about collegiate club-sport female lacrosse players, and this is limited in the scientific literature. The stick carried by players was not controlled in the linear and the COD speed tests. However, this was to allow participants to use the stick they used in games and were most comfortable with, so the results do have practical application. Nevertheless, within the context of these limitations, this study provided new information on collegiate club-sport female lacrosse players.

In conclusion, this study investigated collegiate club-sport female lacrosse players, and provided descriptive data for field players and goalkeepers from one team. The field players tended to perform better in the SBJ, 30-m sprint, modified T-test, and YYIRT1 when compared to goalkeepers. The goalkeepers generated greater VJ power, which was likely related to their greater body mass. The results from this research also highlighted several physiological limitations for players from the club-sport level of play, which could be a function of access to higher levels of coaching and training prescription. Indeed, the participants from this study largely performed poorer in most of the field tests when compared to other similar-aged athletic female populations. Lastly, carrying a stick generally did not affect 30-m sprint or modified T-test performance compared to sprinting without a stick.

ACKNOWLEDGEMENTS

We would like to thank Ming Hui Brown for facilitating this research, in addition to acknowledging our participants for their efforts.

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