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# Match Demands of Male and Female International Lacrosse Players Competing Under the World Lacrosse Sixes Format

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**Abstract**

Weldon, A, Owen, AL, Loturco, I, Kyriacou, Y, Wong, W, Malone, S, Sampaio, J, and Scanlan, AT. Match demands of male and female international lacrosse players competing under the World Lacrosse Sixes format. *J Strength Cond Res* XX(X): 000–000, 2022—World Lacrosse recently announced World Lacrosse Sixes, which aims to be a smaller, faster, and more accessible format of lacrosse, when compared with traditional field lacrosse. This investigation aimed to quantify the movement and physiological demands of World Lacrosse Sixes in male ($n$ = 25) and female ($n$ = 22) international players. Match data were collected using Catapult Sports Vector S7 global navigation satellite system microsensors and Polar H1 heart rate (HR) monitors across 7 competitive matches. Results showed that 30–33% of the total distance covered by players was completed by walking (0–2 $m\cdot s^{-1}$), 42–44% jogging (2–4 $m\cdot s^{-1}$), 21% running (4–6 $m\cdot s^{-1}$), and 0–2% sprinting (>6 $m\cdot s^{-1}$). Mean relative HR (%HRmax) was similar ($p > 0.05$, $\eta_p^2 = 0.002$; *no* effect) between sexes across matches (median values: male players = 93.5%; female players = 93.8%). Male players performed more accelerations ($p < 0.001$; $\eta_p^2 = 0.117$; *moderate*) and decelerations at $\pm 4\ m\cdot s^{-2}$ ($p < 0.001$; $\eta_p^2 = 0.135$; *moderate*) and distance sprinting at >6 $m\cdot s^{-1}$ ($p < 0.001$; $\eta_p^2 = 0.416$; *large*) than female players. Whereas female players performed more accelerations ($p < 0.001$; $\eta_p^2 = 0.20$; *large*) and decelerations at $\pm$2–3 $m\cdot s^{-2}$ ($p < 0.001$; $\eta_p^2 = 0.33$; *large*) and impacts at 5–9 g-forces ($p < 0.033$; $\eta_p^2 = 0.063$; *moderate*) than male players. These data are the first representing the movement and physiological demands of male and female players in World Lacrosse Sixes, allowing lacrosse coaches and the athlete support team to make informed and sex-specific decisions when developing training, testing, and tactical strategies to optimize player health and performance.

**Key Words:** activity profile, global navigation satellite system, workload, team sports, training load, athletic performance

## Introduction

Field lacrosse has shown rapid global growth over recent decades (32). In the United States alone, field lacrosse participation has increased by 325% since 2001, with collegiate participation increasing by 59% since 2006 (31). At the international level, World Lacrosse oversees 70 member-national governing bodies, which has doubled since 2002 (32). The increasing popularity of field lacrosse is multifactorial but partly attributable to the fast-paced and exciting match play involved (1), which has led to similarities drawn with other invasion-based sports that require teams to invade the opponent's territory to score a goal or point, including basketball and soccer (5).

Accordingly, field lacrosse is physically demanding and requires regular sprints, accelerations, decelerations, changes of direction, and collisions, interspersed with skills such as stick manipulation, ball control, passing, catching, and shooting (1,4,19,23,34). Matches are characterized by repeated intense periods of play and regular substitutions, which provide recovery opportunities for players to maintain high work rates (13). Although similar in movement requirements, field lacrosse matches differ between sexes as male players are legally permitted to make contact (stick-to-stick, arm, and body) and female players are not (20). Consequently, male players wear protective equipment including helmets, mouth guards, armguards, and shoulder pads during matches, whereas female players wear only protective goggles and mouth guards (33). Furthermore, the restraining line marked on the field which 4 players must always be positioned behind is placed at the halfway point in men's matches and two-thirds up the field in women's matches. Therefore, these varying match constraints likely impose unique movement and physiological demands according to player sex in field lacrosse, but these assumptions are yet to be elucidated, given the lack of existing research.

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Of the available evidence on the movement and physiological demands in field lacrosse, the following populations have been investigated: male players in an Australian national championship state team (24) and Japanese national team (1) and female players in the Austrian national team (19) and U.S. collegiate teams (13,18,27,30). The match formats used in these studies differed between sexes and to those administered under current international standards (i.e., 4 × 15-minute quarters) (33). These included 4 × 20-minute quarters (1,24) for men's matches, 2 × 30-minute halves for women's matches (13,18,19), and 2 nondisclosed match configurations (27,30). Consequently, it is difficult to use these reported data to inform the training strategies of players competing under current international match formats or to critically compare the movement and physiological demands between sexes.

Although field lacrosse consists of 10 vs. 10 players during matches, World Lacrosse has recently introduced a new shorter match format called World Lacrosse Sixes comprising 6 vs. 6 players (35). World Lacrosse Sixes was developed to further grow participation in lacrosse by reducing barriers for participation evident in field lacrosse, such as the greater number of players and field size requirements, while also promoting wider spectatorship through faster match play (35). Furthermore, World Lacrosse Sixes is more aligned with the Olympic Games 21st-century framework by reducing the cost and complexity of staging competitions and having a hard cap on athlete quota, which will enhance its likelihood of being included in future Olympic Games (35,36). A global poll conducted by World Lacrosse with field lacrosse players (national and recreational representatives) and fans revealed that 97% approved the aim to include World Lacrosse Sixes in the Olympic Games, while 87% would watch and 82% would play this new format (36). These positive statistics have led to World Lacrosse Sixes being initially adopted by 14 of 70 (20%) of the World Lacrosse member-national governing bodies as of May 2021, with the wider adoption imminent given World Lacrosse Sixes will feature widely at domestic and international sporting events (e.g., The World Games, 2022) (36).

The main differences between field lacrosse and World Lacrosse Sixes are that field lacrosse teams comprise 10 players, with 1 goalkeeper and 9 field players, and field positions are allocated as defense, midfield, and attack. Thirteen substitute players are permitted in men's teams and 8 substitute players in women's teams. Match durations are 60 minutes, distributed as 4 × 15-minute quarters, and played on field areas ranging from 91.4 to 110 m in length and 55 to 60 m in width. In contrast, World Lacrosse Sixes have modified these regulations by reducing teams to 6 players, consisting of 1 goalkeeper and 5 field players, with no formal field positions. The number of substitute players has been decreased, with a maximum of 6 per team. Match durations have been reduced to 32 minutes, distributed as 4 × 8-minute quarters, with the inclusion of a 30-second shot clock. Whereas field areas have been condensed to 70 m length and 36 m width.

Currently, there is a lack of research in field lacrosse, and as expected, there is no research in World Lacrosse Sixes that quantifies the movement and physiological demands of male and female lacrosse players under current international guidelines. Therefore, this study aimed to describe and compare the demands of international male and female lacrosse players during competitive matches under the new World Lacrosse Sixes format. These data are an essential first step to inform lacrosse coaches and the athlete support team when making sex-specific decisions for developing training, testing, and tactical strategies to optimize the health and performance of players competing in World Lacrosse Sixes.

## Methods

### Experimental Approach to the Problem

Following a cross-sectional study design, microsensors (global navigation satellite system [GNSS] and triaxial accelerometers) and heart rate (HR) monitors were used to measure the movement and physiological demands of international male and female lacrosse players competing in World Lacrosse Sixes. Each team consisted of 1 goalkeeper, 5 field players, and 5 substitute players, with field players not required to adopt formal positions (e.g., defense, midfield, and attack). Unlimited substitutions were permitted at any time during matches. Goalkeeper data were not collected because of this position being restricted with field placement during matches and therefore covering considerably less distance than field players. A 30-second shot clock was enforced for each possession. Matches were played on a 70 × 36-m field, with a total match duration of 32 minutes distributed as 4 × 8-minute quarters, 2-minute intervals between quarters, and a 5-minute interval at half-time.

Three men's and 4 women's teams containing international players competed in a series of 7 competitive matches (April to May 2021). Matches were administered as part of an intrasquad tournament for a single national team. Data were collected from one team per match because of the limited availability of microsensors and HR monitors. Player trading was permitted between matches, which led to some players contributing more samples than others to the final dataset. There were no limitations on trading, which allowed each player to be selected for each game based on coaches' preference and player availability. Male players played 3 matches on the 13th, 22nd, and 25th of May, with a total of 32 samples collected from 25 male players. Female players played 4 matches, 2 taking place on the 2nd of April and 1 on the 15th and 22nd of April, respectively, with a total of 42 samples collected from 22 female players.

### Subjects

In total, 25 male (age: 25.8 ± 3.1 years [age range: 21–35 years]; body mass: 76.5 ± 7.9 kg; height: 176.9 ± 7.9 cm; ±*SD*) and 22 female (age: 27.2 ± 5.2 years [age range: 21–42 years]; body mass: 58.2 ± 6.8 kg; height: 161.1 ± 6.3 cm) lacrosse players participated in this study. All players were current international representatives for Hong Kong lacrosse, who were internationally ranked 27th for male players and 18th for female players in field lacrosse at the time of this study. A typical weekly in-season schedule for all players included 3 lacrosse training sessions, 2 mandatory resistance training sessions, 1 optional speed session, and 1 match in the Hong Kong domestic league. Although players normally participated in several international tournaments annually, because of the COVID-19 pandemic, no international fixtures were played from November 2019 to April 2021. This study was approved by the Ethics Review Board of The Technological and Higher Education Institute of Hong Kong (THEi) and conducted in accordance with the Declaration of Helsinki. All players provided written informed consent after reading a description of all research procedures and were ensured the anonymity of data and identities.

### Procedures

*Instrumentation.* To collect activity data, players wore a customized vest (Vector Core Vest, Catapult Sports, Melbourne, Australia) with a pocket positioned between the scapulae to hold a microsensor (Vector S7; Catapult Sports), which included a 10-Hz GNSS chip and 100-Hz triaxial accelerometer. The validity of GNSS technology has been deemed acceptable for measuring movements associated with team sports competition (2,12). All GNSS microsensors were activated 10 minutes before matches to ensure a clear satellite reception (2), and players were familiar with the equipment and protocols being conducted for data acquisition. The mean GNSS quality (60.86 ± 2.57), number of available satellites (13.01 ± 1.09), and horizontal dilution of precision (0.86 ± 0.11) during data acquisition were considered satisfactory (21). Concurrently, HR data were monitored for each player using a HR monitor (H1; Polar, Kempele, Finland) sampling at 1 Hz. The HR monitor was affixed to each player's torso at the level of the xiphoid process at the base of the sternum via a chest strap. To improve signal acquisition, water was applied to the electrode sensors on the monitor before being firmly fixed against the skin of each player. Heart rate data were communicated wirelessly with the microsensor and downloaded after every match. Each player wore the same microsensor and HR monitor for each match to reduce any potential interdevice variations. Openfield software (version 2.5.0; Catapult Sports) was used to manually identify the start and end of each 8-minute quarter from live GNSS data, with the start and end of each quarter signaled by the bench official. Thereafter, raw data from each match were exported into a Microsoft Excel spreadsheet (version 16.52, New Mexico) to process the variables for analysis.

*Movement and Physiological Demands.* Various activity and HR variables were measured to comprehensively quantify the movement and physiological demands in World Lacrosse Sixes. Data were collected and reported for each 8-minute quarter and the entire match irrespective of whether players were actively competing or substituted because of the dynamic nature of substitutions. Data were not collected during the 2-minute interquarter breaks or 5-minute half-time break during each match. Furthermore, no timeouts were used or stoppages occurred during the monitored matches. Triaxial accelerometers were used to detect the frequency (count) of accelerations (categorized according to intensity: 2–3 $m \cdot s^{-2}$; 3–4 $m \cdot s^{-2}$; >4 $m \cdot s^{-2}$), decelerations (categorized according to intensity: −2 to −3 $m \cdot s^{-2}$; −3 to −4 $m \cdot s^{-2}$; <−4 $m \cdot s^{-2}$), and impacts (categorized according to intensity: 5–9 g-forces; 9–15 g-forces) completed across matches. The GNSS component of the microsensors was used to measure the absolute (m) and relative ($m \cdot min^{-1}$) distance covered performing various speed-mediated activities, including walking (0–2 $m \cdot s^{-1}$), jogging (2–4 $m \cdot s^{-1}$), running (4–6 $m \cdot s^{-1}$), and sprinting (>6 $m \cdot s^{-1}$), with maximum velocity ($m \cdot s^{-1}$) also recorded. The various intensity and speed thresholds used, in addition to a 1-second minimum effort duration to record acceleration and deceleration counts, were in line with the manufacturers' recommended default settings and previous research in field lacrosse (1,19). Relative distance values were determined as the distance covered relative to the duration of each quarter (8 minutes) and entire matches (32 minutes). Peak 1-minute distances were determined using a 1-minute rolling average, as the maximum distance covered within a 1-minute period for each player, inclusive of all locomotion methods (11). Relative HR data were recorded as the maximum and mean HR (%HRmax) using an age-based prediction formula to estimate maximum HR (220—age in years) (16).

### Statistical Analyses

Statistical analyses were carried out using JASP (version 0.14.01; Amsterdam, Netherlands). Shapiro-Wilk tests indicated that data were not normally distributed; therefore, nonparametric statistical tests were used. Accordingly, all data were presented as median with dispersion shown using an interquartile range and supplemented with minimum and maximum values. Separate Mann-Whitney *U* tests were performed to assess differences between male and female players across each quarter and entire matches for all variables. Friedman tests with Conover's post-hoc tests were performed to identify differences in variables between quarters in male and female players separately (i.e., quarter 1 vs. quarter 2 vs. quarter 3 vs. quarter 4). Statistical significance was set at $p < 0.05$. Effect sizes (ESs) were calculated as partial eta squared ($\eta_p^2$) and interpreted as: <0.01 = *no* effect; 0.010–0.059 = *small* effect; 0.060–0.139 = *moderate* effect; ≥0.140 = *large* effect (10).

## Results

### Movement and Physiological Demands

Tables 1–3 present the descriptive data for frequency, distance, velocity, and HR variables in male and female World Lacrosse Sixes players during each quarter and across entire matches. These data demonstrate that accelerations, decelerations, and impacts during matches infrequently exceeded >4 $m \cdot s^{-2}$, <−4 $m \cdot s^{-2}$, and >9 g-forces, respectively. Absolute and relative distances covered were distributed as 30–33% walking, 42–44% jogging, 21% running, and 0–2% sprinting across sexes. The average peak 1-minute distances covered across matches indicated that ~6–7% of the total distance covered each match can take place during these intense 1-minute periods of play.

### Sex Differences

Comparisons between sexes showed *moderate-to-large* differences, with male players performing more accelerations ($p <$ 0.001) and decelerations at ±4 $m \cdot s^{-2}$ ($p < 0.001$) and distance covered sprinting at >6 $m \cdot s^{-1}$ ($p < 0.001$) than female players during matches (Tables 1 and 2). Furthermore, male players demonstrated greater (*moderate-to-large*) peak 1-minute distance ($m \cdot min^{-1}$) ($p \leq 0.04$) and maximum velocity ($m \cdot s^{-1}$) ($p < 0.001$) than female players in each quarter and entire matches (Tables 2 and 3). In contrast, female players performed more (*moderate-to-large*) accelerations ($p < 0.001$) and decelerations at ±2–3 $m \cdot s^{-2}$ ($p \leq 0.006$) in each quarter and entire matches, and more (*moderate*) impacts at 5–9 g-forces ($p < 0.03$) than male players during entire matches (Table 1).

### Quarter Comparisons in Male Players

*Large* differences in mean and maximum relative HR (%HRmax) were evident across entire matches ($p < 0.001$), with a significant increase in HR during the second-fourth quarters ($p \leq 0.04$) compared with the first quarter (Table 4). *Moderate* differences were observed in peak 1-minute distance ($m \cdot min^{-1}$) covered across entire matches ($p = 0.01$), with greater distances covered in the first ($p = 0.004$) and third quarters ($p = 0.007$) compared with the fourth quarter (Table 5). Also, *moderate* differences in the number of decelerations (−2 to −3 $m \cdot s^{-2}$) performed were evident across entire matches ($p = 0.02$), with significantly fewer decelerations performed during the third and fourth quarters ($p \leq$ 0.04) compared with the first and second quarters (Table 4). Although nonsignificant, *moderate* differences were observed in

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**Table 1**

**Acceleration, deceleration, and impact counts for male and female lacrosse players during each quarter and entire matches under the World Lacrosse Sixes format.***

| | | Male ($n$ = 25) | | Female ($n$ = 22) | | Sex comparison statistics | |
|---|---|---|---|---|---|---|---|
| **Variable (count)** | **Quarter** | **Median (IQR)** | **Min–Max** | **Median (IQR)** | **Min–Max** | $p$ | $\eta_p^2$, **interpretation** |
| Accelerations (2–3 m·s$^{-2}$) | 1 | 9 (5) | 2–15 | 13 (6) | 4–27 | <0.001† | 0.199, large |
| | 2 | 7 (4) | 2–11 | 11 (7) | 3–22 | <0.001† | 0.243, large |
| | 3 | 6 (4) | 2–13 | 10 (4) | 4–23 | <0.001† | 0.245, large |
| | 4 | 6 (5) | 2–13 | 9 (4) | 4–16 | <0.001† | 0.141, large |
| | Match | 31 (16) | 11–41 | 44 (17) | 22–69 | <0.001† | 0.333, large |
| Accelerations (3–4 m·s$^{-2}$) | 1 | 3 (2) | 0–6 | 3 (2) | 0–9 | 0.693 | 0.002, none |
| | 2 | 2 (3) | 0–6 | 3 (4) | 0–7 | 0.204 | 0.022, small |
| | 3 | 2 (2) | 0–6 | 2 (1) | 0–8 | 0.505 | 0.006, small |
| | 4 | 2 (2) | 0–5 | 2 (2) | 0–6 | 0.463 | 0.007, none |
| | Match | 9 (5) | 2–16 | 10 (4) | 1–21 | 0.187 | 0.024, small |
| Accelerations (>4 m·s$^{-2}$) | 1 | 0 (0) | 0–1 | 0 (0) | 0–1 | 0.635 | 0.001, none |
| | 2 | 0 (0) | 0–2 | 0 (0) | 0–2 | 0.027† | 0.023, small |
| | 3 | 0 (1) | 0–2 | 0 (0) | 0–1 | 0.005† | 0.043, small |
| | 4 | 0 (0) | 0–1 | 0 (0) | 0–10 | 0.008† | 0.029, small |
| | Match | 1 (2) | 0–4 | 0 (0) | 0–3 | <0.001† | 0.117, moderate |
| Decelerations (−2 to −3 m·s$^{-2}$) | 1 | 6 (4) | 1–13 | 8 (6) | 4–19 | <0.001† | 0.156, large |
| | 2 | 6 (4) | 3–11 | 8 (5) | 2–19 | 0.006† | 0.102, moderate |
| | 3 | 4 (3) | 3–11 | 9 (3) | 0–17 | <0.001† | 0.361, large |
| | 4 | 5 (3) | 1–10 | 7 (3) | 1–15 | 0.002† | 0.127, moderate |
| | Match | 22 (10) | 9–37 | 36 (13) | 7–60 | <0.001† | 0.336, large |
| Decelerations (−3 to −4 m·s$^{-2}$) | 1 | 3 (2) | 0–9 | 2 (3) | 0–8 | 0.339 | 0.012, small |
| | 2 | 1 (2) | 0–7 | 1 (3) | 0–7 | 0.848 | 0.001, none |
| | 3 | 2 (2) | 0–5 | 1 (1) | 0–4 | 0.010† | 0.087, moderate |
| | 4 | 2 (3) | 0–6 | 1 (2) | 0–6 | 0.014† | 0.078, moderate |
| | Match | 8 (5) | 0–18 | 6 (6) | 1–19 | 0.053 | 0.052, small |
| Decelerations (<−4 m·s$^{-2}$) | 1 | 0 (1) | 0–2 | 0 (0) | 0–3 | 0.089 | 0.028, small |
| | 2 | 0 (1) | 0–3 | 0 (0) | 0–2 | 0.296 | 0.008, none |
| | 3 | 0 (1) | 0–2 | 0 (0) | 0–1 | 0.016† | 0.049, small |
| | 4 | 0 (1) | 0–3 | 0 (0) | 0–1 | 0.035† | 0.028, small |
| | Match | 1 (2) | 0–5 | 0 (2) | 0–5 | <0.001† | 0.135, moderate |
| Impacts (5–9 g-forces) | 1 | 2 (2) | 0–14 | 4 (8) | 0–39 | 0.020† | 0.074, moderate |
| | 2 | 2 (4) | 0–11 | 3 (7) | 0–54 | 0.051 | 0.052, small |
| | 3 | 2 (4) | 0–10 | 4 (5) | 0–39 | 0.044† | 0.056, small |
| | 4 | 2 (2) | 0–11 | 3 (5) | 0–29 | 0.342 | 0.012, small |
| | Match | 9 (9) | 0–40 | 16 (21) | 1–154 | 0.033† | 0.063, moderate |
| Impacts (9–15 g-forces) | 1 | 0 (0) | 0–1 | 0 (0) | 0–1 | 0.857 | 0.000, none |
| | 2 | 0 (0) | 0–1 | 0 (0) | 0–1 | 0.857 | 0.000, none |
| | 3 | 0 (0) | 0–0 | 0 (0) | 0–1 | Nil | Nil, none |
| | 4 | 0 (0) | 0–1 | 0 (0) | 0–0 | Nil | Nil, none |
| | Match | 0 (0) | 0–1 | 0 (0) | 0–1 | 0.246 | 0.006, none |

*IQR = interquartile range; Min–Max = minimum and maximum values; $\eta_p^2$ = partial eta squared; Nil = the variance is equal to 0 after grouping data based on sex.
†Significant difference between sexes at $p < 0.05$.

the number of accelerations performed at 2–3 m·s$^{-2}$ ($p$ = 0.08), absolute (m) and relative distance covered walking at 0–2 m·s$^{-1}$ ($p$ = 0.33–0.36), and absolute and relative distance covered running at 4–6 m·s$^{-1}$ ($p$ = 0.13) across entire matches (Tables 4 and 5).

### Quarter Comparisons in Female Players

*Large* differences in mean HR (%HRmax) were apparent across entire matches ($p < 0.001$), with higher values recorded in the second-fourth quarters ($p < 0.001$) compared with the first quarter (Table 6). *Large* differences across entire matches ($p < 0.001$) were also observed for the absolute and relative total distance, and absolute and relative distance covered running at 4–6 m·s$^{-1}$, with higher distances evident in the first ($p < 0.001$) and second quarters ($p < 0.001$) compared with the fourth quarter (Table 6). Similarly, *large* differences in peak 1-minute distance (m·min$^{-1}$) covered were observed across entire matches ($p < 0.001$), with higher distances covered in the first ($p < 0.001$), second ($p < 0.001$), and third quarters ($p = 0.003$) compared with the fourth quarter (Table 6). The number of accelerations performed at 2–3 m·s$^{-2}$ demonstrated *large* differences across entire matches ($p < 0.001$), with more accelerations completed in the first ($p < 0.001$) and second ($p = 0.023$) quarters compared with the fourth quarter (Table 7). *Moderate* differences were evident in the number of decelerations (−2 to −3 m·s$^{-2}$ and −3 to −4 m·s$^{-2}$) completed across entire matches ($p$ = 0.002–0.007), with more decelerations occurring in the first quarter ($p \leq 0.001$) compared with the fourth quarter (Table 7). Finally, *moderate* differences in the number of impacts experienced at 5–9 g-forces were observed across entire matches ($p = 0.05$), with more impacts occurring in the first ($p = 0.03$) and third quarters ($p = 0.01$) compared with the fourth quarter (Table 7).

**Table 2**
**Absolute distance covered at different speed thresholds, maximum speed, and heart rate data for male and female lacrosse players during each quarter and entire matches under the World Lacrosse Sixes format.***

| | | Male ($n$ = 25) | | Female ($n$ = 22) | | Sex comparison statistics | |
|---|---|---|---|---|---|---|---|
| Variable | Quarter | Median (IQR) | Min–Max | Median (IQR) | Min–Max | $p$ | $\eta_p^2$, interpretation |
| Absolute distance covered (m) | 1 | 601 (110) | 415–782 | 666 (149) | 384–864 | 0.137 | 0.031, small |
| | 2 | 590 (153) | 370–721 | 620 (150) | 427–827 | 0.297 | 0.015, small |
| | 3 | 630 (139) | 379–789 | 604 (136) | 376–881 | 0.512 | 0.006, none |
| | 4 | 568 (148) | 427–761 | 560 (119) | 400–816 | 0.371 | 0.011, small |
| | Match (total) | 2470 (389) | 1683–2930 | 2412 (436) | 1748–3184 | 0.901 | 0.000, none |
| Absolute distance covered walking (m, 0–2 $m \cdot s^{-1}$) | 1 | 177 (33) | 123–223 | 200 (68) | 109–264 | 0.166 | 0.027, small |
| | 2 | 184 (46) | 103–277 | 192 (69) | 115–308 | 0.830 | 0.001, none |
| | 3 | 190 (50) | 127–291 | 185 (53) | 122–292 | 0.760 | 0.001, none |
| | 4 | 195 (60) | 124–276 | 192 (59) | 122–266 | 0.476 | 0.007, none |
| | Match (total) | 745 (158) | 555–937 | 800 (212) | 518–1069 | 0.882 | 0.000, none |
| Absolute distance covered jogging (m, 2–4 $m \cdot s^{-1}$) | 1 | 272 (69) | 119–414 | 298 (104) | 169–537 | 0.371 | 0.011, small |
| | 2 | 256 (109) | 110–392 | 258 (99) | 165–457 | 0.455 | 0.008, none |
| | 3 | 271 (74) | 158–406 | 262 (92) | 171–409 | 0.991 | 0.000, none |
| | 4 | 255 (76) | 136–357 | 254 (68) | 137–471 | 0.838 | 0.001, none |
| | Match (total) | 1049 (168) | 593–1396 | 1061 (248) | 755–1776 | 0.557 | 0.005, none |
| Absolute distance covered running (m, 4–6 $m \cdot s^{-1}$) | 1 | 147 (93) | 61–296 | 146 (96) | 10–263 | 0.384 | 0.011, small |
| | 2 | 140 (69) | 55–236 | 137 (113) | 50–362 | 0.422 | 0.009, none |
| | 3 | 134 (89) | 24–256 | 135 (86) | 34–298 | 0.991 | 0.000, none |
| | 4 | 95 (68) | 21–222 | 101 (80) | 22–267 | 0.377 | 0.011, small |
| | Match (total) | 509 (272) | 267–842 | 503 (369) | 118–1188 | 0.752 | 0.001, none |
| Absolute distance covered sprinting (m, >6 $m \cdot s^{-1}$) | 1 | 6.0 (16.8) | 0.0–60.1 | 0.0 (0.0) | 0.0–22.5 | <0.001† | 0.153, large |
| | 2 | 4.6 (17.4) | 0.0–67.8 | 0.0 (0.0) | 0.0–31.4 | 0.005† | 0.083, moderate |
| | 3 | 12.9 (24.9) | 0.0–53.2 | 0.0 (3.0) | 0.0–19.0 | <0.001† | 0.206, large |
| | 4 | 1.7 (16.7) | 0.0–69.3 | 0.0 (0.0) | 0.0–25.7 | <0.001† | 0.109, moderate |
| | Match (total) | 53.2 (31.2) | 0.0–100.0 | 3.6 (14.1) | 0.0–49.2 | <0.001† | 0.416, large |
| Maximum velocity ($m \cdot s^{-1}$) | 1 | 6.3 (0.7) | 5.3–7.8 | 5.6 (0.8) | 4.2–6.5 | <0.001† | 0.268, large |
| | 2 | 6.1 (0.1) | 5.1–7.8 | 5.6 (0.6) | 4.5–6.8 | <0.001† | 0.170, large |
| | 3 | 6.6 (1.0) | 5.3–7.6 | 5.7 (0.7) | 4.5–6.9 | <0.001† | 0.285, large |
| | 4 | 6.0 (0.9) | 4.9–7.7 | 5.4 (0.6) | 4.4–7.7 | <0.001† | 0.199, large |
| | Match (average) | 6.2 (1.0) | 4.9–7.8 | 5.5 (0.8) | 4.2–7.7 | <0.001† | 0.218, large |
| Maximum HR (%HRmax) | 1 | 91.8 (4.6) | 81.5–98.5 | 92.0 (5.3) | 80.0–99.0 | 0.975 | 0.000, none |
| | 2 | 93.5 (4.3) | 79.0–98.5 | 94.3 (5.6) | 87.5–101.5 | 0.272 | 0.021, small |
| | 3 | 93.5 (4.8) | 83.0–102.0 | 95.0 (4.5) | 81.5–100.0 | 0.746 | 0.002, none |
| | 4 | 94.0 (4.5) | 83.5–100.5 | 93.5 (6.6) | 82.0–99.0 | 0.850 | 0.001, none |
| | Match (average) | 93.5 (4.4) | 79.0–102.0 | 93.8 (4.0) | 80.0–101.5 | 0.514 | 0.002, none |
| Mean HR (%HRmax) | 1 | 79.2 (7.8) | 70.3–90.2 | 82.5 (7.6) | 54.5–92.7 | 0.199 | 0.028, small |
| | 2 | 83.4 (8.7) | 65.3–89.7 | 84.8 (7.2) | 68.0–95.8 | 0.082 | 0.052, small |
| | 3 | 84.2 (7.3) | 70.3–91.4 | 86.8 (6.8) | 75.7–95.4 | 0.105 | 0.047, small |
| | 4 | 83.8 (5.3) | 71.7–92.0 | 85.1 (5.8) | 72.0–91.7 | 0.526 | 0.007, none |
| | Match (average) | 83.0 (5.7) | 65.3–92.0 | 84.6 (6.4) | 54.5–95.8 | 0.011† | 0.028, small |

*IQR = interquartile range; Min–Max = minimum and maximum values; $\eta_p^2$ = partial eta squared; HR = heart rate.
†Significant difference between sexes at $p < 0.05$.

## Discussion

World Lacrosse Sixes was developed to reduce the barriers affecting participation in field lacrosse (e.g., number of players and field size) while promoting greater spectatorship through a more dynamic, fast-paced version of the sport (35). However, the movement and physiological demands of male and female players in World Lacrosse Sixes have yet to be quantified or explained, which this study provides. These data can be used to draw comparisons in player demands between sexes and quarters, and with existing literature examining traditional field lacrosse.

A higher intensity of match play was observed in this study for players competing in World Lacrosse Sixes compared with previous research in field lacrosse players, evidenced through higher mean HR for male (83% HRmax vs. 81% HRmax) (1) and female players (85% HRmax vs. 75% HRmax) (19). This study is also the first to report peak 1-minute demands in lacrosse players, demonstrating that male and female players competing in World Lacrosse Sixes can achieve ~6–7% of their total distance covered per match during these intense 1-minute periods. Furthermore, acceleration and deceleration data from this study show that international male World Lacrosse Sixes players performed more accelerations (1.21 vs. 0.57) and decelerations (0.94 vs. 0.49) at ±2–4 $m \cdot s^{-2}$ per minute than international male field lacrosse players (1). Similarly, international female players in World Lacrosse Sixes also completed more accelerations (1.63 vs. 0.78) and decelerations (1.26 vs. 0.65) at ±2–4 $m \cdot s^{-2}$ per minute than international female field lacrosse players (19). To note, these relative acceleration and deceleration demands derived from previous field lacrosse research (1,19) were manually calculated by dividing the total count of accelerations and decelerations with the reported match duration to make accurate comparisons between studies. The greater relative accelerations and decelerations in World Lacrosse Sixes are possibly associated with reduced field

**Table 3**

**Relative distance covered within different speed thresholds for male and female lacrosse players during each quarter and entire matches under the World Lacrosse Sixes format.***

| Variable | Quarter | Male ($n$ = 25) Median (IQR) | Male Min–Max | Female ($n$ = 22) Median (IQR) | Female Min–Max | Sex comparison statistics $p$ | $\eta_p^2$, interpretation |
|---|---|---|---|---|---|---|---|
| Relative distance covered (m·min$^{-1}$) | 1 | 75 (14) | 52–98 | 83 (19) | 48–108 | 0.137 | 0.031, small |
| | 2 | 74 (19) | 46–90 | 77 (19) | 53–103 | 0.293 | 0.016, small |
| | 3 | 79 (17) | 47–99 | 75 (17) | 47–110 | 0.512 | 0.006, none |
| | 4 | 71 (19) | 54–95 | 70 (15) | 50–102 | 0.371 | 0.011, small |
| | Match (average) | 74 (18) | 46–99 | 74 (19) | 47–110 | 0.613 | 0.001, none |
| Peak 1-min distance covered (m·min$^{-1}$) | 1 | 171 (24) | 138–203 | 154 (24) | 122–209 | <0.001† | 0.215, large |
| | 2 | 163 (18) | 121–209 | 156 (32) | 95–198 | 0.035† | 0.062, moderate |
| | 3 | 168 (28) | 120–210 | 151 (33) | 96–201 | <0.001† | 0.160, large |
| | 4 | 161 (25) | 121–188 | 141 (35) | 82–181 | 0.002† | 0.135, moderate |
| | Match (average) | 167 (26) | 120–210 | 150 (29) | 82–209 | <0.001† | 0.129, moderate |
| Relative distance covered walking (m·min$^{-1}$) | 1 | 22.1 (4.2) | 15.4–27.8 | 24.9 (8.6) | 13.7–33.0 | 0.162 | 0.027, small |
| | 2 | 23 (5.8) | 12.8–34.6 | 24.0 (8.6) | 14.4–38.5 | 0.833 | 0.001, none |
| | 3 | 23.8 (6.3) | 15.9–26.4 | 23.1 (6.7) | 15.3–36.5 | 0.766 | 0.001, none |
| | 4 | 24.3 (7.6) | 15.5–34.5 | 24.0 (7.4) | 15.3–33.3 | 0.488 | 0.007, none |
| | Match (average) | 23.4 (6.2) | 12.8–36.4 | 23.9 (7.75) | 13.7–38.5 | 0.555 | 0.001, none |
| Relative distance covered jogging (m·min$^{-1}$) | 1 | 34.0 (8.7) | 14.9–51.8 | 37.2 (12.9) | 21.2–67.1 | 0.369 | 0.011, small |
| | 2 | 31.9 (13.6) | 13.7–49.0 | 32.3 (12.4) | 20.7–57.1 | 0.453 | 0.008, none |
| | 3 | 33.8 (9.3) | 19.7–50.7 | 32.8 (11.5) | 21.3–51.2 | 1.00 | 0.000, none |
| | 4 | 31.9 (9.5) | 17.0–44.6 | 31.7 (8.6) | 17.1 (58.8) | 0.842 | 0.001, none |
| | Match (average) | 33.5 (10.5) | 13.7–51.8 | 32.8 (10.9) | 17.1–67.1 | 0.491 | 0.002, none |
| Relative distance covered running (m·min$^{-1}$) | 1 | 18.4 (11.6) | 7.6–37.1 | 18.2 (12.0) | 1.3–32.9 | 0.397 | 0.011, small |
| | 2 | 17.5 (8.7) | 6.9–29.5 | 17.2 (14.1) | 6.2–45.2 | 0.416 | 0.009, none |
| | 3 | 16.7 (11.1) | 3.0–32.0 | 16.9 (10.7) | 4.3–37.2 | 0.995 | 0.000, none |
| | 4 | 11.9 (8.6) | 2.6–27.7 | 12.6 (9.6) | 2.7–33.4 | 0.372 | 0.011, small |
| | Match (average) | 16.3 (10.8) | 2.6–37.1 | 16.3 (12.3) | 1.3–45.2 | 0.727 | 0.000, none |
| Relative distance covered sprinting (m·min$^{-1}$) | 1 | 0.7 (2.1) | 0.0–7.5 | 0.0 (0.0) | 0.0–2.8 | <0.001† | 0.152, large |
| | 2 | 0.6 (2.2) | 0.0–8.5 | 0.0 (0.0) | 0.0–3.9 | 0.005† | 0.084, moderate |
| | 3 | 1.6 (3.1) | 0.0–6.7 | 0.0 (0.4) | 0.0–2.4 | <0.001† | 0.205, large |
| | 4 | 0.2 (2.1) | 0.0–8.7 | 0.0 (0.0) | 0.0–3.2 | <0.001† | 0.109, moderate |
| | Match (average) | 0.7 (2.4) | 0.0–8.7 | 0.0 (0.0) | 0.0–3.9 | <0.001† | 0.131, moderate |

*IQR = interquartile range; Min–Max = minimum and maximum values; $\eta_p^2$ = partial eta squared.
†Significant difference between sexes at $p < 0.05$.

areas and a shorter 30-second shot clock, leading to increased congestion between players and a higher number of possessions across teams, which requires more multidirectional changes to create space and when transitioning between attack and defense.

Conversely, data from this study showed that World Lacrosse Sixes does not seem to impose greater movement demands concerning relative distances covered and high-intensity running actions compared with field lacrosse players examined previously (1,13,18,24,27,30). Specifically, male players in this study covered ~17–19% lower relative total distances (m·min$^{-1}$) compared with male international (88 m·min$^{-1}$) (1) and club (89 m·min$^{-1}$) (24) field lacrosse players. Whereas, female players in this study covered ~7% lower relative total distances compared with female collegiate field lacrosse players (79 m·min$^{-1}$) (13). Comparisons regarding the distribution of total distance across different forms of locomotion revealed that international field lacrosse players performed less distance jogging (33%), similar distance running (22%), and greater distance walking (41%) and

**Table 4**

**Comparisons in acceleration, deceleration, and impact data between quarters for male lacrosse players ($n$ = 25) competing under the World Lacrosse Sixes format.***

| Variable (count) | $p$ for quarter comparisons 1 vs. 2 | 1 vs. 3 | 1 vs. 4 | 2 vs. 3 | 2 vs. 4 | 3 vs. 4 | Overall | $\eta_p^2$, interpretation |
|---|---|---|---|---|---|---|---|---|
| Accelerations (2–3 m·s$^{-2}$) | 0.127 | 0.016† | 0.054 | 0.358 | 0.682 | 0.609 | 0.075 | 0.127, moderate |
| Accelerations (3–4 m·s$^{-2}$) | 0.674 | 0.636 | 0.319 | 0.958 | 0.563 | 0.599 | 0.797 | 0.031, small |
| Accelerations (>4 m·s$^{-2}$) | 0.314 | 0.123 | 0.394 | 0.587 | 0.876 | 0.485 | 0.488 | 0.035, small |
| Decelerations (−2 to −3 m·s$^{-2}$) | 0.542 | 0.117 | 0.039† | 0.031† | 0.008† | 0.611 | 0.020† | 0.112, moderate |
| Decelerations (−3 to −4 m·s$^{-2}$) | 0.007† | 0.596 | 0.341 | 0.028† | 0.074 | 0.671 | 0.034† | 0.040, small |
| Decelerations (<−4 m·s$^{-2}$) | 0.392 | 0.843 | 0.189 | 0.510 | 0.644 | 0.263 | 0.531 | 0.016, small |
| Impacts (5–9 g-forces) | 0.394 | 0.749 | 0.594 | 0.594 | 0.749 | 0.831 | 0.854 | 0.021, small |
| Impacts (9–15 g-forces) | 1.000 | 0.474 | 0.154 | 0.474 | 0.154 | 0.034† | 0.284 | 0.041, small |

*$\eta_p^2$ = partial eta squared.
†Significant difference between quarters at $p < 0.05$.

**Table 5**

**Comparisons in absolute and relative distances covered within different speed thresholds, maximum velocity, and heart rate data between quarters for male lacrosse players ($n$ = 25) competing under the World Lacrosse Sixes format.***

| | *p* for quarter comparisons | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | 1 vs. 2 | 1 vs. 3 | 1 vs. 4 | 2 vs. 3 | 2 vs. 4 | 3 vs. 4 | Overall | $\eta_p^2$, interpretation |
| Absolute distance covered (m) | 0.330 | 0.922 | 0.380 | 0.284 | 0.922 | 0.330 | 0.582 | 0.036, small |
| Absolute distance covered walking (m, 0–2 $m \cdot s^{-1}$) | 0.845 | 0.243 | 0.121 | 0.330 | 0.174 | 0.696 | 0.325 | 0.084, moderate |
| Absolute distance covered jogging (m, 2–4 $m \cdot s^{-1}$) | 0.380 | 0.770 | 0.558 | 0.558 | 0.770 | 0.770 | 0.832 | 0.033, small |
| Absolute distance covered running (m, 4–6 $m \cdot s^{-1}$) | 0.922 | 0.696 | 0.043† | 0.770 | 0.053 | 0.099 | 0.133 | 0.090, moderate |
| Absolute distance covered sprinting (m, >6 $m \cdot s^{-1}$) | 0.829 | 0.361 | 0.484 | 0.259 | 0.628 | 0.108 | 0.427 | 0.024, small |
| Peak 1-min distance covered ($m \cdot min^{-1}$) | 0.330 | 0.845 | 0.004† | 0.435 | 0.053 | 0.007† | 0.012† | 0.133, moderate |
| Relative distance covered ($m \cdot min^{-1}$) | 0.330 | 0.922 | 0.380 | 0.284 | 0.922 | 0.330 | 0.582 | 0.036, small |
| Relative distance covered walking ($m \cdot min^{-1}$) | 0.807 | 0.242 | 0.132 | 0.354 | 0.205 | 0.732 | 0.360 | 0.084, moderate |
| Relative distance covered jogging ($m \cdot min^{-1}$) | 0.380 | 0.770 | 0.558 | 0.558 | 0.770 | 0.770 | 0.832 | 0.033, small |
| Relative distance covered running ($m \cdot min^{-1}$) | 0.922 | 0.696 | 0.043† | 0.770 | 0.053 | 0.099 | 0.133 | 0.090, moderate |
| Relative distance covered sprinting ($m \cdot min^{-1}$) | 0.871 | 0.389 | 0.483 | 0.306 | 0.589 | 0.120 | 0.466 | 0.024, small |
| Maximum velocity ($m \cdot s^{-1}$) | 0.696 | 0.406 | 0.306 | 0.223 | 0.525 | 0.066 | 0.298 | 0.055, small |
| Maximum HR (%HRmax) | 0.040† | <0.001† | <0.001† | 0.118 | 0.162 | 0.866 | <0.001† | 0.276, large |
| Mean HR (%HRmax) | 0.008† | <0.001† | <0.001† | 0.152 | 0.055 | 0.618 | <0.001† | 0.383, large |

*$\eta_p^2$ = partial eta squared; HR = heart rate.
†Significance difference between quarters at $p < 0.05$.

sprinting (5%) (1) than World Lacrosse Sixes players in this study. It was also observed that female collegiate field lacrosse players recorded considerably higher maximal sprinting velocities of 6.7 $m \cdot s^{-1}$ (13) to 7.3 $m \cdot s^{-1}$ (18,27) than those achieved by female World Lacrosse Sixes players in this study. The lower distances covered sprinting in male players and slower maximal sprinting velocities achieved by female players in World Lacrosse Sixes reported in this study compared with field lacrosse players may be because of the smaller field areas used in World Lacrosse Sixes (70 × 36 m vs. 91.4–110 m × 55–60 m). This reduction in field size may limit the ability to reach and complete greater distances at higher speeds, given players will be forced to decelerate because of encroaching upon field perimeters, colliding with or evading opponents during congested play, or covering shorter distances during transitions between attack and defense. This notion has been partially supported in elite male soccer players, whereby maximal sprinting velocities reached during small-sided games were *moderately* correlated with longer field lengths ($r$ = 0.53, $p < 0.001$) and larger field areas ($r = 0.45$, $p < 0.001$) as players potentially had to cover greater distances while attacking (e.g., attempting to score) and defending (e.g., protecting their goal) (14). Furthermore, a recent investigation into the training load measures for different training drills in female collegiate lacrosse players revealed that small-sided games (≤5 players on smaller field dimensions) elicited lower movement demands when compared with team drills (≥5 players and full-field lacrosse field dimensions) for total distance (504 ± 259 vs. 920 ± 342 m), high-intensity distance (62 ± 121 vs. 82 ± 86 m), accelerations (12 ± 8 reps vs. 21 ± 12 reps), and decelerations (2.6 ± 2.3 reps vs. 4.4 ± 3.3 reps) (4).

Comparisons between sexes in the present study showed that male players experienced more intense movement demands in the form of peak 1-minute distance covered, sprinting distance covered, and maximum velocity reached than female players. Similar findings have been observed in research reporting the movement demands during professional European soccer competitions, where male players covered significantly ($p < 0.01$) more distance sprinting (>6 $m \cdot s^{-1}$) compared with female players (3). These superior distances covered at high intensities in male players is likely because of sex-related physiological differences as male players typically possess more muscle mass, strength, and power (25) combined with lower-body fat and an increased ability to maintain high rates of ATP resynthesis compared with female players, allowing higher peak activity outputs to be reached and maintained across matches (22). However, it must be considered that the distances covered by male players sprinting during matches in the present study were small (2% of total distance), and most female lacrosse players did not reach the speed threshold needed to accrue distances within the predefined sprinting category (>6 $m \cdot s^{-1}$). Consequently, future lacrosse research should seek to develop suitable speed thresholds that adequately detect intense movements during matches across sexes, such as relative thresholds (%) based on individualized peak sprint speed for more conclusive differences between sexes to be drawn considering the capacities of players (7).

Female lacrosse players in this study were involved in a greater number of impacts at 5–9 g-forces than male players and performed more accelerations and decelerations at ±2–3 $m \cdot s^{-2}$. Given stick and body contact is not permitted in women's lacrosse but allowed in men's lacrosse, it was surprising to see these findings. However, research has shown that a total of 204 high impacts (≥20 g-forces) were recorded over 33 games in U.S. high school girls' field with only 24% of these impacts considered illegal (9). Similarly, another study investigating the insurance claims of U.S. lacrosse players demonstrated that a large proportion of reported injuries from female players were because of stick and body contact, and also very few of these incidents were considered illegal (6). These collective findings indicate that lacrosse rules relating to stick and body contact may not be adequately enforced in female matches (6,9). Furthermore, impacts ≥20 g-forces in magnitude were only considered in previous studies as impacts below this threshold are commonly caused by normal physical movements during matches (e.g., jumps, changes of direction, decelerations, and accelerations) (8,9). Therefore, given this study recorded low threshold impacts (5–9 g-forces) and female players tended to perform a greater number of accelerations and decelerations at ±2–3 $m \cdot s^{-2}$, it is feasible to suggest that these movements may have contributed to the impacts recorded. Possible reasons for the greater number of accelerations and decelerations performed by female players may be

**Table 6**

**Comparisons in absolute and relative distances covered within different speed thresholds, maximum velocity, and heart rate data between quarters for female lacrosse players ($n$ = 22) competing under the World Lacrosse Sixes format.***

| Variable | $p$ for quarter comparisons | | | | | | | $\eta_p^2$, interpretation |
|---|---|---|---|---|---|---|---|---|
| | 1 vs. 2 | 1 vs. 3 | 1 vs. 4 | 2 vs. 3 | 2 vs. 4 | 3 vs. 4 | Overall | |
| Absolute distance covered (m) | 0.865 | 0.552 | <0.001† | 0.444 | <0.001† | 0.004† | <0.001† | 0.153, large |
| Absolute distance covered walking (m, 0–2 $m\cdot s^{-1}$) | 0.799 | 0.671 | 0.734 | 0.496 | 0.552 | 0.932 | 0.896 | 0.009, none |
| Absolute distance covered jogging (m, 2–4 $m\cdot s^{-1}$) | 0.932 | 0.932 | 0.091 | 1.000 | 0.108 | 0.108 | 0.250 | 0.054, small |
| Absolute distance covered running (m, 4–6 $m\cdot s^{-1}$) | 0.396 | 0.671 | <0.001† | 0.203 | <0.001† | <0.001† | <0.001† | 0.350, large |
| Absolute distance covered sprinting (m, >6 $m\cdot s^{-1}$) | 0.684 | 0.379 | 0.839 | 0.635 | 0.542 | 0.279 | 0.716 | 0.016, small |
| Relative distance covered ($m\cdot min^{-1}$) | 0.865 | 0.552 | <0.001† | 0.444 | <0.001† | 0.004† | <0.001† | 0.153, large |
| Peak 1-min distance covered ($m\cdot min^{-1}$) | 0.799 | 0.671 | <0.001† | 0.496 | <0.001† | 0.003† | <0.001† | 0.158, large |
| Relative distance covered walking ($m\cdot min^{-1}$) | 0.798 | 0.669 | 0.864 | 0.495 | 0.669 | 0.798 | 0.919 | 0.010, small |
| Relative distance covered jogging ($m\cdot min^{-1}$) | 0.898 | 0.966 | 0.090 | 0.932 | 0.117 | 0.099 | 0.248 | 0.054, small |
| Relative distance covered running ($m\cdot min^{-1}$) | 0.394 | 0.798 | <0.001† | 0.268 | <0.001† | <0.001† | <0.001† | 0.349, large |
| Relative distance covered sprinting ($m\cdot min^{-1}$) | 0.683 | 0.342 | 0.786 | 0.587 | 0.497 | 0.222 | 0.643 | 0.016, small |
| Maximum velocity ($m\cdot s^{-1}$) | 0.551 | 0.116 | 0.639 | 0.328 | 0.287 | 0.042† | 0.193 | 0.044, small |
| Maximum HR (%HRmax) | <0.001† | <0.001† | 0.004† | 0.775 | 0.047† | 0.088 | <0.001† | 0.031, small |
| Mean HR (%HRmax) | <0.001† | <0.001† | <0.001† | 0.449 | 0.395 | 0.110 | <0.001† | 0.359, large |

*$\eta_p^2$ = partial eta squared; HR = heart rate.
†Significance difference between quarters at $p < 0.05$.

because of technical, tactical, and rule differences compared with male players. Technically, female lacrosse players may change possession more frequently than male players, resulting in a greater need to accelerate and decelerate as play transitions between attack and defense. Tactically, female lacrosse players may be more reliant on using cutting maneuvers that involve decelerating, changing direction, and accelerating to create space away from opponents, given their reduced ability to reach higher speeds compared with male players. Finally, as female players are not permitted to make contact, they may more actively attempt to evade opponents (and avoid contact) compared with male players, leading to more accelerations and decelerations.

In addition to comparisons in demands between sexes in World Lacrosse Sixes, temporal comparisons across match quarters were also conducted. Findings showed *moderate-to-large* differences across quarters where the number of accelerations and decelerations at ±2–3 $m\cdot s^{-2}$, running distance at 4–6 $m\cdot s^{-1}$, and peak 1-minute distance covered ($m\cdot min^{-1}$) decreased, and mean HR (%HRmax) increased with match progression, especially between the first and fourth quarters across sexes. Previous data showing temporal changes in the movement and physiological demands during male field lacrosse matches were presented separately for Japanese international team players (1) and Australian national championship state team players (24). Specifically, Akiyama et al. (2019) reported no significant differences ($p$ > 0.05) for any variables between quarter 1 and quarter 4, whereas Polley et al. (24) reported ≥75% *likely positive* reductions in relative distances covered ($m\cdot min^{-1}$) and player load (au) between quarter 1 and quarter 4. Consequently, it seems that the movement demands across male and female players competing in World Lacrosse Sixes tend to decline with match progression, which may be attributed to fatigue and tactics. Concurring with the findings from this study, a recent systematic review and meta-analysis on the effects of fatigue on the running profile of soccer, rugby, and handball players concluded that fatigue caused by competitive matches leads to a significant ($p$ = 0.04; ES = 1.6; *large*) reduction in running performance (17), which is likely attributable to perceptual (e.g., homeostasis and psychological) and performance fatigue (e.g., muscle contractile function and activation) (15). To overcome this issue, lacrosse coaches and the athlete support team may use live GNSS monitoring to gather individual player data (e.g., running distance, accelerations, and decelerations) for determining optimal substitution strategies and maintain player outputs across matches (26). Tactically, movement demands may decrease toward the latter stages of World Lacrosse Sixes matches as teams adopt strategies to slow playing

**Table 7**

**Comparisons in acceleration, deceleration, and impact data between quarters for female lacrosse players ($n$ = 22) competing under the World Lacrosse Sixes format.***

| Variable (count) | $p$ for quarter comparisons | | | | | | | $\eta_p^2$, interpretation |
|---|---|---|---|---|---|---|---|---|
| | 1 vs. 2 | 1 vs. 3 | 1 vs. 4 | 2 vs. 3 | 2 vs. 4 | 3 vs. 4 | Overall | |
| Accelerations (2–3 $m\cdot s^{-2}$) | 0.019† | <0.001† | <0.001† | 0.188 | 0.023† | 0.333 | <0.001† | 0.188, large |
| Accelerations (3–4 $m\cdot s^{-2}$) | 0.746 | 0.460 | 0.108 | 0.289 | 0.054 | 0.381 | 0.213 | 0.059, small |
| Accelerations (>4 $m\cdot s^{-2}$) | 0.034† | 0.019† | 0.008† | 0.822 | 0.574 | 0.736 | 0.043† | 0.052, small |
| Decelerations (−2 to −3 $m\cdot s^{-2}$) | 0.175 | 0.630 | <0.001† | 0.381 | 0.027† | 0.002† | 0.002† | 0.139, moderate |
| Decelerations (−3 to −4 $m\cdot s^{-2}$) | 0.078 | 0.010† | 0.001† | 0.401 | 0.137 | 0.513 | 0.007† | 0.100, moderate |
| Decelerations (<−4 $m\cdot s^{-2}$) | 0.267 | 0.179 | 0.023† | 0.812 | 0.235 | 0.341 | 0.158 | 0.053, small |
| Impacts (5–9 g-forces) | 0.751 | 0.717 | 0.028† | 0.497 | 0.059 | 0.011† | 0.046† | 0.066, moderate |
| Impacts (9–15 g-forces) | 1.000 | 1.000 | 0.293 | 1.000 | 0.293 | 0.293 | 0.801 | 0.008, none |

*$\eta_p^2$ = partial eta squared.
†Significant difference between quarters at $p < 0.05$.

pace and maintain possession, given the increased importance of each play as match outcomes are closer to being determined. Similar findings have been observed in professional basketball, where players adopted slower offensive tactics through significantly ($p < 0.05$) reducing the amount of dribbling and overall activity velocities with game progression (28).

Although this study provides novel insight into the demands of the new World Sixes Lacrosse match format, the following limitations should be considered. First, the 7 competitive matches included in this study were implemented using simulated intrasquad competition for players in the Hong Kong national team rather than an official international competition consisting of different nations. Consequently, further research should extend on this foundational study through obtaining longitudinal match data throughout a season or competition in World Lacrosse Sixes in a wider range of national teams and international competitions. Second, video recording matches would have allowed additional analyses to provide tactical insights and further explain findings provided in this study to reach more robust conclusions (e.g., minutes played, number of substitutions, offensive tactics, defensive tactics, turnovers, and impacts). Third, an age-based formula was used to determine the maximum HR for each player in the present study. Given some players exceeded their age-predicted maximum HR during matches, direct determination of maximum HR during maximal aerobic testing may have provided a more accurate indication of the relative cardiovascular stress encountered during matches. Fourth, manufacturer-derived absolute speed thresholds were used to delineate intensity zones for the activity data in this study. In turn, individualized relative thresholds may yield different, more specific data in different intensity zones for male and female players during matches relative to their maximal sprint capacities (4).

In conclusion, this is the first study to quantify the movement and physiological demands of the new World Lacrosse Sixes format for male and female players. Results indicated that World Lacrosse Sixes matches are more demanding (higher HR and more accelerations and decelerations) for male and female players than previously reported in field lacrosse. However, male players examined in this study covered proportionately less distance sprinting and female players reached lower maximum velocities compared with players competing in field lacrosse. Comparisons in demands between sexes during World Lacrosse Sixes matches showed male players covered greater peak 1-minute and sprinting distances and reached higher maximum velocities than female players, whereas female players performed more accelerations and decelerations at $\pm 2$–$4\ \mathrm{m \cdot s^{-2}}$ and impacts at 5–9 g-forces than male players. Comparisons in demands between quarters during World Lacrosse Sixes matches showed a decrease in accelerations, decelerations, running distance covered, and peak 1-minute distance covered and an increase in mean HR (%HRmax) between the first and fourth quarters across sexes.

## Practical Applications

This study provides foundational data regarding the movement and physiological demands experienced in the newly developed World Lacrosse Sixes format in international male and female players. Accordingly, these data may be used to adapt training and tactical strategies specific to World Lacrosse Sixes. Lacrosse coaches and the athlete support team may use these data to inform training plans, through designing specific drills, sessions, and cycles to best prepare players to cope with the movement and physiological demands of World Lacrosse Sixes. For example, implementing small-sided games that mimic and challenge players to endure the likely peak 1-minute distances covered in matches may help prepare players to meet the most demanding phases of play. Furthermore, when developing training plans for players competing in World Lacrosse Sixes matches, lacrosse coaches and the athlete support team should develop sex-specific training programs to promote player capacities that endure the physical (i.e., accelerations, decelerations, and movement intensities) and cardiovascular demands (%HRmax) of match play in male and female players. Furthermore, the temporal reductions in movement demands and intensities with match progression in the present study suggest that strategic tactical decisions (e.g., player substitutions) may be needed throughout World Lacrosse Sixes matches to offset the deterioration in player outputs and optimize their readiness for key match scenarios encountered late in matches.

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