Quantifying external and internal loads of the average and high-intensity phase demands of university female footballers.

Abstract

The match-play external and internal loads of university female footballers are not well understood. Therefore, the aims of this study were to quantify the average and 5-minute high intensity phase (HIP) match-play loads of university female footballers. With institutional ethical approval granted, twenty trained female footballers (age 20.0 ± 1.3, mass 64.9 ± 12.9 kg) volunteered to take part in the study across six competitive fixtures. Global positioning systems (Catapult, Australia) and heart rate monitors (Polar, Finland) were used to quantify external and internal loads during match-play. Linear mixed models with fixed and random effects were used to analyse match data and compare between positions. Forty-five and 53 observations were used for the average and HIP **loads**. Players covered total distances of 8160**m**, with 456m covered at high speed and 151m covered at sprint distance; central defenders completed less high intensity running than attackers ($p < .005$). During 5-minute HIP's, no differences were observed for accelerations (n) and PlayerLoad (au) between positional groups ($p > .05$). Attackers covered more high-speed running ($p = .005$) and sprint distance ($p = .019$) than central defenders and midfielders ($p = .012$; $p = .017$**)**. These data describe average whole match and 5-minute HIP **external and internal loads** of university female footballers. **Coaches could use this to inform conditioning practices by exposing attacking players to greater volumes of high intensity running.**

Key Words; female football, university, ***global positioning systems, heart rate, match-play***

Introduction

The number of women and girls playing organised football has grown by a quarter since 2019 to 16.6 million as reported by FIFA (Inside FIFA, 2023). This growth is likely aided by **events such as** the recent FIFA Women's World Cup which drew record levels of engagement and publicity ("Women's World Cup 2023 hailed as 'most successful in history' at halfway point", 2023). **The growth in these events and the game naturally leads to increased performance expectations** (Martínez-Lagunas et al., 2014). However, a challenge for practitioners is the lack of female specific research available to facilitate evidence-based athlete support (Cowley et al., 2021; James et al., 2023; Roberts & Forsyth, 2019; Smith et al., 2022)**. This challenge is compounded for practitioners working with non-elite populations as the majority of research within football has studied elite players** (Harkness-Armstrong et al., 2022; Kirkendall & Krustrup, 2021; Okholm Kryger et al., 2022)**.** This highlights that efforts should be made within sport and exercise science to deliver more diverse and equitable research. **For example, a systematic review of match-play characteristics within women's football included 69 studies of which only 13 of these studies quantified collegiate match demands** (Harkness-Armstrong et al., 2022)**. Of these 13 studies, all were conducted within the National Collegiate Athletics Association (NCAA) system which may not be transferable to other competitions.** The NCAA has 180,000 students supported through scholarships (NCAA, 2014) which is in stark contrast to the 5,569 of the British Universities and Colleges Sport (BUCS) system (Prinz et al., 2023). **Comparative data in male football shows similar distances covered between NCAA division 1 (9,367 ± 2,149) and South African university players (9,329 ± 1,286) however, high intensity running data could not be compared which is likely where discrepancies would be observed** (Dellal et al., 2011; Morgans et al., 2025). It **could be hypothesised that match-play loads could be different between populations, and this should be elucidated for the improvement of coaching and talent development.**

The quantification of football match-play loads is important for practitioners to adequately prescribe training programmes and assess performance to match increasing physical demands (Datson et al., 2017). With rising sports science support and access to technology (e.g. Global Positioning Systems (GPS)) within the women's game, investigations into sub-elite populations such as collegiate are growing (Benjamin et al., 2020; Bohner et al., 2015; Bozzini et al., 2020; Choice et al., 2023; Ishida et al., 2021; Jagim et al., 2020; Lockie et al., 2018; McCormack et al., 2015; Mcfadden et al., 2020; Paulsen et al., 2017; Sausaman et al., 2019; Wells et al., 2015; Williams et al., 2019). Current literature has reported total distances (TD) from 9486 – 10,036 metres, high-speed running (HSR) values of 1014-1080m and sprint distances (SD) of 267 – 428 metres alongside average heart rates (HR) of 142bpm across division 1 and 3 players (Ishida et al., 2021; Jagim et al., 2020; Sausaman et al., 2019; Vescovi & Favero, 2014; Williams et al., 2019). The TD and HSR demands seem to be similar across studies, however (Sausaman et al. (2019) have reported greater SD values than other authors but this may be explained by differences in speed zone classification. Currently, important information on other high intensity actions such as accelerations and decelerations are limited. Jagim and colleagues (2020) investigated high intensity (>3m/s) accelerations (10 ± 5.9) and decelerations (16.5 ± 8.4) performed within division 3 collegiate players. PlayerLoad is another variable that has been shown to be useful in quantifying global exercise load (Vanrenterghem et al., 2017). PlayerLoad is the sum of the accelerations across all axes of the internal tri-axial accelerometer) and is presented in arbitrary units (au) (Oliva-Lozano et al., 2023). PlayerLoads of (905 ± 645 au) were reported by Jagim and colleagues (2020). Taken together, the monitoring of these variables is important to understand and plan workloads and understand responses such as muscle damage (Young et al., 2012).

In comparison to the elite level, TD values are similar to the collegiate level ranging from 9,408 – 10,619m depending on positional group (Scott et al., 2020). However, HSR values (1936 – 2651m) are much greater (Scott et al., 2020). Additionally, elite females have been shown to complete 174 accelerations (>2.26m/s) and 1096au of PlayerLoad. These data underline the difference in physical qualities between levels and further support the need to quantify different competitive levels.

Whilst quantifying average match-play load is important for planning training volumes, dividing the data into set epochs (e.g. 5 minutes) better reflects the intermittent nature of football (Oliva-Lozano et al., 2021) as it accounts for lower, average and peak intensities (e.g. worst-case scenario referred to from herein as high intensity phases (HIP)). Ramos et al. (2017) compared the average versus HIP demands of female **under-20 national team** fixtures, describing the 5-minute values for TD (594-653m vs 463-495m), HSR (69-100m vs 28-45m), sprint distance (SD) (36-61 vs 5-17m), accelerations above 2m/s (2-3 vs 1), decelerations above 2m/s (2-4 vs 1) and PlayerLoad (68-75 vs 49-54au). From a practical standpoint the use of average loads could under prepare players to be able to physically cope with periods of greater intensity (Whitehead et al., 2019), which are often match deciding moments (Delaney et al., 2018). Moreover, Coaches may be interested in these peak periods from a technical and tactical perspective to understand if players are able to perform the density of actions required in a match (e.g. pressing). Outside of elite populations information on match-play loads, in particular high-intensity phases, is scarce. Therefore, it is necessary to create information that can benefit practitioners in providing an evidence base for designing conditioning programmes in university female football. Moreover, there is a need to ensure that girls and women are benefitting from the same quality and quantity of sport and exercise science (Cowley et al., 2021). Thus, the aim of this study was to quantify average match external and internal loads in university female footballers. A secondary aim was to quantify the 5-minute high-intensity phases associated with match-play.

Methods

Participants

Twenty **British** university female footballers (age 20.0 ± 1.3, mass 64.9 ± 12.9 kg, stature 164.9 ± 6.6 cm) with a minimum training age of 2 years in structured football training volunteered to take part in the study. Participants completed two strength and conditioning sessions (~60 minutes) and two pitch-based training sessions (~90 minutes) as part of their normal routine. The average maximal aerobic speed (1200m time trial) for the squad in which the participants were drawn **was 3.41m/s.** Due to the stark differences in locomotion between goalkeepers and outfield players, only the latter were recruited. Positional data was split into the following, central defenders, full backs, central midfielders and attackers **(i.e.,** wingers and strikers). This positional split **allowed** distinction between wide and central players (Griffin et al., 2020). Institutional ethical approval was granted (ETHICS2021-02).

Study design

A longitudinal design was employed to quantify the average and 5-minute high phases of university female footballers. Participants attended the host university's biomechanics laboratory prior to their competitive fixture where they were provided with a GPS unit **(Catapult Vector S7, Australia)** and a heart rate (HR; **Polar H9, Finland**) monitor. Participants completed a 30-minute warm up prior to the match consisting of a 10-minute standardised warm up including dynamic stretches, jumps, and sprints. After this, participants engaged in passing pattern and shooting drills. Data **were** collected from 6 home matches over the course of a competitive season. GPS and HR data was first clipped on the manufacturer's software (Catapult Openfield version 3.7.3 Build#79834) then transferred to custom excel sheets for analysis of average and 5-minute HIP demands.

Match characteristics

The competitive matches were home games played across a **43-week period**. No matches were played with adverse weather conditions (i.e., snow, heavy rain, high winds **etc.),** with an average temperature of 11.1^{o}C **(average temperature for the day taken from online weather reports for the area. Range 7-14^{0}C).** The matches were played at least 7 days apart. The results were **4** wins (13-0, 2-1, 4-0 and **3-1)** and 2 losses (2-1, 4-3). Matches were played on 100m X 65m pitch dimensions on natural (n=2) and synthetic (n=**4**) turf surfaces.

Procedures

External load data collection occurred during the normal competitive fixture schedule. The GPS unit was worn in between the scapula, contained in a purpose made vest. The units were activated prior to the start of the warmup to acquire signal (~30 minutes before kick-off). Observations were classified by the aforementioned positional groups. Whole match GPS data was used to quantify the external load experienced during match-play (total observations, n=45; central defenders, n=12; fullbacks, n=12; central midfielders, n=8; attackers, n=13). This data was then broken down further to find the 5-minute high-intensity demands (highest external load during a 5-minute period) during match-play (central defenders, n=15; fullbacks, n=16; central midfielders, n=13; attackers, n=19). The metrics collected were total distances covered and the speeds at which they were covered. Speeds were operationally defined as standing and walking, 0-6.0km/h; jogging, 6.1-8.0km/h; low-intensity running 8.1-12km/h; moderate-intensity running 12.1-15.5km/h; high-intensity running 15.6-20.0km/h, sprinting >20.0km/h. These speed zones are based off previous work in a similar population (Hearn et al., 2024; Ramos et al., 2017; Vescovi & Favero, 2014). Unfortunately, it was not possible to utilise individualised thresholds however it should be noted that these approaches are not without limitations (Clemente et al., 2023). The study also included PlayerLoad (Barrett et al., 2014; Oliva-Lozano et al., 2023) and the number of high accelerations and decelerations (performed at >3m/s/s). Connection of satellites were examined across all matches finding an average number of satellites of 14.8 ± 1.2 and an average horizontal dilution of precision of 1. These values are indicative of acceptable signal accuracy and satellite connection (Malone et al., 2017).

Internal load data was collected via telemetric HR monitors, worn around the chest, with the sensor placed just below the sternum. **The monitors send HR data once per second and automatically link to the GPS units. When the GPS data is clipped the peak (maximum HR value reached) and average (average value of the whole activity) HR values are given.**

Data analysis

Match analysis dependent variables (i.e., TD, HSR, SD, accelerations, decelerations, PlayerLoad, peak and average HR were inputted into a custom excel spreadsheet (Microsoft, Redmond, USA). The raw censor CSV data was imported to create the 5-minute HIP's for TD, HSR, SD, accelerations and PlayerLoad. Data points are sampled every tenth of a second, rolling averages were created for 5-minute periods across the duration off the match to find the highest demand period. The suitability of the rolling average method has been demonstrated previously (Cunningham et al., 2018). To be included for average match demand analysis, participants were required to complete the whole match (~90 minutes) in the same positional group. For analysis of 5-minute HIP, participants were required to have played at least 60 minutes to be included (Baptista et al., 2019; Bortnik et al., 2023).

Statistical analysis

Data was analysed using Jamovi version 2.3.28 (*The Jamovi Project,* 2018). The data was analysed using linear mixed-models (LMM), to assess differences in average and 5-minute demands. Positional group was included as a fixed effect and opposition and individual players were included as a random effect (Whitehead et al., 2019). The assumptions of the LMM were checked and found to be satisfied. Effect sizes were calculated using the t and df statistics from the post-hoc comparisons using the formula $2t/\sqrt{(df)}$ (Beato et al., 2023). To interpret the effect size the Hopkins scale was used <0.2 = trivial; 0.2-0.59 = small; 0.6-1.19 = moderate, 1.2-1.99 = large and >2 very large (Batterham & Hopkins, 2006). Alpha was set at 0.05.

Results

Average whole match values

Table 1 and 2 **illustrate** the average whole match load and effect size comparisons between positions, respectively. Significant differences were observed between certain positional groups for high-intensity metrics (*p* < .05), whereas TD, metres per minute (m/min), PlayerLoad, accelerations, **peak** HR, and average HR were similar across positional groups (*p* > .05; Table 1). Attacking players performed greater HSR than central defenders (*p* = .032; d = 1.61) and central midfielders (*p* = .013; d = 1.70) with a large effect size. Attackers completed greater SD than central defenders (*p* < .001; d = 2.70), full backs (*p* = 013; d = 2.07) and central midfielders (*p* < .003; d = 2.09) with a very large effect. Attackers also performed more decelerations than central defenders (*p* = .023; d = 1.67) and central midfielders (*p* = .047; d = 1.41) with a large effect.

5-minute high intensity phases

Table 3 and 4 **illustrate** the 5-minute HIP external load and effect size comparisons between positions. HIP data contained less positional differences with the only differences present for high-intensity running metrics. Attackers covered greater HSR (m/min) than central defenders (*p* = .047; d = 1.39) with a large effect size. Attackers also performed greater SD (m/min) compared with central defenders (*p* = .047; d = 1.49) with a large effect.

Table 1 about here.

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Discussion

The purpose of this study was to quantify the average and 5-minute HIP loads of university female football players. These data demonstrate that university female football players 1) on average **complete** TD's of 8160m, 456m of HSR, 151m of SD, 9 accelerations, 17 decelerations and 796au of PlayerLoad at average HR's of 170bpm; and 2) during 5-minute HIP players performed 562m TD, 95m HSR, 2 accelerations, 61 au of PlayerLoad and 42m of SD. The results of this study provide the first quantification of average whole match and 5-minute HIP demands in university female football players.

Average whole match external load data

TD (8160m), HSR (456m) and SD (151m) were lower in this study than reported in division 3 collegiate players (9793m, 1019m, 282m respectively) (Jagim et al., 2020). However, the total distances covered are similar to a study of division 1 females (8310m) (Mcfadden et al., 2020). As in other cohorts, comparison of values can be challenging due to the variety of speed zones deployed (Griffin et al., 2020). For example, both Jagim et al., (2020) and Sausaman et al., (2019) utilised lower thresholds for HSR (>15kmh) and SD (>18-19kmh), which can explain the vast difference in high-intensity running performance compared with the current study. Moreover, the lower thresholds adopted previously could result in an overestimation in the external load completed. Our speed zones align with Vescovi & Favero, (2014), who observed greater high-intensity running values of 813m and 267m in division 1 collegiate players. The values presented in the current study of English university players are lower than observed in NCAA studies (Ishida et al., 2021; Jagim et al., 2020; Junior et al., 2021; Sausaman et al., 2019; Vescovi & Favero, 2014) potentially highlighting the difference between the competitions performance status or athletes physical qualities. Previous studies have demonstrated high intensity running to be discriminant between competition levels in football (Krustrup et al., 2005; Mohr et al., 2003) The discrepancy could also be explained by tactical approaches, for example formation or strategy (i.e. counter attack) could lead to increased high-intensity running (Modric et al., 2020).

The current study also aimed to provide more information on high intensity actions like accelerations and decelerations within of match-play for sub-elite females. Previous reported values of 10 high accelerations (>3m/s/s) and 17 high decelerations (>3m/s/s) in division 3 female football players (Jagim et al., 2020), were similar to the 9 and 17, respectively observed in our study. Again, these results could be explained by the nuances of specific tactics, but alternatively could offer insight into a player's or teams physical capability to perform these actions (Mara et al., 2017). Furthermore, our results recorded average PlayerLoad values of 796au which is lower than the 905au reported by Ishida et al., (2021). Although, Ishida and colleagues reported TD (10,036m) and HSR (1049m) alongside PlayerLoad, their metrics are both higher would explain the higher calculated PlayerLoad.

Analysis of match loads by position showed that attackers performed larger amounts of HSR than central defenders and midfielders. Although shown in collegiate female footballers (Sausaman et al., 2019), at higher levels central midfielders may perform more comparable levels of HSR (Datson et al., 2017). This could be explained by skill level and elite midfielders linking in with attacking players more frequently, leading to covering greater distance at higher speed (Di Salvo et al., 2007). Attackers also performed higher numbers of decelerations compared to central defenders and midfielders which is consistent with previous work (Vigh-Larsen et al., 2018). Attackers performed more SD than every other positional group with very large effect sizes observed. In our study, including wingers within the attacker category may have led to increased differences between positions. Indeed, Jagim and colleagues (2020) found that flank players performed more SD than all other positions, with forwards only different to central defenders. It is generally accepted that positional differences in physical demand are the product of the positional roles played (Modric et al., 2020). Equally, players who have the physical capacity to perform these actions may be more likely to succeed in these positions. Therefore, coaches may target certain performance qualities for players in these positions to maximise their performance and resistance to injury.

Average whole match internal load data

The HR values found in this study are commensurate with those recorded in elite match-play (Mohr et al., 2008; Panduro et al., 2021). Jagim and colleagues (2020) reported average HR's of 142bpm during collegiate match-play that are significantly lower than our results (170.2 ± 2.36**bpm**). The similarity in HR response with elite players despite significantly lower external loads has been observed previously and could be due to differences in training age and aerobic capacity (Dellal et al., 2012). **However, average HR values alone do show the variation in HR response over the course of a match in response to different actions** (Silva et al., 2018)**. For example, female NCAA division 1 players have been reported as spending the majority of a match between 80-90% (~32%) and 90-100% (~33%) of maximum HR** (Mcfadden et al., 2020)**. These data highlight how the fluctuations in HR response across a match may be more useful to determine internal load than arbitrary maximum and average values.**

5-minute high intensity demand periods

Despite greater positional differences being observed for average whole match data, HIPs only displayed differences for HSR and SD between central defenders and attacking players. Positionally this is supported by other work where wide players covered more high intensity running than central positions (Winther et al., 2021). These results make sense as attacking players are often able to accumulate higher values of higher intensity running due to positional demands (Modric et al., 2020). Although the opportunity to perform high intensity running due to tactical reasons could explain these results, players physical capacity could also be **a factor. For example, central defenders** in the present study did not have the physical capacities to perform high intensity running commensurate with the other positional groups.

Currently, the author is not aware of any studies that have quantified 5-minute HIP within university female players, however, a study of elite female under 20's by Ramos and colleagues (2017) found similar HSR values to the current study albeit with slightly higher TD, SD and PlayerLoad. It would be expected that the participants in the Ramos study would display higher values across all metrics as these were taken during international competition which is known to elicit greater high intensity running than domestic competition (Andersson et al., 2010). However, the participants in the current study are older (~ 2 years), this extra time for physical development could offset the difference in competition level between the studies. Quantifying the demand of players across the competition levels is important to support development pathways for players who are wanting to transition to higher levels of competition.

In conclusion, the current study is the first quantification of match-play loads for university female football players including 5-minute HIP which have not been explored previously in this population. This study found that university players cover TD's of 8160m ± 324m. This study found similar positional trends to other populations of elite senior and youth females. Central defenders complete less high intensity running than attackers. Attackers displayed the highest demand for full match demands and 5-minute HIP. Quantifying match-play demands for university players will help coaches and performance staff to understand the loads that players will be subjected to and will need to be prepared for**. Further this demonstrates that the use of collegiate load data would be inappropriate for British university players. These data can be used to design position and HIP specific conditioning programmes.**

Limitations

Despite some novel findings the current study is not without limitations. One of the main limitations of the study is the small subject numbers and match profile that was included in the study. A comparable study by (Ramos et al., 2017) used similar match numbers (7) as this was reflective of the competition studied. The match profile being from a university league means there was reduced opportunities to include high match numbers. **Further, score differential in this study were fairly high with one match being very high (13-0). This could affect loads compared to more competitive leagues where score differentials are lower** (Redwood-Brown et al., 2012)**.** Another limitation that should be addressed is that matches were performed on both natural turf and synthetic pitches. **There is conflicting evidence of the effect of natural and synthetic surfaces on running performance**

(Andersson et al., 2008; Modric et al., 2023; Wundersitz et al., 2021). It is suggested that differences can be observed even between different artificial pitches (Sanchez-Sanchez et al., 2016) suggesting it is likely surface could have an effect. On the other hand, these different surfaces are representative of the competition level studied. Future studies could look to include more than one team which would be beneficial in improving the number of observations and giving a more complete understanding of the competition demands. Further, the present study only included 5-minute epochs, future work could study different time periods to build a more comprehensive understanding of HIP demands at this level.

Disclosure Statement

The authors report no conflicts of interest.

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Figures and Tables

Table 1. ***Average match external and internal load values (Estimated mean ± standard error).***

	CD	FB	CM	A	Comparison
TD **(m)**	7705.0 ± 291.0	8240.0 ± 313.0	8221.0 ± 316.0	8473.0 ± 315.0	CD vs. FB (p=1.000), CD vs. CM (p=.834), CD vs. A (p=.461), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
M/min	79.1 ± 3.23	84.6 ± 3.43	84.6 ± 3.49	86.7 ± 3.46	CD vs. FB (p=1.000), CD vs. CM (p=.807), CD vs. A (p=.510), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
HSR **(m)**	356.0 ± 72.1	472.0 ± 77.0	304.0 ± 79.2	695.0 ± 77.6	CD vs. FB (p=1.000), CD vs. CM (p=1.000), **CD vs. A (p=.032) ***, FB vs. CM (p=.839), FB vs. A (p=.331), **CM vs. A (p=.013) ***
SD **(m)**	70.3 ± 39.9	135.6 ± 41.0	105.4 ± 42.6	294.5 ± 41.2	CD vs. FB (p=.817), CD vs. CM (p=1.000), **CD vs. A (p<.001) ***, FB vs. CM (p=1.000), **FB vs. A (p=.013) ***, **CM vs. A (p=.003) ***
PlayerLoad **(au)**	715.0 ± 55.4	805.0 ± 60.4	838.0 ± 60.1	824.0 ± 60.8	CD vs. FB (p=1.000), CD vs. CM (p=.499), CD vs. A (p=1.000), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
Accelerations (n)	5.58 ± 2.39	9.51 ± 2.59	5.39 ± 2.61	14.1 ± 2.61	CD vs. FB (p=1.000), CD vs. CM (p=1.000), CD vs. A (p=.174), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=.182)
Decelerations (n)	10.5 ± 3.49	17.6 ± 3.74	11.7 ± 3.83	28.2 ± 3.77	CD vs. FB (p=1.000), CD vs. CM (p=1.000), **CD vs. A (p=.023) ***, FB vs. CM (p=1.000), FB vs. A (p=.407), **CM vs. A (p=.047) ***
Peak HR **(bpm)**	197.0 ± 4.41	191.0 ± 4.42	191.0 ± 5.05	197.0 ± 4.42	CD vs. FB (p=1.000), CD vs. CM (p=1.000), CD vs. A (p=1.000), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
Average HR **(bpm)**	170.0 ± 4.16	172.0 ± 4.26	167.0 ± 4.68	172.0 ± 4.29	CD vs. FB (p=1.000), CD vs. CM (p=1.000), CD vs. A (p=1.000), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)

Note: CD, central defender; FB, full back; CM, central midfielder; A, attacker; M/min, metres per minute; **TD, total distance; HSR, high-speed running; SD, sprint distance. Values marked in bold and with * are those comparisons which are significantly different (p < .05).**

Table 2. *Effect size differences between positional groups.*

	CD vs. FB	CD vs. CM	CD vs. A	FB vs. CM	FB vs. A	CM vs. A
TD **(m)**	0.66	0.48	0.94	-0.02	0.30	0.28
M/min	0.66	0.50	0.91	0.00	0.27	0.24
HSR **(m)**	0.55	-0.18	**1.61 ***	-0.74	1.13	**1.70 ***
SD **(m)**	0.80	0.30	**2.70 ***	-0.34	**2.07 ***	**2.09 ***
PlayerLoad **(au)**	0.54	0.56	0.65	0.18	0.12	-0.07
Accelerations (n)	0.55	-0.02	1.19	-0.53	0.68	1.11
Decelerations (n)	0.68	0.08	**1.67 ***	-0.51	1.06	**1.41 ***
Peak HR **(bpm)**	-0.55	-0.37	-0.04	0.00	0.55	0.45
Average HR **(bpm)**	0.14	-0.16	0.16	-0.33	0.03	0.36

Note: CD, central defender; FB, full back; CM, central midfielder; A, attacker; M/min, metres per minute; **TD, total distance; HSR, high-speed running; SD, sprint distance. Values marked in bold and with * are those comparisons which are significantly different (*p* < .05).**

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Table 3. *Positional 5-minute high-intensity values (Estimated mean ± standard error).*

	CD	FB	CM	A	Comparison
TD (m)	533.0 ± 18.6	564.0 ± 19.7	581.0 ± 18.6	571.0 ± 18.7	CD vs. FB (p=1.000), CD vs. CM (p=.098), CD vs. A (p=.691), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
HSR (m)	68.8 ± 14.5	104.6 ± 15.2	83.8 ± 14.6	122.1 ± 14.5	CD vs. FB (p=.404), CD vs. CM (p=1.000), **CD vs. A (p=.047) ***, FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=.266)
Accelerations (n)	1.10 ± 0.356	1.54 ± 0.395	1.24 ± 0.358	2.27 ± 0.368	CD vs. FB (p=1.000), CD vs. CM (p=1.000), CD vs. A (p=.217), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=.365)
PlayerLoad (au)	57.4 ± 3.90	60.0 ± 4.1	65.4 ± 3.92	62.1 ± 3.90	CD vs. FB (p=1.000), CD vs. CM (p=.528), CD vs. A (p=1.000), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
SD (m)	29.0 ± 8.51	42.0 ± 8.63	33.5 ± 8.75	61.7 ± 8.27	CD vs. FB (p=1.000), CD vs. CM (p=1.000), **CD vs. A (p=.047) ***, FB vs. CM (p=1.000), FB vs. A (p=.521), CM vs. A (p=.112)
M/min	107.0 ± 3.73	113.0 ± 3.94	116.0 ± 3.73	114.0 ± 3.75	CD vs. FB (p=1.000), CD vs. CM (p=.098), CD vs. A (p=.691), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)
HSR (m/min)	13.8 ± 2.91	20.9 ± 3.03	16.8 ± 2.92	24.4 ± 2.89	CD vs. FB (p=.404), CD vs. CM (p=1.000), **CD vs. A (p=.047) ***, FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=.266)
Accelerations (n/min)	0.22 ± 0.07	0.31 ± 0.08	0.25 ± 0.07	0.45 ± 0.07	CD vs. FB (p=1.000), CD vs. CM (p=1.000), CD vs. A (p=.217), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=.365)
PlayerLoad (au/min)	11.5 ± 0.78	12.0 ± 0.83	13.1 ± 0.78	12.4 ± 0.78	CD vs. FB (p=1.000), CD vs. CM (p=.528), CD vs. A (p=1.000), FB vs. CM (p=1.000), FB vs. A (p=1.000), CM vs. A (p=1.000)

SD (m/min)	5.80 ± 1.70	8.41 ± 1.73	6.70 ± 1.75	12.34 ± 1.65	CD vs. FB (*p*=1.000), CD vs. CM (*p*=1.000), **CD vs. A (*p*=.047) ***, FB vs. CM (*p*=1.000), FB vs. A (*p*=.521), CM vs. A (*p*=.112)

Note: CD, central defender; FB, full back; CM, central midfielder; A, attacker, M/min, metres per minute; **TD, total distance; HSR, high-speed running; SD, sprint distance. Values marked in bold and with * are those comparisons which are significantly different (p < .05).**

Table 4. *Effect size differences between positional groups.*

	CD vs. FB	CD vs. CM	CD vs. A	FB vs. CM	FB vs. A	CM vs. A
TD (m)	0.62	0.75	0.76	0.34	0.15	-0.20
HSR (m)	0.94	0.30	**1.39 ***	-0.53	0.49	0.97
Accelerations (n)	0.38	0.10	1.02	-0.25	0.68	0.88
PlayerLoad (au)	0.22	0.52	0.41	0.46	0.20	-0.27
SD (m)	0.59	0.15	**1.49 ***	-0.36	0.96	1.19
M/min	0.62	0.75	0.76	0.34	0.15	-0.20
HSR (m/min)	0.94	0.30	**1.39 ***	-0.53	0.49	0.97
Accelerations (n/min)	0.38	0.10	1.02	-0.25	0.68	0.88
PlayerLoad (m/min)	0.22	0.52	0.41	0.46	0.20	-0.27
SD (m/min)	0.59	0.15	**1.49 ***	-0.36	0.96	1.19

Note: CD, central defender; FB, full back; CM, central midfielder; A, attacker; M/min, metres per minute; **TD, total distance; HSR, high-speed running; SD, sprint distance.** Values in bold and marked with * are those comparisons which are significantly different ($P < 0.05$).