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Repeated high-speed running in elite female soccer players during international competition

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ABSTRACT

The purpose of the present study was to provide a detailed analysis of the repeated high-speed demands of competitive international female soccer match-play. A total of 148 individual match observations were undertaken on 107 outfield players in competitive international matches during the 2011-2012 and 2012-2013 seasons, using a computerized tracking system (STATS, Leeds, England). High-speed activity was classified as either sprint activity (SA) or high-speed running (HSR), with thresholds of >25.1 km.h^{-1} or >19.8 km.h^{-1} applied respectively. Repeated sprint activity (RSA) was defined as a minimum of two sprints with 20 s or less recovery between sprints and repeated high-speed activity (RHSA) was defined as a minimum of two high-speed runs or sprints with 20 s or less recovery between efforts. HSR bouts occurred ~5 times more frequently than SA bouts. Central defenders completed ~50-80 fewer HSR bouts (moderate count ratio (CR): range 0.61-0.70) and ~10-20 fewer SA bouts (moderate CR: range 0.53-0.69) than all other playing positions. RSA bouts occurred less frequently than RHSA bouts (33 ± 10 v 1.1 ± 1.1) with 37 % of players failing to complete any RSA bouts. Central defenders completed fewer RHSA bouts compared to all other playing positions (moderate CR: range 0.57-0.69). Consideration of both RHSA and RSA bouts is necessary to ensure a comprehensive understanding of the demands of female match-play. Practitioners can utilise this

information to construct position-specific training and testing programmes which are aligned to the RHSA demands of match-play for elite female players.

INTRODUCTION

High-speed activity consisting of running, high-speed running (HSR) and sprinting is considered an integral component of soccer performance (Bradley et al., 2009; Di Salvo, Gregson, Atkinson, Tordoff & Drust, 2009). This stems from findings which demonstrate that isolated and repeated bouts of HSR frequently precede crucial moments within match-play (Taylor, Macpherson, Spears & Weston, 2015), such as the movements required to win the ball and to evade the opposition (Faude, Koch & Meyer, 2012; Stølen, Chamari, Castagna & Wisløff, 2005). High-speed activity has also been shown to differ between standards of competition (Andersson, Randers, Heiner-Møller, Krustrup & Mohr, 2010; Rampinini et al., 2010) and the tactical role of the player (Bradley, Di Mascio, Peart, Olsen & Sheldon, 2010; Carling, Le Gall, & Du Pont 2012; Datson et al., 2017).

Available data on repeated high-speed activity in female soccer match-play are both limited and highly variable (repeated sprint activity (RSA), n = 2-25; repeated high-speed activity (RHSA), n = 27-297) (Gabbett, Wiig & Spencer, 2013; Mara, Thompson & Pumpa, 2016; Nakamura et al., 2017). The high variability likely reflects differences in operational definitions (i.e. the use of different speed thresholds), methods of data collection and the standard of competition examined. Recent research has questioned the importance of RSA due to its infrequent occurrence in match-play (~2 bouts per match) (Schimpchen, Skorski, Nopp & Meyer, 2016; Taylor, Macpherson, Spears & Weston, 2016). RSA has traditionally been defined as a minimum of three sprints, with a mean recovery duration between sprints of less than 21 s (Spencer et al., 2004). However, in an attempt to provide a more comprehensive representation of the patterns of high-speed activity within team sports, recent research (Buchheit, Mendez-Villanueva, Simpson & Bourdon, 2010; Carling et al., 2012; Gabbett et al., 2013) has moved towards a different definition of RSA through the inclusion of a minimum of two sprints and the lowering of the speed threshold to include HSR activity. As a consequence, such changes to the traditional definition of RSA will serve as a further source of variability between existing observations on repeated high-speed activity in female soccer.

Alongside variability in methodology, a major limitation of existing data surrounds the limited observations on elite players. International female match-play represents the highest standard within the female game and requires an increased physical demand compared to domestic match-play (Andersson et al., 2010; Datson et al., 2017; Gabbett & Mulvey, 2008). To date, only one study has documented the RHSA of female players in competitive international match play (Gabbett et al., 2013). However, these observations are limited by the small sample of players studied (n=13) which restricts the ability to analyse by playing position. Furthermore, the use of a traditional video-based time motion analysis system limited the depth of analysis permitted.

Understanding the varied and most demanding patterns of high-speed activity within match-play is important from both a performance capability and an injury prevention perspective (Dawson, 2012). The physiological demands associated with performing RHSA will differ to RSA and substantially increase the contribution to the energy cost of competition, despite failing to qualify as a RSA (Gabbett et al., 2013; Iaia & Bangsbo, 2010). As a consequence, an appreciation of the global requirements of isolated and repeated high-speed activity will have implications for the type of training prescription and performance assessment required. It has been suggested that training programmes which prepare the player to tolerate the "worst case scenario" during match-play might be considered an effective strategy (Dawson, 2012). Furthermore, such training programmes are deemed an efficient method of training as they have been shown to simultaneously improve speed, power and high-intensity running performance in team sport players (Taylor et al., 2015). Such approaches may also prove effective from an injury prevention perspective as it has previously been demonstrated that reduced recovery between high-intensity efforts during match-play may be associated with an increased risk of injury (Carling, Le Gall & Reilly, 2010). Furthermore, high-speed training has also been shown to offer protective benefits to players by reducing subsequent injury risk (Malone et al., 2017).

The aim of the current investigation therefore was to provide a detailed analysis of position-specific RSA and RHSA activity in a large sample of female soccer players during competitive international match-play. Such information is necessary to assist applied practitioners with informing training prescription, performance assessment and the overall preparation of players to perform while minimising the risk of injury.

METHODS

SUBJECTS

To quantify the RSA and RHSA demands of competitive international female match-play, physical performance data were collected during the 2011-2012 and 2012-2013 seasons. Data were derived from ten matches, featuring thirteen teams playing in different stadiums across Europe.

A total of 148 individual match observations were undertaken on 107 outfield players (goalkeepers were excluded) with a median of two matches per player (range = 1-4). Data were only included for those players completing entire matches (i.e. 90 minutes). Data were collected as a condition of employment in which player performance is routinely measured during match-play (Winter & Maughan, 2009). Therefore, usual appropriate ethics committee clearance was not required. Nevertheless, to ensure team and player confidentiality, all physical performance data were anonymised before analysis. Permission to publish this data was granted by STATS (formerly Prozone Sports Ltd., Leeds, UK). Data collection and analysis were approved by Liverpool John Moores University.

METHODOLOGY

Match physical performance data were collected using a computerised semi-automated multi-camera image recognition system (STATS, Leeds, UK). This system provides valid (Di Salvo, Collins, McNeil & Cardinale, 2006) and reliable (Di Salvo et al., 2009) estimations of a variety of match performance indices. Players were categorised by playing position; central defenders (CD) (n = 25; 35 match observations), wide defenders (WD) (n = 28; 34 match observations), central midfielders (CM) (n = 31; 40 match observations), wide midfielders (WM) (n = 17; 20 match observations) and attackers (A) (n = 16; 19 match observations) to determine the influence of playing position on RSA and RHSA.

High-speed running (HSR) and sprint activity (SA) were defined as efforts over >19.8 $km.h^{-1}$ and >25.1 $km.h^{-1}$, respectively. Repeated sprint activity was defined as a minimum of two sprints with 20 s or less recovery between sprints and RHSA was defined as a minimum of two high-speed runs or sprints with 20 s or less recovery between efforts (Gabbett et al., 2013). These velocity thresholds for RSA and RHSA have been extensively employed to quantify the physical demands of male match-play (Bradley et al., 2010; Di Salvo et al., 2009). While we acknowledge that individualisation of velocity thresholds significantly alters high-speed running performance (Murray, Gabbett & Townshend, 2017), this process has recently been shown to add no further value in our understanding of dose-response (Scott & Lovell, 2017). Multiple repeated high-speed efforts were analysed up to a maximum of six efforts (Gabbett et al., 2013). The recovery duration between efforts were also examined.

STATISTICAL ANALYSIS

Data are presented as mean ± standard deviation (SD). Data were analysed using the Statistical Package for Social Sciences (Version 21). For the analysis of continuous variables, we used the general mixed linear model with distance per effort (RHSA, RSA) and recovery duration (HSR, RHSA, RSA) as fixed effects and player entered as a random effect with a random intercept to account for the repeated measurements. For the analysis of our count data, we used the generalised mixed linear model (Poisson loglinear). Fixed effects in the model were total number of single efforts (HSR, SA), total number of repeated bouts (RHSA, RSA) and the number of instances where a recovery occurred within a specified timeframe (<10 s, 10-19 s, 20-29 s, 30-60 s and > 60 s). Player was again entered as a random effect to account for the repeated measures. Mean differences are presented with 95% confidence limits (CL) as markers of uncertainty in the estimates. Standardised thresholds of 0.2, 0.6, 1.2, 2.0 and 4.0 multiplied by the pooled between-player SD were used to anchor small, moderate, large, very large and extremely large differences for continuous variables (Hopkins, Marshall, Batterham & Hanin, 2009). Thresholds of 1.11, 1.43, 2.0, 3.3 and 10 and their inverses 0.9, 0.7, 0.5, 0.3 and 0.1 were used to anchor small, moderate, large, very large and extremely large differences for count data (Hopkins et al., 2009).

RESULTS

HIGH-SPEED AND REPEATED HIGH-SPEED ACTIVITY

TOTAL MATCH PERFORMANCE

The number of isolated (HSR and SA) and repeated high-speed bouts (RHSA and RSA) along with playing position differences are shown in Table 1. In general, players completed ~5 times more HSR than SA. Central defenders completed ~50-80 fewer HSR bouts (moderate Count Ratio (CR): range 0.61-0.70) and ~10-20 fewer SA bouts (moderate CR: range 0.53-0.69) than all other playing positions.

Overall, the number of RHSA bouts was ~30 times higher than the number of RSA bouts. Central defenders completed fewer RHSA bouts (22 bouts) compared to all other playing positions

(33-40 bouts) (moderate CR: range 0.57-0.69). The frequency of RSA was low for all positions (~1). Some playing position differences were observed for the mean distance per RHSA and RSA. Central defenders completed shorter efforts for RHSA (moderate ES: range 0.83-1.10) compared to wide players (WD and WM) and A. Attackers completed shorter efforts for RSA (moderate ES: range 0.63-0.78) compared to defenders (WD and WM) and CD. These differences equated to a maximum distance of 1.1 m for RHSA and 0.8 m for RSA (Table 1).

******Table 1 near here******

MULTIPLE REPEATED HIGH-SPEED EFFORTS

The number of RHSA and RSA bouts consisting of multiple efforts, along with playing position differences are shown in Table 2. As the number of efforts per repeated bout increased, the frequency of RHSA and RSA bouts was reduced. Bouts consisting of two efforts were more common than those of three or more efforts for RHSA (large – very large CR: range 2.1-4.3). Similarly, bouts consisting of two or three efforts were more common than those of four or more efforts for RSA (large CR: range 2.3-2.4).

******Table 2 near here******

RECOVERY DURATION BETWEEN HIGH-SPEED AND REPEATED HIGH-SPEED ACTIVITY

The recovery duration between isolated and repeated bouts per playing position are shown in Table 3. The recovery duration between HSR efforts was generally similar between playing positions, except for CD where recovery duration was greater by 14-19 s (large – very large ES: range 1.5-2.2).

The recovery duration between RHSA bouts was ~4 times shorter than RSA bouts. Attacking-based players (CM, WM, and A) had a similar recovery duration between RHSA bouts, which was 24-29 s shorter than WD (small – moderate ES: range 0.55-0.62) and 94-99 s shorter than CD (large ES: range 1.8-1.9). Attackers had the shortest recovery duration between RSA bouts, which was 200-293 s shorter than CM, WM and WD (small – moderate ES: range 0.43-0.74). It was not possible to consider the duration between RSA bouts for CD due to the infrequent occurrence of these events, indeed 37 % of all players failed to complete any RSA bouts.

The frequency of different recovery durations between HSR efforts along with playing position differences are shown in Table 4. Recovery durations that were less than 10 s occurred more frequently than any other recovery duration. In general, a recovery duration of less than 10 s occurred 4-5 times more often than 10-19 s and 20-29 s and twice as often as 30-60 s or >60 s. Midfielders (CM and WM) had the highest occurrence of very short duration recoveries (<10s and 10-19s) and CD the least (large CR: range 0.45-0.50). Similarly, the occurrence of a longer duration recovery (30-60s) was ~1.5 times lower in CD compared to all other playing positions (moderate CR: range 0.61-0.64). The frequency of recovery durations >60 s were very similar between all playing positions (trivial CR: range 0.97-1.05).

******Table 3 and 4 near here******

DISCUSSION

The present study is the first to utilise contemporary match analysis techniques to provide a detailed examination of isolated and repeated high-speed bouts across different playing positions in a large sample of elite soccer players during competitive international match-play. HSR and RHSA bouts occurred more frequently than SA and RSA respectively. Repeated bouts consisting of two efforts were the most frequent for both RHSA and RSA. Marked positional differences were observed across the majority of metrics which were primarily a result of differences between CD and other playing positions. Collectively the current data provide practitioners with a detailed insight into the repeated high-speed activity demands of different positions in elite female players. Such insights can assist practitioners with constructing appropriate performance assessments, as well as help inform the design and delivery of training programmes which prepare players for the "worst case scenario" (Dawson, 2012) demands of competition whilst minimising the risk of injury (Malone et al., 2017).

In the present study, the number of RSA bouts was generally low across all playing position (~1 per match; range 1-5) with ~40 % of the sample performing no RSA bouts. Previous studies on both domestic and international level female players, have reported a much higher (5-25 bouts) frequency of RSA (Gabbett et al., 2013; Mara et al., 2016; Nakamura et al., 2017). The only other study to date that has examined RSA in international female match-play (Gabbett et al., 2013) used a traditional video-based analysis system. It has previously been suggested that the use of such systems might over-estimate RSA (Gabbett & Mulvey, 2008) due to the subjective nature of the observer visually identifying different match-play activities (Bradley, Lago-Penas, Rey & Gomez Diaz, 2013). Other factors responsible for a higher frequency of RSA reported in previous studies are likely due to methodological differences, with previous studies on domestic players selecting a lower threshold for sprint activity (~19-20 $km.h^{-1}$ compared to 25.2 $km.h^{-1}$ in the current study) (Nakamura et al., 2017) and a greater recovery duration between sprints (60 s compared to 20 s in the current study) (Nakamura et al., 2017).

Recent studies (Buchheit et al., 2010; Carling et al., 2012; Gabbett et al., 2013) have altered the traditional RSA definition to include high-speed running as well as sprinting activity. This change helps to provide a more practically valid representation of the repeated high-speed demands of match-play, as such efforts make a substantial contribution to the energy cost of competition, despite failing to qualify as a RSA (Gabbett et al., 2013). The number of RHSA bouts in the present study (33 bouts) was similar to those previously reported during international female match-play (31 bouts) (Gabbett et al., 2013). The present study extends the findings of Gabbett et al. (2013) and is the first to examine positional differences in RSA and RHSA during competitive international female match-play. CD completed fewer RHSA bouts (~20 bouts) compared to all other playing positions with the remaining positions completing a similar number of bouts (~30-40 bouts). Previous studies have also observed that CD completed fewer repeated sprint sequences (>20 $km.h^{-1}$) during domestic female match-play (Nakamura et al., 2017). The positional differences highlighted in the present study are likely attributed to the match-load of CD being largely limited to defensive actions and the relatively small area of the pitch in which they operate, which likely reduces the ability to reach the high-speed velocity threshold. This justification is also supported by lower HSR and sprint distances observed in CD relative to other players (Datson et al., 2014; Mara et al., 2016).

The traditional definition of RSA was introduced in field hockey and considered three or more sprints with a short recovery (≤21 s) between efforts (Spencer et al., 2004). This definition has since been applied to male (Carling et al., 2012) and female soccer (O'Donoghue, Minnis & Harty, 2004). However, use of this definition eliminates the consideration of consecutive efforts which may also be physically demanding (Gabbett et al., 2013) and as such some studies have opted to alter the traditional definition to include two or more sprints (Buchheit et al., 2010; Gabbett et al., 2013). The present study analysed repeated bouts based on the number of efforts per bout (2-6 efforts) and observed that as the number of efforts per RSA and RHSA bout increased, the number of instances decreased. Two efforts per bout were the most common for both RHSA (~17 per match) and RSA (~1 per match). The maximum number of efforts per bout observed were six for RHSA and four for RSA. This trend was also previously reported by Gabbett et al. (2013).

The present study is the first to provide a detailed examination of the recovery duration between single HSR efforts in international female match-play. A comparison with previous research is limited due to their use of a greater minimum time period (1 s) to detect the occurrence of efforts compared to the current study (0.5 s) (Buchheit et al., 2010; Carling et al., 2012; Nakamura et al., 2017; Schimpchen et al., 2016). Other studies (Mara et al., 2016; O'Donoghue et al., 2004) have failed to include the minimum time period for activity to be classified as a HSR and therefore it is unclear as to whether direct comparisons to these studies are permissible. Nevertheless, mean duration between HSR efforts (~40 s) in the present study was similar to those previously reported for domestic level female match-play (~44 s) when using a simplistic visual live coding system (O'Donoghue et al., 2004). In contrast, a marked increase in the mean recovery duration between high-speed efforts (~119 s) was reported in a more recent examination of domestic match-play when data were derived using an optical player tracking system (Mara et al., 2016). These differences may be a result of the increased physical demand of international compared to domestic match-play (Andersson et al., 2010; Datson et al., 2017; Gabbett & Mulvey, 2008) or indeed they may be attributed to methodological differences between studies. The mean recovery duration reported in the current study (~40 s), is reflective of the fact that the two most frequent classifications of recovery duration were <10 s and > 60 s.

The mean duration between HSR efforts in the current study was generally similar between playing positions except for CD. The increased duration between efforts in CD is likely attributed to the reduced total high-speed distance covered (>19.8 $km.h^{-1}$) in this position (Datson et al., 2017). This finding supports recent research in domestic-level female players (Nakamura et al., 2017) but is contradictory to other research that highlights midfielders demonstrate the longest durations between sprints (Vescovi, 2012). These differences may be partly explained by the fact that previous studies have used generic positional groups (Vescovi, 2012) by combining CD and WD and CM and WM. Positional differences were also currently observed across the different durations of recovery between HSR efforts. Short duration recoveries (<20 s) were more common in CM and WM with longer recoveries (>60 s) more common in CD. These observations are similar to previous reports in male match-play (Carling et al., 2012) and are likely a consequence of differences in the tactical requirements of each position. The role of the midfield player (CM and WM) is to support both attacking and defensive activities and therefore the duration between high-speed involvements is likely to be shorter than other positions, conversely CD’s are predominantly only involved in defensive activities and therefore the requirements for high-speed activity may be interspersed with long recovery periods.

Throughout this paper we have attempted to highlight the varied patterns of RHSA and RSA in elite female players. Whilst it is interesting to consider the typical or average demands of repeated high-speed bouts, it is perhaps more relevant to consider the maximum demands, or "worst case scenario" (Dawson, 2012). This ensures the required information is available to inform the development of training programmes which not only enhance the players ability to perform during the most intense periods of match-play, but which also minimise the risk of injury associated with such activities (Carling et al., 2010; Malone et al., 2017). Furthermore, the incorporation of isolated and repeated bouts of high-speed training are deemed an efficient method of training, as inclusion of such activities have been shown to simultaneously improve speed, power and high-intensity running performance in team sport players (Taylor et al., 2015).

This approach appears to have more ecological validity and significance for practitioners rather than preparing players to meet the average demands of competition (Dawson, 2012). For example, whilst RHSA bouts consisting of two efforts were the most common, players still completed up to a maximum of six efforts per bout. Similarly, the present study highlighted a mean recovery duration between HSR efforts of ~40 s; however, over 40 % of all recovery durations recorded were less than 10 s. Appreciation of these observed match-play work-to-rest ratios as are imperative for translation to training prescription (O'Donoghue et al., 2005). Furthermore, awareness of key positional differences enable further specificity and ecological validity of training programmes. For example, CD complete less short duration (<10 s) recoveries (34 %, compared to 40-43 %) and more long duration (>60 s) recoveries (33 %, compared to 19-23 %) compared to other playing positions.

Finally, the findings from this study may also have implications for the validity of current popular repeated sprint assessments (e.g. 6 sprints of 20-30 m distance) (Mujika, Spencer, Santisteban, Goiriena & Bishop, 2009; O'Donoghue et al., 2005). The present data highlight that 2-3 effort RHSA (> 19.8 $km.h^{-1}$) bouts of ~6 m occur most frequently during international female match-play, with maximum requirements of 4 effort RSA of ~5 m observed. As such, it could be argued that future physical performance assessments be adapted, by possibly reducing the number and distance of efforts, to ensure they are more closely aligned with match demands. However, the time and distance required for player's to reach high-speeds shoud be considered when planning future performance assessments.

PRACTICAL APPLICATIONS

The present findings are of direct relevance to applied practitioners responsible for the physical development of elite female players. Several positional differences were observed between CD and other playing positions. CD completed ~68 %, ~57 % and ~69 % less RHSA bouts, HSR efforts and SA efforts respectively. Positional differences were also evident for recovery duration with ~45 % and ~62 % longer durations between HSR efforts and RHSA in CD compared to all other playing positions. These findings suggest that practitioners may wish to consider different training regimes for different positional subsets. The present study highlights an average recovery duration of ~40 s between HSR, yet ~40 % of all recoveries are less than 10 s. Similarly, repeated bouts of high-speed activity consisting of two efforts occur most frequently, yet instances of 6-effort RHSA bouts and 4-effort RSA bouts were also observed. This appreciation of both the average and maximum demands of match-play are important in order for practitioners to prescribe effective training programs.

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Table 1 Between position comparisons and inferential statistics (count ratios and effect sizes ± 95 % confidence limits) for the number of HSR (>19.8 km.h^{-1}) and SA (>25.1 km.h^{-1}) efforts as well as the total number of RHSA and RSA bouts and distance covered per bout during elite female soccer match-play (mean ± SD)

		CD	WD	CM	WM	A	All Outfield	Count ratios with ±95% confidence limits
Total number of efforts	**HSR**	119 (22)	170 (45)	190 (46)	197 (46)	189 (36)	169 (49)	**Moderate:** WM, CM, A, WD v CD (0.61; ±0.1, 0.63; ±0.1, 0.63; ±0.1, 0.70; ±0.1) **Small:** WM, CM, A v WD (0.86; ±0.1, 0.89; ±0.1; 0.90; ±0.1) **Trivial:** WM v CM (0.97; ±0.1), CM, WM v A (1.0; ±0.1; 1.0; ±0.1)
	SA	22 (6.9)	32 (14)	35 (12)	40 (14)	42 (8.4)	33 (13)	**Moderate:** A, WM, CM, WD v CD (0.53; ±0.1, 0.55; ±0.1, 0.63; ±0.1, 0.69 ±0.1) **Small:** A, WM v WD (0.77; ±0.1, 0.80; ±0.1), A, WM v CM (0.83; ±0.1, 0.87 ±0.1) **Trivial:** CM v WD (0.91; ±0.1), A v WM (0.96; ±0.1)
Total number of repeated bouts	**RHSA**	22 (5)	33 (8)	38 (8)	40 (9)	37 (9)	33 (10)	**Moderate:** WM, CM, A, WD v CD (0.57; ±0.1, 0.59; ±0.1, 0.62; ±0.1, 0.69; ±0.1) **Small:** WM, CM, A v WD (0.82; ±0.1, 0.86; ±0.1, 0.89 ±0.1) **Trivial:** WM v A, CM (1.08; ±0.1, 0.96; ±0.1), CM v A (1.04; ±0.1)
	RSA	0.6 (0.7)	0.9 (0.9)	1.6 (1.2)	1.4 (1.3)	1.4 (1.4)	1.1 (1.1)	**Large:** CM, WM, A v CD (0.36; ±0.1, 0.42; ±0.2, 0.42; ±0.2) **Moderate:** WD v CD (0.67; ±0.3), CM, A, WM v WD (0.54; ±0.2, 0.62; ±0.3, 0.63; ±0.3) **Small:** CM v WM, A (1.17; ±0.5, 1.15; ±0.5) **Trivial:** A v WM (0.99; ±0.5)
								Effect Sizes with ±95% confidence limits
Distance per effort during repeated bouts (m)	**RHSA**	5.9 (1.0)	6.8 (0.9)	6.3 (0.9)	7.0 (1.5)	6.9 (0.7)	6.5 (1.1)	**Moderate:** A, WD, WM v CD (1.1; ±0.2, 0.96; ±0.21, 0.83; ±0.20), CM v A (0.71; ±0.20) **Small:** WD v CM (0.58; ±0.20) CM v WM (0.54; ±0.2), CM v CD (0.42; ±0.20) **Trivial:** WD v WM (0.12; ±0.19), WD, WM v A (0.06; ±0.19, 0.08; ±0.19)
	RSA	5.1 (1.4)	5.0 (1.4)	4.8 (1.4)	5.0 (1.2)	4.3 (0.6)	4.9 (1.3)	**Moderate:** WM, CD, WD v A (0.78; ±0.20, 0.76; ±0.20, 0.63; ±0.20) **Small:** CM v A (0.49; ±0.20), CD v CM (0.20; ±0.20) **Trivial:** WM, WD v CM (0.15; ±0.19, 0.10; ±0.19), CD v WD, WM (0.10; ±0.19, 0.07; ±0.19), WM v WD (0.04; ±0.19)

Table 2 Frequency of RHSA and RSA bouts comprising differing numbers of efforts (2-6) (mean ± SD) along with inferential statistics (count ratios ± 95 % confidence limits) during elite female soccer match-play (mean ± SD)

		Number of Efforts					
		2	**3**	**4**	**5**	**6**	**Count ratios with ±95% confidence limits**
Total number of repeated bouts	**RHSA**	16.7 (4.5)	8.4 (3.5)	4.1 (2.5)	2.0 (1.7)	1.8 (2.1)	**Very Large:** 2 v 5, 6, 4 (4.3; ±0.2, 4.2; ±0.2, 3.4; ±0.1) **Large:** 3 v 5, 6 (2.3; ±0.1, 2.3; ±0.1), 2 v 3 (2.1; ±0.1) **Small:** 3 v 4 (1.4; ±0.1) **Trivial:** 4 v 6, 5 (1.0; ±0.1, 1.0; ±0.1), 5 v 6 (1.0; ±0.1)
	RSA	1.0 (1.1)	0.8 (0.27)	0.01 (0.08)	N/A	N/A	**Large:** 2, 3 v 4 (2.4; ±0.2, 2.3; ±0.1) **Small:** 3 v 2 (1.2; ±0.1)

Table 3 Between position comparisons and inferential statistics (effect size ± 95 % confidence limits) for the mean recovery duration between HSR (>19.8 km.h^{-1}) efforts and the recovery duration between RHSA and RSA bouts during elite female soccer match-play (mean ± SD)

		CD	WD	CM	WM	A	All Outfield	Effect sizes with ±95% confidence limits
Recovery Duration (s)	**HSR**	54 (9.1)	40 (9.3)	36 (8.8)	35 (8.1)	38 (8.3)	41 (12)	**Very Large:** WM, CM v CD (2.2; ±0.3, 2.1; ±0.2) **Large:** A, WD v CD (1.9; ±0.2, 1.5; ±0.2) **Small:** WM, CM v WD (0.58; ±0.20, 0.51; ±0.20) WM v A (0.31; ±0.20), A v WD (0.28; ±0.20), CM v A (0.25; ±0.20) **Trivial:** WM v CM (0.05; ±0.19)
Recovery Duration Between Bouts (s)	**RHSA**	236 (62)	166 (52)	141 (40)	137 (42)	142 (35)	169 (62)	**Large:** A, WM, CM, WD v CD (1.9; ±0.2, 1.8; ±0.2, 1.8; ±0.2, 1.2; ±0.2) **Moderate:** WM v WD (0.62; ±0.20) **Small:** CM, A v WD (0.56; ±0.20, 0.55; ±0.20) **Trivial:** WM v A, CM (0.12; ±0.19, 0.08; ±0.19), CM v A (0.04; ±0.19)
	RSA	N/A	834 (544)	697 (564)	790 (822)	497 (351)	700 (547)	**Moderate:** A v WD (0.74; ±0.20) **Small:** A v WM, CM (0.46; ±0.20, 0.43; ±0.20), CM v WD (0.25; ±0.20) **Trivial**: CM v WM (0.13; ±0.19), WM v WD (0.06; ±0.19)

Table 4 Between position comparisons and inferential statistics (count ratios ± 95 % confidence limits) for the frequency of different recovery durations between HSR efforts during elite female soccer match-play (mean ± SD)

	CD	WD	CM	WM	A	All Outfield	Count ratios with ±95% confidence limits
<10 s	32 (11)	54 (19)	65 (23)	64 (21)	56 (16)	53 (22)	**Large:** CM, WM v CD (0.49; ±0.1, 0.50; ±0.1) **Moderate:** A, WD v CD (0.56; ±0.1, 0.59 ±0.1) **Small:** CM, WM v WD (0.83; ±0.1, 0.84; ±0.1), CM, WM v A (1.16; ±0.2, 1.14; ±0.2) **Trivial:** CM v WM (1.01; ±0.2)
10-19 s	8 (3)	13 (6)	17 (6)	17 (6)	15 (6)	14 (7)	**Large:** CM, WM v CD (0.45; ±0.1, 0.46 ±0.1) **Moderate:** A, WD v CD (0.52; ±0.1; 0.57; ±0.1) **Small:** CM, WM v WD (0.78; ±0.1; 0.81; ±0.2), CM, WM v A (1.17; ±0.2, 1.13; ±0.2) **Trivial:** A v WD (0.91; ±0.2), WM v CM (1.03; ±0.2)
20-29 s	7 (3)	10 (5)	14 (5)	12 (5)	13 (4)	11 (5)	**Moderate:** CM, A, WM, WD v CD (0.51; ±0.1, 0.55; ±0.1, 0.57; ±0.1, 0.69; ±0.1) **Small:** CM, A, WM v WD (0.74; ±0.1, 0.79; ±0.1, 0.83; ±0.2), CM v WM (1.12; ±0.2) **Trivial**: CM v A (1.07; ±0.1), A v WM (0.95; ±0.2)
30-60 s	17 (5)	24 (7)	27 (8)	29 (7)	27 (8)	24 (8)	**Moderate:** WM, CM, A v CD (0.61; ±0.1, 0.64; ±0.1, 0.64; ±0.1) **Small:** A, CM, WM v WD (0.88; ±0.1, 0.87; ±0.1, 0.83; ±0.1), WD v CD (0.73; ±0.1) **Trivial**: A, CM v WM (1.06; ±0.2, 0.96; ±0.1), A v CM (1.01; ±0.1)
>60 s	31 (3.5)	30 (3.3)	29 (3.4)	30 (3.8)	30 (3.5)	30 (3.4)	**Trivial:** CD v CM (1.05; ±0.0), A, WD, WM v CM (0.97; ±0.1, 1.03; ±0.0, 0.98; ±0.1), CD v WM, A, WD (1.02; ±0.1, 1.02; ±0.1; 1.01; ±0.1), A, WM v WD (0.97; ±0.1, 0.98; ±0.1, A v WM (0.99; ±0.1)