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The Influence of Short-term Fixture Congestion on Position Specific Match Running Performance and External Loading Patterns in English Professional Soccer.

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Running head:

The effect of fixture congestion on running and external loading in soccer

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Abstract

The aim of the current study was to investigate positional specific physical performance and external load responses to short term fixture congestion in English professional soccer. A total of 515 match observations were categorised as *G1*: the first game in a week with >4 days following a previous game, *G2*: the second game in a week played <4 days since G1, and *G3*: the third game in a week played with <4 days between each of the previous games. Global positioning system and accelerometer-based metrics were partitioned into fifteen-minute epochs. These data were then analysed using a linear mixed model to assess both the within and between game positional differences. Total, low-intensity (<4.0m·s^{-1}), medium-intensity (MID; 4.0-5.5m·s^{-1}), and sprint distance (>7.0m·s^{-1}) were significantly different across games. No between game positional differences were identified; however, within match position specific differences were observed for measures of MID and HID. No significant differences were evident for accelerometer derived metrics between games or across positions. The current data suggests that the use of fifteen minute within game epochs enables the detection of alterations in physical output during congested schedules. The observed within game positional differences has implications for player specific conditioning and squad rotation strategies.

Introduction

Soccer players are regularly required to compete in two matches per week, with some teams completing as many as three matches in a weekly microcycle (Carling & Dupont, 2011; Carling, Le Gall, & Dupont, 2012; Dellal, Lago-Peñas, Rey, Chamari, & Orhant, 2015; Odetoyinbo, Wooster, & Lane, 2009). Competing in up to three games in a seven day period leaves limited recovery time between fixtures, thus resulting in residual fatigue and increased injury risk (Bengtsson, Ekstrand, Waldén, & Hägglund, 2013; Carling, McCall, Le Gall, & Dupont, 2016; Dellal et al. 2015; Dupont et al. 2010). Previous studies from French (Djaoui et al. 2014; Dupont et al. 2010; Carling and Dupont, 2012), Spanish (Rey, Lago-Penãs, Lago-Ballesteros, Casáis, & Dellal, 2010; Lago-Peñaz, Rey, Lago-Ballesteros, Casais & Domínguez, 2011), and Polish (Andrzejewski, Konarksi, Chmura, & Pluta, 2014) elite soccer have consistently identified that physical performance is maintained when two or three games are completed in a weekly microcycle. The observed increase in injury risk may therefore be related to fatigue induced reductions in a players capacity to cope with a maintenance of physical performance.

It is widely accepted that the style of play, tactics, and the physicality of match play differ considerably across elite leagues and, as such, although there appears to be somewhat of a consensus associated with the influence of fixture congestion on physical performance, these data should be considered with respect to the league from which the data has been recorded. When considering literature associated with English soccer, to the author's knowledge, only two papers have previously been conducted (Folgado, Duarte, Marques, & Sampaio, 2015; Odetoyinbo et al., 2009), with these studies also reporting equivocal findings. The lack of literature associated with English soccer seems somewhat surprising, especially when considering criticisms of the potential increased occurrence of congested fixture schedules due to the current lack of a winter break in English soccer. Likewise, when considering the purported evolutions in match-play demands in English soccer (Barnes et al., 2014), there exists a need to consider the contemporary within and between match responses to periods of fixture congestion in English soccer match-play.

It is well established that there exists position specific differences in physical performance during soccer match-play (Di Salvo et al, 2007; Di Salvo, Pigozzi, Gonzalez-Laughlin, & De Witt, 2013; Mohr, Krustrup, & Bangsbo, 2003; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007) and, as such, match-play analyses should be position specific. It is has also been identified that these positional differences also exist during periods of fixture congestion (Djaoui et al. 2014; Penedo-Jamardo, Rey, Padrón-Cabo, and Kalén, 2017; Varley, Di Salvo, Modonutti, Gregson, and Villaunueva, 2017; Soroka and Lago-Peñas, 2016). There is however, a lack of literature associated with position specific differences during periods of fixture congestion in professional English soccer. Due to the inherent variability associated with match-based performance metrics, where studies have identified positional differences across congested schedules, they have often utilised a large number of match observations, thus increasing population sample and subsequent statistical power.

Furthermore, no study is yet to examine the positional specific mechanical loading during fixture-congested periods. Recently, in an attempt to quantify the mechanical demand associated with intermittent team sports, PlayerLoad^{TM} data has been calculated from the tri-axial accelerometer (Kionix: KXP94, Kionix, Ithaca, New York, USA) housed within the Catapult (Catapult Innovations, Scoresby, Australia) Global positioning system (GPS) devices (Boyd, Ball & Aughey, 2011; Barron, Atkins, Edmundson & Fewtrell, 2014). The high sample rate (100 Hz) of the accelerometer in relation to the GPS (typically 5-10 Hz), and the capacity to measure movement in three planes, provides scope to further evaluate the mechanical response to exercise. The International Football Association Board (IFAB) has also recently approved the use of GPS technologies during competitive matches, thus allowing a method of assessing the within-match mechanical efficiency. Based on previous literature (Barrett et al., 2016a; Barrett et al., 2016b; Page, Marrin, Brogden & Greig 2016; Page, Marrin, Brogden & Greig 2017), PlayerLoad™ appears to be sensitive enough to detect fatigue induced differences in movement efficiency during the completion of soccer-specific activity. These metrics may therefore offer an additional and novel opportunity to detect temporary, cumulative, and residual physical fatigue during periods of short-term fixture congestion.

Given the potentially detrimental effects associated with periods of short-term fixture congestion, the lack of fixture congestion literature associated with English professional soccer, and the recent advancements in measurement technology, the aim of the current study was to investigate positional specific physical performance and external load responses associated with one, two, and three game weekly microcycles in English professional soccer.

Method

Participants

Thirty seven adult professional male soccer players (Age= 23 ± 4 years, Stature= 181.8 ± 6.5 cm, Body mass= 79.1 ± 8.4 kg) playing in four positional categories: Central Defenders (CD, *n*=6), Wide Defenders (WD, *n*=8), Midfielders (MD, *n*=12) and Attackers (AT, *n*=11) volunteered to participate in the study. All participants were recruited from one professional English third tier team (English Football League One) competing in league and domestic cup competitions. All participants were declared injury free and fit for competition by medical staff prior to participation in any match. Although GPS data is recorded as part of daily monitoring; as good practice, and in line with ethical approval, the participants were asked to provide written informed consent for the use of their match data beyond how it is normally used.

Research Design

Data was collected in seventy-nine competitive matches, providing 515 match observations across the 2015-2016 (n= 41 matches) & 2016-2017 (n= 38 matches) seasons. These observations were subsequently partitioned into three fixture congestion scenario (FCScen) groups according to the number of days between successive matches. The first group (G1, *no. of observations*=314) comprised of players completing a single match performed in a weekly microcycle with no additional match performed within four days of this match. The second group (G2, *no. of observations* =130) encompassed data from the second match of a two match weekly micro cycle whereby two matches are performed with <4 days between matches. The third group (G3, *no. of observations* =71) contained data from the third match of a three game weekly mirco-cycle whereby three matches are performed with <4 days between each match. The criterion for the data to be included in G2 and G3 was for the participant to have played ≥75 minutes in the each of the preceding matches in the weekly microcycle. Only data that was provided by a player completing a full match in either G2 or G3 was included in the subsequent analyses. The inclusion into each group was not made according to the team matches, but according to the matches played by each player.

Between Match Practices

Players were provided with a high-carbohydrate meal ~3-4 hours prior to each game. Players also consumed whey protein based milkshakes and fruit within 30 minutes of the end of the match. In the day following each game, players took part in an active recovery session comprising of a 20 minute spin on static cycle ergometer, a 20 minute flexibility and mobility routine encompassing static/ dynamic stretching and foam rolling, and eight minutes of contrast water therapy (2x 2 mins hot and 2 mins cold). Throughout the week (excluding the day off) players were provided with a balanced breakfast and lunch with a variety of carbohydrate, protein, and fat contents available. Players could also request soft tissue manual therapy. Considering the periodisation of training load (figure 1), players completed one grass based training session between G1 and G2, and one session between G2 and G3. All of the above was kept consistent throughout the data collection period.

** Insert figure 1 about here **

Data Collection

The data collection procedures associated with the current study are presented considering recent recommendations by Malone, Lovell, Varley, & Coutts, (2016). During all competitive league and domestic cup matches the current participants were required to continuously wear a Microelectromechanical systems (MEMS) device (Optimeye X4, firmware version 8.11, Catapult Sports, Melbourne, Australia). In an attempt to avoid erroneous data due to excessive movement artefact, the MEMS devices were housed between the participants scapulae in a standardised custom fitted neoprene garment worn directly against the participant’s skin. Each MEMS device comprised a GPS component and a tri-axial piezoelectric linear accelerometer

(Kionix: KXP94) with sampling frequencies of 10 and 100Hz respectively. Each player wore the same device across matches to reduce any variation in GPS derived data due to potential between-unit discrepancies (Coutts & Duffield, 2010; Duffield, Reid, Baker, & Spratford, 2010). Acceptable inter-unit reliability has however been identified for the GPS ([CV= 0.7-1.3%] Castellano, Casamichana, Calleja-Gonzalez, San Roman, & Ostojic, 2011) and accelerometer ([CV= 1.94%] Boyd et al. 2011) hardware contained within the MEMS devices used in the current study. Prior to the commencement of each season, all units were sent to the manufacturer for calibration using their preferred "jig" method. Units were orientated and secured in a stationary position in each plane of movement and recordings were set at 1g for that position to reduce any bias or drift. Every two weeks, units were checked for calibration, with all units remaining within the manufacturer's tolerance thresholds during the entire testing period. In line with previous research (Barrett et al. 2016a; Malone et al. 2016), GPS data was only included for statistical analyses if a horizontal dilution of precision (HDOP) of <1.5 and a number of satellites ≥6 was achieved.

Data Analysis

In accordance with FIFA regulations, all match data was retrospectively analysed using Catapult Sprint software (version 5.1.7, Melbourne, Australia) to initially analyse the HDOP and number of satellites, then further analysed using the Catapult Openfield (version 1.11.2, Melbourne, Australia) software, before then being exported into Excel 2013 (Microsoft, Redmond, Washington, USA). All warm up and stoppage time data at the end of each half was excluded from the study. All fixtures therefore contained two 45 minute halves interspersed by a passive half time interval. Match data was partitioned into fifteen minute segments to assess the within match patterns of Total Distance (m) (TD), Low Intensity Distance (m) (*LID*) ($<4.0 m \cdot s^{-1}$), Moderate

Intensity Distance (m) (*MID*) (4.0-5.5m·s^{-1}), High Intensity Distance (m) (*HID*) (5.5-7.0m·s^{-1}) and Sprint Distance (m) (*SprintD*) (>7.0m·s^{-1}), 3D PlayerLoad™ per distance covered (au/m) (PL_{3D}/m), PlayerLoad™ anterior-posterior per distance covered (au/m) (PL_{AP}/m), PlayerLoad™ medio-lateral per distance covered (au/m) (PL_{ML}/m), PlayerLoad™ vertical per distance covered (au/m) (PL_{Vert}/m). The aforementioned velocity thresholds are similar to those previously utilised in the literature (Barnes et al. 2014; Bradley et al. 2009; Mohr et al. 2003; Rampinini et al. 2007; Varley et al. 2017).

Statistical Analyses

Exploratory data analysis was initially carried out to assess the assumptions of the linear mixed model (LMM), with none of the current variables violating these assumptions. A LMM was utilised to overcome the assumption of independence, and also because of the flexibility that this method has in accounting for the altering sample sizes between groups with repeated measures (Field, 2013). All models began as a null and were progressed to more complex parsimonious hierarchical models. A basic variance components model was executed to calculate the intraclass correlation (ICC) of the random factors of *game*, *player* and *formation* and to determine if any contributed significant variance to the dependant variable (Table 2). Given the large sample sizes, Wald Z statistics were utilised to test the null hypothesis that the population variance is zero, if rejected the proposed random factors were included in subsequent larger models. The covariance structure of the random factors was set to variance components in all models. Model fit was assessed using Akaike's information criterion (AIC). For each dependant variable, AIC revealed the model that best fit the data utilised the first order auto-regressive (AR-1) repeated covariance structure for the repeated measures of *time period*, and *game.* The three fixed effects and their interactions in each model included *in match time epoch, FCScen* and *position*. All models estimated parameters using the maximum likelihood method. Where appropriate, Sidak adjusted post hoc analyses, Cohen's d (*d*) effect sizes, and the inclusion of 95% confidence intervals (C.I.) of the differences were reported. Cohen's d effect sizes were calculated using the pooled SD data and were classified as trivial (<0.2) small (0.2-0.49), moderate (0.50-0.79), and large >0.80) (Cohen, 1992). All statistical procedures were carried out using IBM SPSS Statistics (Version 22, Chicago, IL, USA), with two-tailed significance being accepted at $p<0.05$. All data is presented as mean±SD unless otherwise stated.

Results

Variance Calculations

Table 1 depicts the ICC's (%) of the random factors accounted for in the LMM. The individual player and game contributed significant variance to all dependant variables and was subsequently included in all of the larger hierarchical models. Team formation did not contribute significant variance to any dependant variable and, as such, was excluded as a random factor in the larger models.

** Insert table 1 about here **

Total Distance

The LMM did not identify significant interactions between position, FCScen, and time period (p= 0.917), position and FCScen (p= 0.950), nor position and time period (p= 0.649). As identified in figure 2, the LMM did however identify a significant interaction ($p<0.001$) for time period and FCScen. Post hoc analyses identified that TD in the 0-15 (p=0.029; d= 0.29; C.I.= 5 to 125 m) and 15-30 (p=0.042; d= 0.27;

C.I.= 1 to 120 m) minute periods of G2 (0-15= 1837 ± 235 m; 15-30= 1732 ± 213 m) were significantly higher than that covered in the same period in G3 (0-15= 1772 ± 236 m; 15-30= 1671 ± 215 m). Significantly higher TD was also identified in the 15-30 minute period (*p*=0.025; *d*= 0.26; C.I.= 6 to 113 m) in G1 (1731 ± 303 m) when compared to G3. During the 30-45 minute period, significantly higher distance (*p*<0.001; *d*= 0.26; C.I.= 34 to 113 m) was recorded in G2 (1726 ± 236 m) when compared to G1 (1653 ± 304 m). In the 75-90 minute period, significantly less distance was covered in G3 (1496 ± 211 m) when compared to both G2 (1582 ± 236 m; *p*=0.002; *d*= 0.38, C.I.= -147 to -26 m) and G1 (1563 ± 303 m; *p*=0.008; *d*= 0.24; C.I.= -122 to -14 m).

** Insert figure 2 about here **

The LMM also identified a significant main effect for position (p<0.001), with MD (1774 ± 699 m) covering significantly greater distance per 15 minute period than CD (1588 ± 795 m, *p*=<0.001, *d*=0.25; C.I.= 92 to 281m), WD (1634 ± 764 m, *p*<0.001, *d*= 0.19; C.I.= 59 to 222 m) and AT (1703 ± 499 m, *p*=0.041, *d*= 0.11; C.I.= 2 to 139 m). Significantly higher TD was also covered per fifiteen minute period by the AT when compared to the CD (*p*=0.014, *d*= 0.16; C.I.= 17 to 216 m).

Low Intensity Distance

The LMM did not identify a significant interactions between position, FCScen, and time period (*p*= 0.886), position and FCScen (*p*= 0.967), nor position and time period (*p*= 0.624). As identified in figure 3, the LMM did however identify a significant interaction (*p*<0.001) for time period and FCScen, with significantly (*p*<0.001; *d*=0.27; C.I.= 23 to 85 m) higher LID recorded in the 30-45 minute period of G2 (1395 ± 168 m) when compared to G1 (1341 ± 208 m). Significantly lower LID was covered in the 75-90 minute period of G3 (1222 ± 155 m) when compared to both G2 (1296 ± 168 m; p<0.001; d= 0.46, C.I.= -121 to -28 m) and G1 (1274 ± 209 m; p=0.008; C.I.= -94 to -11 m).

** Insert figure 3 about here **

The LMM also identified a significant main effect for position (p=0.001), with MD (1398 ± 487 m) covering significantly higher LID per fifteen minute period than WD (1333 ± 544 m, p=0.023, d= 0.13, C.I.= 6 to 124 m) and AT (1329 ± 356 m, p=0.002, d= 0.15, C.I.= 18 to 120 m), but not CD (1338 ± 542 m).

Moderate Intensity Distance

The LMM did not identify significant interactions between position, FCScen, and time period (p= 0.424), nor position and FCScen (p= 0.998). As identified in figure 4, the LMM did however identify a significant interaction (p=0.026) between time period and FCScen, with significantly higher (p=0.011; d= 0.32; C.I.= 5 to 54 m) MID covered in the 0-15 minute period of G2 (284 ± 95 m) when compared to G3 (254 ± 87 m). As identified in table 2, the LMM also identified a significant interaction between time period and position (p=0.039).

** Insert figure 4 about here **

** Insert table 2 about here **

High Intensity Distance

The LMM did not identify significant interactions between position, FCScen, and time period (p= 0.549), position and FCScen (p= 0.481), nor FCScen and time period (p= 0.162). As identified in table 3, the LMM did however identify a significant interaction effect (p=0.001) for time period and position. There was also no significant main effect for FCScen (p= 0.834).

** Insert table 3 about here **

Sprint Distance

The LMM did not identify significant interactions between position, FCScen, and time period (p= 0.376), position and FCScen (p= 0.911), nor position and time period (p= 0.241). The LMM did however identify a significant interaction (p<0.001) between time period and FCScen, with the SprintD being significantly higher in the 30-45 minute time period G3 (26 ± 26 m) when compared to the same period in G1 (16 ± 35 m, p=0.001, d=0.30, C.I= 4 to 17 m) and G2 (18 ± 28 m, p=0.013, d=0.32, C.I= 1 to 16 m).

The LMM also identified a significant main effect for position (p<0.001), with AT (31 ± 54 m) covering significantly higher SprintD per 15 minute period than CD (10 ± 88 m, p<0.001, d=0.26, C.I.= 9 to 31 m), WD (17 ± 83 m, p=0.001, d=0.18, C.I.=4 to 23 m) and MD (18 ± 77 m, p<0.001, d=0.17, C.I.= 5 to 20 m).

PlayerLoad^{TM}

The LMM did not identify any significant interactions or main effects for the $PL_{Total/m}$, $PL_{AP/m}$, or $PL_{ML/m}$ data, with average values for a 15 minute bout of match play being 0.139 ± 0.002 a.u/m, 0.036 ± 0.001 a.u/m, 0.035 ± 0.001 a.u/m respectively.

The LMM did however identify a significant main effect (p=0.005) for time with the $PL_{V/m}$ data. With the exception of 30-45 minute period (0.068 ± 0.001 au/m), significantly higher $PL_{V/m}$ data was recorded in the 0-15 minute period of the matches (0.069 ± 0.001au/m) when compared to all other time points (p≤0.021; d< 0.09).

Significantly lower $PL_{Vert/m}$ was also recorded in the 75-90 minute period (0.067 ± 0.001au/m) when compared to the 15-30 (0.068 ± 0.001 au/m, p<0.001, d= -0.04 , C.I.= -0.002 to 0 au/m) and 30-45 minute periods (0.068 ± 0.001 au/m, p<0.001, d= -0.04, C.I.= -0.002 to 0 au/m).

Discussion

The aim of the current study was to investigate positional specific within-match physical performance and mechanical response across one, two, and three game weekly microcycles in English professional soccer. Irrespective of position, the present study reported 'small' yet significant effects of altered within match patterns of TD, LID, and SprintD across the three FCScen. It was identified that TD in the 15-30 and 75-90 minute periods was lower in G3 when compared to both G1 and G2. Higher TD data was also elicited in the 30-45 minute period of G2 when compared to the corresponding period in G1, with these differences appearing to be a result of increased work at low intensities. These data are in contrast to previous research that has highlighted no differences in TD covered during periods of short term fixture congestion (Andrzejewski et al., 2014; Carling & Dupont, 2011; Rey et al., 2010). The discrepancy between the current data and that of previous literature may be explained by the fact that the aforementioned studies typically only considered differences in TD across halves or across a full game and not in fifteen minute epochs. In support of this, the present study identified trivial to no effects in any of the dependent variables when comparing whole match averages. The analysis of whole match data or data recorded across halves may also explain why the majority of literature examining physical performance in fixture congested periods have reported limited differences in whole match physical performance between two games that are played with 3-4 days between them (Carling & Dupont 2011; Dellal et al., 2015; Djaoui et al., 2014; Dupont et al., 2010; Folgado et al., 2015; Lago Penas et al., 2011; Rey et al., 2010; Soroka & Lago-Peñas, 2016) or between 3 games played in a weekly microcycle (Carling and Dupont, 2011; Dellal et al., 2015; Soroka & Lago-Peñas, 2016).The current data therefore provides rationale for the use of fifteen minute epochs to further aid the detection of a cumulative fatigue response within halves rather than just between halves.

The current data also identified ‘small’ yet significant differences in LID in the final fifteen minute period of G3 when compared to G1 and G2; however, MID, HID, and SprintD were maintained. The observed differences in LID may be a result of conscious or unconscious pacing strategies in an attempt to offset fatigue and aid the successful completion of match-play (Drust, Atkinson, & Reilly, 2007; Edwards and Noakes, 2009; Folgado et al., 2015; Smith, Macora, & Coutts, 2015). It is possible that players utilise a pacing strategy whereby they reduce the volume of low intensity activity in order to facilitate the maintenance of high velocity movements. In support of this, Folgado et al., (2015) identified that during periods of fixture congestion, players had impaired latitude and longitudinal displacements at velocities less than $14.4 km \cdot h^{-1}$, thus suggesting an impairment in medium and low intensity actions, with no observed impairment of higher intensity actions. The current between match differences in LID are also in support of previous literature (Andrzejewski et al., 2014; Odeyotimbo et al., 2009) that has also reported increased distance elicited whilst standing or walking in the first game in a weekly microcyle when compared to a third game played in the same week. These authors also identified that MID, HID, and SprintD were maintained across three successive matches during a period of short-term fixture congestion. The current data also identified increased SprintD in the last fifteen minutes of the first half of G3 when compared to the corresponding period in G1 and G2. It is possible that these differences are associated with a conscious pacing strategy. For example, when considering that a player will possess knowledge of a nearing halftime interval, this could elicit motivational increases in high intensity output (Hanson, 2013).

To the author's knowledge, the present study is the first study to assess between positions within match patterns of physical performance across fifteen minute epochs in professional English soccer. The findings of present study conflict those of previous research (Soroka and Lago-Peñas, 2016; Varley et al., 2017), by not identifying any inter position differences across three games played in a weekly microcycle. It should however be acknowledged that the aforementioned studies also reported conflicting findings when compared to each other. The observed differences in the literature could be attributable to the varying formations utilised and not accounted for (Bradley et al., 2011), and also the variable standards of the populations utilised between studies (Mohr et al., 2003). Despite the lack of FCScen interactions, Small to large effects were observed for position specific within match patterns of MID and HID. When considering the MID data, MD covered 'small' to 'moderate' increased distances across all time points when compared to both CD and WD. Likewise, with the exception of the last fifteen minute period, AT covered 'small' to 'moderate' increases in MID than CD. Across all second half time periods, MD also elicited 'small' MID than AT. Such findings are in line with a number of previous studies reporting greater volumes of submaximal distance being completed by the MD when compared to other positions (Andrzejewski et al., 2015; Clemente et al., 2013; Di Salvo et al., 2007; Di Salvo et al., 2013; Rampinini et al., 2007). In relation to the HID data, AT and MD covered significantly greater distance than CD across all time points. AT also covered more HID across specific phases of match-play when compared to both WD and MD. These data are again in line with previous research suggesting the greatest volume of work at high intensity is carried out by attacking players (Mohr et al., 2003). Moreover, when compared to CD, the WD covered small, yet significantly higher HID in the first and last fifteen minute periods of each half. The lower MID and HID observed for the CD when compared to other positions is consistent with previous research suggesting CD position elicits the lowest physical output out of all the outfield positions (Andrzejewskiet al, 2015; Clemente et al., 2013; Di Salvo et al., 2007; Di Salvo, Gregson, Atkinson, Tordoff, and Drust 2009; Mohr et al., 2003; Rampinini et al., 2007). The aforementioned data therefore identifies a strong rationale for position specific conditioning and has implications for player rotation strategies.

PlayerLoad^{TM} has previously been shown to be highly positively correlated with the volume of locomotion performed in team sports (Polglaze, Dawson, Hiscock, & Peeling 2015; Scott, Lockie, Knight, Clark, & Janse De Jonge 2013). As such, examination of the absolute PL response would inherently reflect the typical in match total distance response typically shown to reduce within and across halves (Barrett et al., 2016a; Mohr et al. 2003; Rampinini et al., 2009; Weston et al., 2011). The present study therefore normalised the PL metrics to distance covered to assess any potential changes in locomotive efficiency that may be indicative of fatigue and potentially increased injury risk (Barrett et al., 2016a). In light of the non-significant or trivial effects reported when examining the tri-axial and planar derivatives ($PL_{total/m}$, $PL_{AP/m}$, $PL_{ML/m}$, $PL_{Vert/m}$) it appears the players in the present study elicited little to no alterations in locomotive efficiency during games, between positions, or across successive games during a period of short-term fixture congestion. Alternatively, it could be suggested that the PL metrics utilised in this current study are possibly insensitive in detecting changes in locomotive efficiency within soccer match-play and across successive games. In contrast to Barrett et al., (2016a) the present study highlighted no significant time response of PL_{Total}/m across match-play. Barrett and colleagues (2016a) suggested small to large increases in $PL_{Total/m}$ in the last fifteen minute period of the first half and the last thirty minutes of the second half when compared to the first fifteen minute period of the first half. Although this seems sensible given the reduced physical output (Mohr et al. 2003; Rampinini et al., 2009; Weston et al., 2011), and increased injury risk associated with the later stages of each half of soccer match play (Bengtsson et al., 2013; Ekstrand, Hägglund and Waldén 2011; Hawkins and Fuller, 1999), the present study failed to detect such changes and, as such, questions the efficacy of such metrics in detecting alterations in mechanical efficiency during intermittent match play. When considering the observed between individual variation in the current PL metrics (ICC: 69-78%) (Table 2), these metrics may only be sensitive to detecting altered movement efficiency during the completion of standardised activity profiles (Barrett et al., 2016b; Page et al., 2016), or across distinctively different modes of activity.

It should be acknowledged that the current study only assessed data from a single team and, as such, although a number of contextual factors were considered, the current data may have limited application across different leagues and playing standards. Although beyond the scope of the current study, future research could also consider the influence of additional contextual and environmental factors which could explain some of the observed findings. Due to an inability to collect data on max velocities for all participants, the current also only considered absolute velocity thresholds.

Conclusion

This is the first study to investigate the positional and within game differences during periods of fixture congestion in English professional soccer. Given the propensity of match congestion with the involvement in several league and domestic cup competitions, such information is of practical use to coaches and practitioners working in professional soccer. The current data identified that the tri-axial and uni-axial PlayerLoad^{TM} metrics did not identify altered locomotive efficiency between fifteen minute epochs during match-play, with this lack of sensitivity likely to be due to large between individual variability. Regardless of playing position, the current data identified that the physical performance measures of locomotive activity differed between the within match fifteen minute epochs recorded across matches in a weekly microcycle. This response may be due to the player's ability to consciously adopt pacing strategies in which volumes of LID are reduced to facilitate continued high intensity output. The current data does however provide a rationale for examining within match responses in fifteen minute epochs in future fixture congestion research. In relation to positional differences, no observed differences were identified for any of the current variables across matches; however, positional differences were observed for measures of TD, LID, MID, HID, and sprintD within matches. These data therefore reiterate the need for positional specific strength and conditioning, post-match recovery strategies, and squad rotation practices.

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Figure legends

Figure 1: *A)* three game microcycle starting Saturday, *B*) three game microcycle starting Tuesday. *Note:* M=Matchday, G= game, TD= Total Distance (m), HSR= High speed running distance (m). HSR represents an amalgamation of HID and Sprint distance (i.e. distance covered >5.5m/s), thus providing a measure of high intensity activity performed across each session within the microcycle.

Figure 2: The TD covered in each time period across the fixture congestion scenarios. [a and b] denote significant differences with G1 and G2 respectively.

Figure 3: The LID covered in each time period across the fixture congestion scenarios. [a and b] denote significant differences with G1 and G2 respectively.

Figure 4: The MID covered in each time period across the fixture congestion scenarios. [a] denotes a significant differences with G3

Table 1: The ICC's (%) of each random factor considering all of the dependant variables. *Note*: *Represents significant determinant of variance within the linear mixed model (p<0.05).

Dependant Variable	*Player (%)*	*Game (%)*	*Formation (%)*
TD (m)	32.0*	4.3*	0.7
LID (m)	22.5*	10.9*	2.4
MID (m)	37.8*	3.2*	1.7
HID (m)	38.7*	4.0*	2.5
SprintD (m)	37.7*	1.7*	0.0
3D PL/m (au/m)	71.1*	9.6*	4.5
AP PL/m (au/m)	73.2*	13.9*	10.3
ML PL/m (au/m)	68.7*	8.9*	4.6
Vert PL/m (au/m)	77.8*	7.5*	1.4

Table 2: Within game positional specific differences in MID. [a, b, and C] denote a significantly higher value when compared to CD, WD, and AT respectively.

	Time (Mins)					
Position	0-15	15-30	30-45	45-60	60-75	75-90
CD	228 ± 143 m	197 ± 143 m	175 ± 143 m	188 ± 143 m	165 ± 143 m	172 ± 143 m
WD	245 ± 139 m	211 ± 139 m	205 ± 139 m	216 ± 139 m	195 ± 139 m	193 ± 138 m
MD	316 ± 130 m [a] *d*= 0.65; [a] C.I= 46 to 135 m [b] *d*= 0.65; [b] C.I= 34 to 108 m	280 ± 131 m [a] *d*= 0.61; [a] C.I= 41 to 125 m [b] *d*= 0.51; [b] C.I= 32 to 106 m	271 ± 130 m [a] *d*= 0.70; [a] C.I= 53 to 137 m [b] *d*= 0.49; [b] C.I= 28 to 103 m	282 ± 130 m [a] *d*= 0.69; [a] C.I= 52 to 137 m [b] *d*= 0.65; [b] C.I= 29 to 104 m [c] *d*= 0.32; [c] C.I= 2 to 78 m	267 ± 131 m [a] *d*= 0.75; [a] C.I= 60 to 144 m [b] *d*= 0.54; [b] C.I= 35 to 110 m [c] *d*= 0.31; [c] C.I= 1 to 76 m	237 ± 131 m [a] *d*= 0.48; [a] C.I= 23 to 108 m [b] *d*= 0.33; [b] C.I= 8 to 82 m [c] *d*= 0.33; [c] C.I= 3 to 79 m
AT	291 ± 108 m [a] *d*= 0.47; C.I= 15 to 110 m [b] *d*= 0.35; [b] C.I.=1 to 90 m	245 ± 108 m [a] *d*= 0.61; [a] C.I= 0 to 95 m	245 ± 109 m [a] *d*= 0.53; [a] C.I= 22 to 117 m	243 ± 109 m [a] *d*= 0.41; [a] C.I= 7 to 102 m	229 ± 108 m [a] *d*= 0.48; [a] C.I= 16 to 122 m	197 ± 108 m

Table 3: Within game positional specific differences in HID. [a, b, and C] denote a significantly higher value when compared to CD, WD, and MD respectively.

	Time (Mins)					
Position	0-15	15-30	30-45	45-60	60-75	75-90
CD	53 ± 74 m	55 ± 74 m	49 ± 74 m	43 ± 74 m	52 ± 74 m	41 ± 74 m
WD	84 ± 73 m [a] *d*=0.42; [a] C.I= 10 to 52 m	72 ± 73 m	74 ± 73 m [a] *d*= 0.35; [a] C.I= 5 to 47 m	78 ± 73 m [a] *d*=0.47; [a] C.I= 14 to 56 m	69 ± 73 m	65 ± 73 m [a] *d*= 0.33; [a] C.I= 3 to 45 m
MD	87 ± 68 m [a] *d*=0.49; [a] C.I= 12 to 57 m	81 ± 68 m [a] *d*= 0.37; [a] C.I= 4 to 48 m	86 ± 69 m [a] *d*= 0.52; [a] C.I= 15 to 59 m	85 ± 68 m [a] *d*= 0.59; [a] C.I= 20 to 64 m	82 ± 69 m [a] *d*= 0.43; [a] C.I= 8 to 53 m	81 ± 69 m [a] *d*= 0.57; C.I= 18 to 63 m
AT	125 ± 59 m [a] *d*= 1.04; [a] C.I= 46 to 97 m [b] *d*= 0.59; [b] C.I= 17 to 65 m [c] *d*= 0.57; [c] C.I= 16 to 58 m	91 ± 59 m [a] *d*= 0.53; [a] C.I= 11 to 62 m	102 ± 59 m [a] *d*= 0.78; [a] C.I= 4 to 42 m [b] *d*= 0.41; [b] C.I= 4 to 42 m	104 ± 59 m [a] *d*= 0.88; [a] C.I= 35 to 86 m [b] *d*= 0.38; [b] C.I= 2 to 50 m	87 ± 59 m [a] *d*= 0.52; [a] C.I= 11 to 62 m	85 ± 58 m [a] *d*= 0.64; [a] C.I= 19 to 69 m

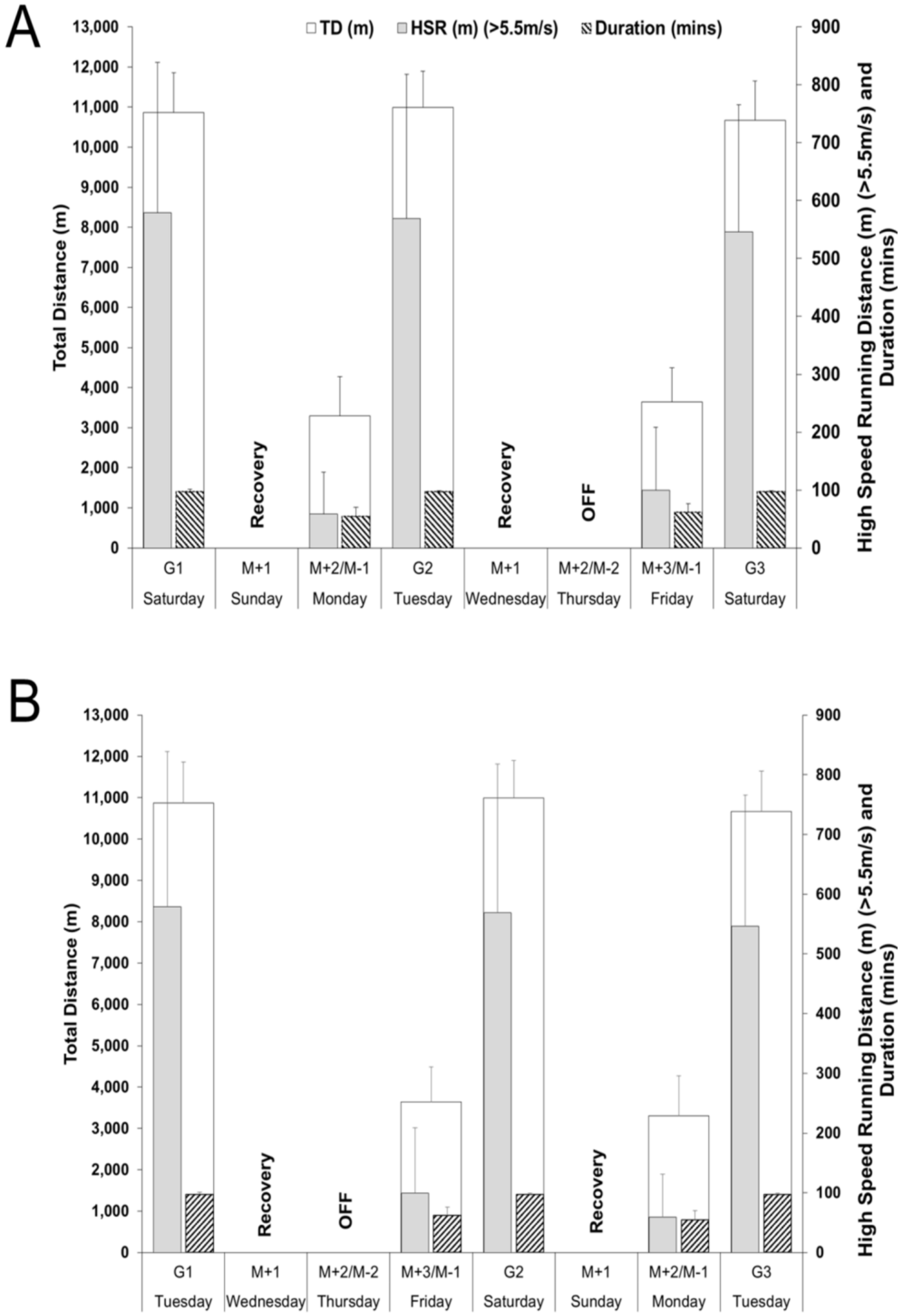

Figure 1: *A)* three game microcycle starting Saturday, *B*) three game microcycle starting Tuesday. *Note:* M=Matchday, G= game, TD= Total Distance (m), HSR= High speed running distance (m). HSR represents an amalgamation of HID and Sprint distance (i.e. distance covered >5.5m/s), thus providing a measure of high intensity activity performed across each session within the microcycle.

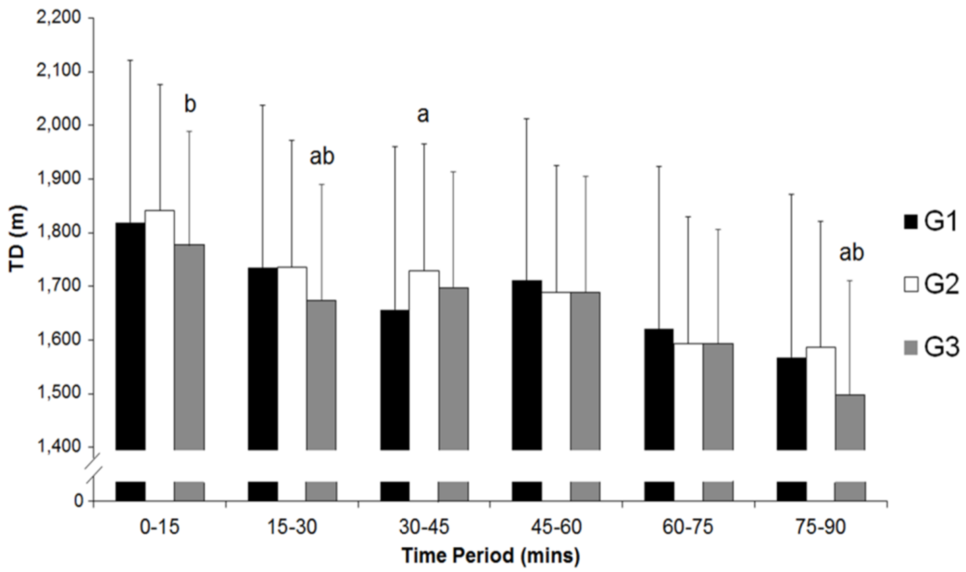

Figure 2: The TD covered in each time period across the fixture congestion scenarios. *a and b* denote significant differences with G1 and G2 respectively.

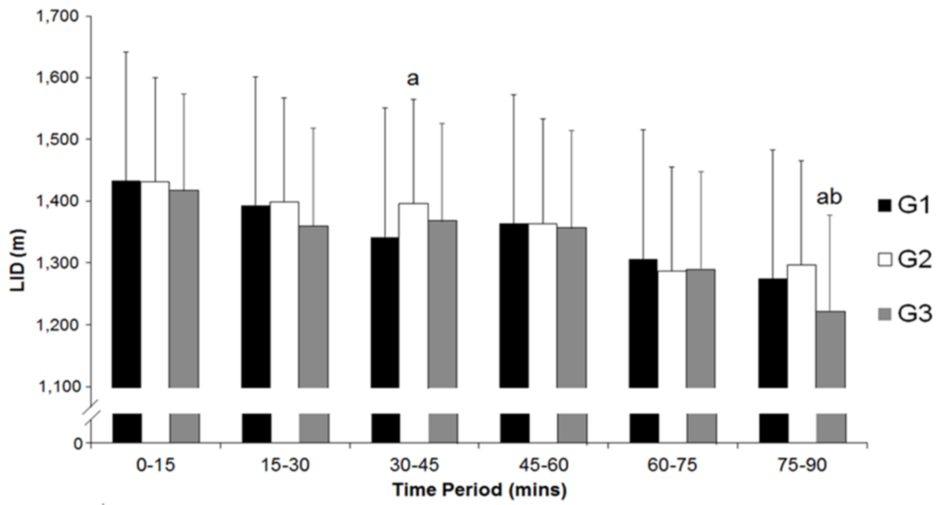

Figure 3: The LID covered in each time period across the fixture congestion scenarios. *a and b* denote significant differences with G1 and G2 respectively.

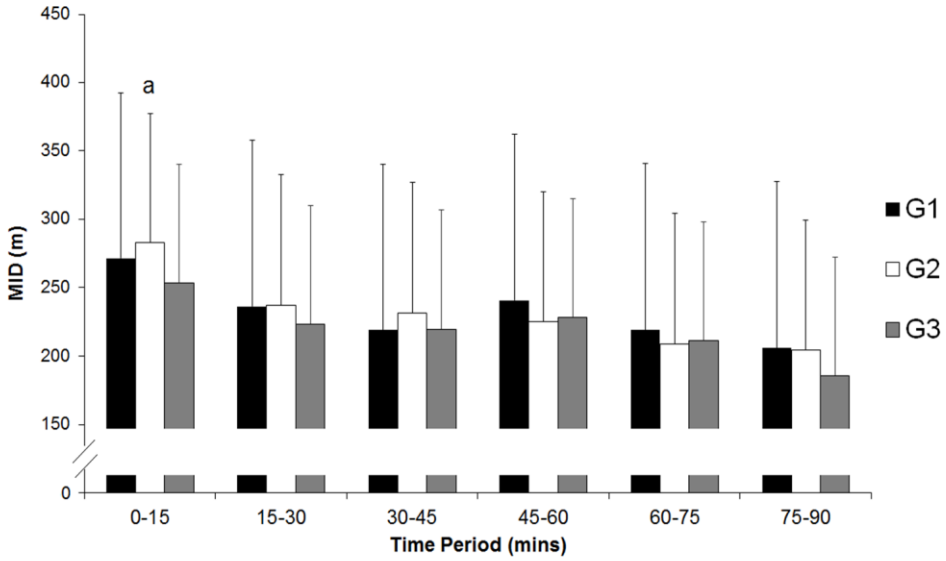

Figure 4: The MID covered in each time period across the fixture congestion scenarios. [a] denotes a significant differences with G3