Match-to-match variability in high-speed running activity in a professional soccer team

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Running head: Running performance in elite soccer

Abstract

This study investigated variability in competitive high-speed running performance in an elite soccer team. A semi-automated tracking system quantified running performance in 12 players over a season (median 17 matches per player, 207 observations). Variability (coefficient of variation [CV]) was compared for: total sprint distance (TSD, >25.2 km/h), high-speed running (HSR, 19.8-25.2 km/h), total high-speed running (THSR, ≥19.8 km/h); THSR when the team was in and out of ball possession, in individual ball possession, in the peak 5-min activity period; and distance run according to individual maximal aerobic speed (MAS). Variability for % declines in THSR and distance covered at ≥80% MAS across halves, at the end of play (final 15-min versus mean for all 15-min periods), and transiently (5-min period following peak 5-min activity period) was analysed. Collectively, variability was higher for TSD versus HSR and THSR and lowest for distance run at ≥80% MAS (CVs: 37.1%, 18.1%, 19.8% and 11.8%). THSR CVs when the team was in/out of ball possession, in individual ball possession and during the peak 5-min period were 31.5%, 26.1%, 60.1% and 23.9%. Variability in THSR declines across halves, at the end of play and transiently, ranged from 37.1%-142.6%, while lower CVs were observed in these metrics for running at ≥80% MAS (20.9%-53.3%).These results cast doubt on the appropriateness of general measures of high-speed activity for determining variability in an elite soccer team although individualisation of high-speed running thresholds according to fitness characteristics might provide more stable indicators of running performance and fatigue occurrence.

Key words:

Football, time motion analysis, locomotor activity, performance, variation

Introduction

Time motion analysis is a commonly used technique to analyse elite soccer performance as it allows quantification of player running activities and indirect verification of the energetics of match-play (Carling, 2013). Research has shown that match running demands are influenced by a multitude of contextual factors such as competitive standard (Di Salvo, Pigozzi, González-Haro, Laughlin, & De Witt, 2013), tactical system (Bradley et al., 2011), the opposition (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007), possession status (Bradley, Lago-Peñas, Rey, Gomez Diaz, 2013), seasonal period (Mohr, Krustrup, & Bangsbo, 2003), playing surface (Andersson, Ekblom, & Krustrup (2008) and the environment (Mohr, Nybo, Grantham, & Racinais, 2012). These studies attempt to apply their findings to generate testing and training protocols that mimic the game and identify key physical performance indicators (Castellano, Alvarez-Pastor, & Bradley, 2014). However, the interpretation and application of findings from time motion studies can be hampered by the large natural match-to-match variability in performance within and between players, which is typically reported as a coefficient of variation (CV; Hopkins, 2000a). Without a stable measure of performance it is difficult to evaluate the effectiveness of a training intervention programme (Mackenzie & Cushion, 2013). Work by Gregson, Drust, Atkinson, & Di Salvo (2010) examined a large sample of elite players and demonstrated that the high-speed running and sprinting profiles varied by 20-30% from match-to-match with central players exhibiting greater CV's than wide players. This work has recently been extended by examining the physical and technical match-to-match variability of a large population of elite players in different positional roles and contexts including score, location and standard of opposition (Bush, Archer, Hogg, & Bradley, 2015). Technical metrics (CV ~40-80%) were shown to vary more from match-to-match than running metrics (CV ~20-30%) with match context having minimal impact on the CV.

Yet, one might question the real-world relevance and practical utility of match analysis data derived from such large-scale investigations and as such more work is needed on quantifying variability in individual reference teams and players. In reality, disparities will exist in the physical, tactical and technical abilities of players making up the team squads in individual clubs compared to data derived for teams across a League as a whole. This combined with cultural and philosophical differences in practitioners' approach to competition will always lead to doubts on the pertinence and practical applicability of any published data from large sample studies for use in a single club setting (Carling, Wright, Nelson, & Bradley, 2013). It is imperative that an applied research perspective is provided, so that club practitioners are informed of the noise around relevant performance metrics for a realistic data set. To date, Mohr et al. (2003) and Rampinini et al. (2007) are the only investigations that have verified general match-to-match variability in smaller samples of elite players. In the former, the authors observed a moderate CV (~10%) for high-speed running performance in players completing two matches in a 3-wk period with a high CV (~25%) for matches played in different seasonal periods. However, none of the aforementioned studies accounted for the possible impact of

playing system and team tactics. As such, analyses conducted in a single reference team setting will arguably provide a better opportunity to control for these potentially confounding factors. In addition, variability data solely derived from repeated measures for individual players and comparisons across individual players competing in the same positional role are currently unavailable. These points are also pertinent as the question arises as to whether variability will be altered when the fixed speed thresholds typically used to quantify distances covered are 'adjusted' to account for individual physical fitness characteristics (Carling et al., 2013). One could speculate that adjusted high-speed running data might demonstrate lower between-match variability, hence providing a more stable indicator of running performance, as players potentially self-regulate their efforts to remain with their 'physiological limits' (Bradley & Noakes, 2013).

Finally, time motion analyses data for professional soccer competition have provided comprehensive evidence of time-dependent declines in the distances covered by players over the course of play suggesting the occurrence of accumulated and transient fatigue (Castellano et al., 2014). In contrast, the match-to-match variability of declines in high-speed running activity across halves, in the latter stages of competition and following short intense periods of play have not received any attention. This information could provide insight into the appropriateness and hence interpretation of declines in running performance as potential indicators of fatigue occurrence in match-play (Carling, 2013). This study investigated the between and in-match variability for high-speed running output and time-dependent reductions in activity in an elite soccer team using both fixed and relative speed thresholds.

Methods

Participants and match sample

Match performance was investigated in first-team players belonging to a single elite soccer team competing in the French Ligue 1 during the 2012/13 season. Over the course of the entire season a total of 31 matches (21 home and 10 away) in which match data derived from semi-automatic computerised player tracking were available for analysis. Player inclusion criteria included: 1) participation in a minimum of 10 of these matches; 2) matches in which 90-min play were completed; 3) matches in which players played in their customary position throughout play and the team playing system was unchanged. These stringent criteria led to inclusion of 12 (age: 25±3 yrs, stature: 178.1±1.0 cm and body mass: 76.9±6.8 kg) out of a possible 25 players. Players were categorised into one of five individual playing positions including full-backs (n=3), central-defenders (n=3), central-midfielders (n=3) and wide-midfielders (n=2) and centre-forwards (n=1). In total, 207 observations of match performance were obtained with a median of 17 games per player (range: 10-28).

While consent from players and club was obtained for this study, these data arose as a condition of employment in which player performance was routinely measured over the course of the

competitive season (Winter & Maughan, 2009). Therefore, usual appropriate ethics committee clearance was not required.

Data collection procedures and competitive performance-related measures

A multiple camera semi-automatic computerised player tracking system (AMISCO Pro®, Sport-Universal Process, Nice, France) was used to characterise match running performance. The workings and quality control of this match analysis system have been described elsewhere (Randers et al., 2010; Rodriguez de la Cruz, Croisier, & Bury, 2010; Zubillaga, 2006).

Two main research avenues were explored:

1) Analysis of match-to-match variability in overall high-speed running activities: To facilitate comparisons with the work previously conducted by Gregson et al. (2009), identical thresholds for high-speed activities were used: a) Total high-speed running (THSR) distance (average running speed ≥19.8 km/h over a 0.5s time interval) b) High-speed running (HSR) distance (average running speed from 19.8 km/h to 25.2 km/h over a 0.5s time interval) and c) Total sprint distance (TSD) (average running speed >25.2 km/h over a 0.5s time interval). Total high-speed running was also expressed as THSR distance completed when the players' team was in possession and out of ball possession. This distinction was made in an attempt to determine if the variation in high-speed activity was influenced by the tactical considerations associated with ball possession.

Additional novel analyses performed in this study included THSR travelled in individual possession of the ball, and the peak THSR period represented by the 5-min of play during which players covered their largest distance. In addition, an individualised approach to determining match running performance (Hunter et al, 2015) in relation to aerobic capacity represented by maximal aerobic speed (MAS) was employed. The MAS for each individual player was determined via a continuous progressive incremental running test performed on a motorised treadmill (Desmo 3.0, Woodway, Waukesha, WI, USA) at the beginning of the competitive season. This protocol employed a 4-min warm-up run performed at 10 km/h on a constant 1.5% gradient followed by 2 km/h increments for 4-min stages until voluntary exhaustion with running speed attained at volitional test termination considered MAS (Carling, Le Gall, McCall, Nedelec, & Dupont, 2013). Analysis of the distances covered by each player in relation to their individual MAS included those at 80-100% MAS, >100% MAS and ≥80% MAS (running actions over a 0.5s time interval).

2) Analysis of variations in declines in high-speed running activity: To investigate match-to-match variation in declines, the percentage change in THSR distance covered was compared across match halves (excluding injury time) and for the final 15-min period of play versus both the first 15-min period, and the mean (minus first and final periods) for all 15-min periods. The percentage change in THSR was analysed in the following 5-min period versus the preceding peak 5-min activity period and the mean value (minus peak and following periods) for all other 5-min periods. Analyses across the aforementioned match intervals were also conducted for running activity performed ≥80% MAS.

Statistical Analyses

All statistical analyses were conducted using Microsoft Excel (SPSS Inc., Chicago, IL, USA). Data are presented as means and standard deviations unless otherwise stated. Data normality was assessed by the Kolmogorov-Smirnov test. The mean data for distances covered in high-speed running activities were normally distributed and match-to-match variability for each player was examined using the Coefficient of Variation (CV). This value was derived from the means and standard deviations of the repeated match data. 95% Confidence Intervals (95%CI) were calculated for the 12 players as a whole but not for individual players as these are relevant to sample mean inference and not individual values. The data for percentage changes in high-speed running distances across the aforementioned different match intervals did not follow a normal distribution and were subsequently log-transformed (Hopkins, 2000b) to enable the calculation of the CV.

Results

Analysis of match-to-match variability in high-speed running activities

Table 1 presents match-to-match variations in overall distance covered in high-speed running (HSR), sprinting (TSD) and total high-speed running (THSR). In the cohort as a whole, CV values were highest for TSD while compared to HSR and THSR respectively: 37.1% vs. 18.1% vs. 19.8%. A comparison of the present individual CV values for THSR with those reported in a large scale study Gregson et al. (2009) is presented in Figure 1.

A trend for an increase in individual and collective variability in THSR was observed according to distance covered when the players' team was in ball possession (collective range: 16.6%-50.5%; 31.5% for all players) or not (range: 18.1%-45.6%; 26.1% for all players). Individually and collectively, the THSR distance in individual ball possession demonstrated the largest CVs while the lowest values were observed for peak 5-min THSR distance.

Regarding running efforts in relation to the three individual maximal aerobic speed thresholds (MAS) (Table 2), CV values were highest for distances covered >100% MAS. (17.0% in all players, range: 10.1%-25.2%) while at ≥80% MAS, a CV of 11.8% was observed (range: 7.8% -17.5%).

Analysis of match-to-match variability in declines in high-speed running activities

The match-to-match variations in changes in THSR activity overall across match halves are presented in Table 3, with a CV value of 37.1% reported for all players (range: 22.9%-46.4%). In relation to team ball possession, a trend for larger individual and collective variability in THSR changes was observed according to whether the players' team was in ball possession (CV range: 26.2%-189.2%; 79.2% for all players) or not (range: 36.4%-233.2%; 74.8% for all players). The lowest CV values in

changes in running activity across halves were observed for distances covered ≥80% MAS (range: 6.4%-38.3%; 20.9% for all players).

Table 4 presents match-to-match variability in changes in THSR over 15-min intervals. The CV value for the % change in THSR covered between 0-15 mins and 75-90 mins for all players was 108.3% (range: 56.4%-286.6%). Regarding the % change in THSR covered between 75-90 mins and the mean for all 15-min periods, CV values ranged from 31.8% to 228.2% with a value of 85.4% in all players. Analysis of % changes in running performance across 15-min intervals reported lower CV values for distance covered according to ≥80% MAS for the 75-90 min period versus 0-15 min (range: 27.8%-68.8%, 43.3% for all players) and versus the mean for all 15-min periods (range: 15.6-53.3%, all players: 33.7% for all players).

Individual and group match-to-match variations in changes in running activity overall across 5-min intervals are presented in Table 5. The CV for the change in THSR distance for the following 5-min period versus the peak 5-min period ranged from 63.4% to 221.9% with a value of 134.0% reported for all players). In the cohort as a whole, a CV of 142.6% was observed for the change in THSR distance in the following period after the peak period versus the mean for all 5-min periods (range: 63.4%-241.7%. Regarding distance covered at ≥80% MAS, CV values for the aforementioned analyses across 5-min periods showed values that were lower than those reported for THSR (range: 34.4%-81.5%; ~50% for all players).

Discussion

The present study examined match-to-match variability of high-speed running activities in elite soccer. It aimed to quantify variability in a single club context and compare data with that previously reported notably in large scale studies conducted by Bush et al. (2015) and Gregson et al. (2009). Novel high-speed activity variables such as running in individual possession of the ball and in the peak 5-min period were also investigated, as were the effects of individual fitness characteristics on variability. Finally, the study also examined the variability in declines in high-speed running performance across match periods.

Match-to-match variability in high-speed running activities

In the time motion analysis literature generally, there is little information on match-to-match variations in running performance in elite standard soccer players. While large sample sizes enable precise estimates of the between match variation in high-speed activity across a professional League generally, the present study provides repeated match measures in the same players that were directly relevant to an individual team context (Carling et al., 2014). Here, the CV value for THSR across the 12 players collectively equalled 19.8% (95% CI 17.1, 22.5). This result is not dissimilar to data previously reported in elite Italian (Rampinini et al., 2009: 14.4%), English (Gregson et al., 2009: 17.7%; Bush et al., 2015; range 14-20%) and Danish players (Mohr et al., 2003: 24.8%).

The CV values for THSR covered according to individual playing positions ranged from 11% in a fullback to 25.7% in a central defender. In comparison, Bush et al. (2015) and Gregson et al. (2009) reported THSR CV values ranging from ~15% in wide-midfielders to ~20% in central-defenders. While these position-specific discrepancies in CV values across reports might partly be related to contextual differences affecting running demands that are inherent to various top soccer Leagues (here French Ligue 1 vs. English Premier League), the present data suggest that the results obtained from larger scale studies (Bush et al. 2015; Gregson et al. 2010: 451 and 485 English Premier League players respectively) cannot always be generalised to single club contexts and that clubs should quantify match-to-match variability in their own players. However, despite the differences in the range of CV values reported above, it is important to compare whether the lower and upper values reported here (fullback: 11.0% and central-defender: 25.7%) would still fit into an 'expected' range (e.g., 95% of individuals in a large sample population) for their playing position. Using information reported in Gregson et al. (2009), reference ranges (calculated from the SD of mean CV values) for their central defenders and fullbacks were 8.3%-33.3% and 5.0-30.8% respectively. Values in the present fullbacks and central-defenders in the present club were close to the extremities of this reference range. Furthermore, the disparity in CVs for THSR across the three present fullbacks is noteworthy (11.0%, 17.4% and 21.4%) and suggests a need to quantify individual variability across players performing in a single positional role. Together, these results strengthen the aforementioned point on the need to determine match-to-match variability in individual club settings

Akin to results in Gregson et al. (2009), the present CV values for THSR according to team ball possession demonstrated substantially higher variability than for THSR alone (26% and 32% when team was in and out of possession). A considerably larger variability (>37%) in comparison to THSR was also reported for the TSD variable which reflects findings reported by Bush et al. (2015). Together, these results demonstrate substantial inconsistency across matches in high-speed running activity when a team is in ball possession or not as well as in producing near or maximal running efforts. These findings thereby cast doubt on the appropriateness of these high-speed activity variables as stable indicators of match performance. However, in comparison to the work by Gregson et al. (2009), a relatively higher CV value (37% vs. 31%) and wider confidence intervals for TSD were reported across the present cohort as a whole again demonstrating the need for clubs to quantify their own match-to-match variability.

In this study, variability in several high-speed activity metrics not previously examined in the literature was quantified. Analysis of THSR covered in individual ball possession reported a large range of CVs across positional roles: 27.8% in a central-midfielder to 96.6% in a central-midfielder and 60.1% for all players. This result shows a high level of inconsistency in reproducing high-speed efforts with the ball across matches and casts doubt on the use of this variable as part of a precise and stable set of indicators of match running performance. Similarly, the peak 5-min period for THSR covered demonstrated CVs across individuals ranging from 15.6% to 31.2% (23.9% in all players,

95% CI 21.5-26.3). This finding is noteworthy as it suggests that the present players were more inconsistent from match-to-match in reproducing high-intensity running distances 'transiently' than globally for 90-min play. This result on one of the 'key' match fitness requirements has practical implications. It notably casts doubt on whether it is feasible to determine whether a meaningful change in high-speed running activity has occurred following a training intervention that aims to replicate and subsequently improve performance for the most intense demands of the game. Additional research using a greater number of players and match observations is nevertheless important to verify these findings.

Finally, match-to-match variability in running activity was examined according to aerobic fitness using distances covered at different percentages of MAS (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010; Hunter et al., 2014). Individual and group CVs were generally lower for distances covered at 80-100%, >100% and ≥80% MAS compared to those reported for the fixed high-speed thresholds. For instance, comparisons of CVs for running performed at the highest intensities, >100% MAS versus >25.2km/h, showed values of 17.0% and 37.1% respectively. This finding is noteworthy and has implications for practitioners and researchers as it suggests that high-speed running thresholds individualised according to player fitness characteristics might provide more stable indicators of running performance than arbitrary defined thresholds. A possible explanation for this finding could be that the players consciously or unconsciously adopted individual pacing strategies to regulate physical exertion across matches and remain within their 'physiological limits' (Bradley & Noakes, 2013). Thus the distances they cover are less variable when adjusted for individual fitness characteristics. In future studies, first-hand match-to-match accounts from the players on potential pacing strategies combined with subjective ratings of perceived exertion would be useful in interpreting variations in match performance. Information from additional fitness testing protocols (e.g., combinations of maximal sprinting speed, anaerobic threshold, Yo-Yo Intermittent Recovery Tests) to individually adjust speed thresholds and strengthen analysis and interpretation of time motion analysis data is also warranted to verify the present findings (Hunter et al. 2015; Lovell & Abt, 2013).

Variations in declines in high-speed running activities

Time motion analyses have generally provided strong evidence of time-dependent reductions in the high-speed distances covered by players over the course of elite match-play (Carling, 2013). To our knowledge, the present study is the first to have quantified match-to-match variability in changes in high-speed running activity across match intervals. Here, CV values for the % change in THSR across halves ranged from 22.9% in a fullback to 46.4% in a central-defender while a value of 37.1% was observed for all players. These large discrepancies across positional roles can be linked to the changes in THSR covered according to team ball possession (in and out of possession). While CVs >70% were reported for changes in high-speed distances covered according to possession across match halves in all players, values >150% in two-central defenders when their team was in possession and in two

wide-midfielders when their team was not in possession were observed. Overall, this considerable individual and collective variability casts doubt on the appropriateness of declines in high-speed running distances as stable enough indicators of the occurrence of physical fatigue in games. It also confirms the practical difficulties in interpreting whether a meaningful reduction in running performance has actually occurred (Carling, 2013). The lower individual and group CVs reported for declines in distance run ≥80% MAS (20.9% in all players) are noteworthy and again could be linked to the aforementioned point on the self-regulation of efforts in order to reduce the onset of accumulated fatigue.

Collectively, the CV values for the declines in THSR during the final period versus the first 15-min period and the mean for all 15-min periods surpassed 80%. Similarly, data for the THSR covered in the 5-min period following the peak 5-min period of activity reported a CV value for all players of >100%. These results once more demonstrates the difficulties in interpreting end and transient declines in high-speed running activity and the magnitude to which fatigue in reality occurs in elite match-play. In comparison however, when variability in these changes across 5- and 15-min periods were analysed according to the distance covered ≥80% MAS, substantially lower CVs were again reported. The aforementioned potential pacing strategies are once again a reasonable explanation for this finding. Future work could investigate the appropriateness of match-to-match variations in diminutions in the frequency of 'hard' acceleration and deceleration actions (Akenhead, Hayes, Thompson, & French, 2013) as alternative indicators of fatigue over the course of play. Similarly, while recent evidence shows that the match-to-match frequency of technical events is highly variable (Bush et al., 2015, Liu, Miguel-Angel, Gonçalves, & Sampaio, 2015), research is warranted to determine variability in transient and end-match changes in the occurrence of and success rates in actions such as ball possessions, passing and tackling.

Strengths and limitations

The main strength here was the stringent individual match profiling using repeated measures in the same players who systematically performed in the same positional role and in a team using the same playing system. This is important as it reduced the potential confounding effects of playing style and tactical organisation of teams which inherently influence match variability (Bush et al, 2015). Here, contextual issues such as home and away games and score-line and their effects on high-speed movement activity were unaccounted for in the analysis. However, complementary analyses (not reported here) show that when running data for each variable were adjusted for effective playing time (Castellano, Alvarez-Pastor & Bradley, 2014), similar CV values to those for overall activity were generally reported individually and for players as a whole (e.g., THSR CV in all players: overall=19.8% vs. effective time=20.0%).

Another potential limitation was the single measure of MAS obtained at the start of the playing season used to investigate variability in running activity in relation to aerobic fitness.

Between-match variability in running activity is dependent upon the time of the season at which data are collected (Gregson et al. 2009) and research is necessary to determine whether there is an association between this variation and potential changes in player fitness characteristics.

Conclusion

In summary, these data show that the high-speed activity completed by players in a single professional soccer team during competition is highly variable across and within matches. Some discrepancies in variability were reported in comparison to results previously published in larger scale studies suggesting that the results obtained using large samples cannot always be generalised to individual club contexts and demonstrates a need for clubs to quantify their own match-to-match variability. Very high between-match variations were observed for end-match and transient reductions in high-speed running performance casting doubt on the appropriateness of declines in such variables as stable enough indicators of the occurrence of fatigue. Finally, the match-to-match variability in distances covered according to individual aerobic capacity was generally lower implying a link with the self-regulation of efforts to reduce the risk of fatigue. Systematic individualisation of high-speed running thresholds according to player fitness characteristics might therefore provide more stable indicators of running performance.

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Table 1: Analysis of individual match-to-match variability in high-speed running distance.

Positional role N° of match observations	Fullback (n=19)	Fullback (n=28)	Fullback (n=11)	Centre-half (n=19)	Centre-half (n=26)	Centre-half (n=10)	Central-midfield (n=10)	Central-midfield (n=17)	Central-midfield (n=26)	Wide-midfielder (n=18)	Wide-midfielder (n=12)	Centre-forward (n=11)	All players (n=207)
Distance covered 19.8>25.2km/h													
Overall													
Mean SD	743±79	681±115	663±145	347±67	397±95	439±84	629±95	633±96	506±97	743±110	596±135	652 ±119	587±133
%CV (95% CI)	10.7	16.9	21.8	19.4	24	19.2	15	15.2	19.1	14.8	22.7	18.3	18.1 (16.0, 20.3)
Distance covered >25.2km/h													
Overall													
Mean SD	252±54	227±71	270±79	112±62	104±47	108±63	116±57	107±29	93±43	349±100.9	223±76	247±48	184±87
%CV (95% CI)	21.5	31.4	29.1	55.4	44.7	58.3	48.9	27.1	46	29	33.9	19.5	37.1 (29.7, 44.5)
Distance >19.8km/h													
Overall													
Mean SD	995±110	908±158	933±200	458±118	502±129	547±135	745±142	740±110	599±124	1091±179	819±196	899±154	770±206
%CV (95% CI)	11	17.4	21.4	25.7	25.7	24.7	19.0	14.8	20.7	16.4	23.9	17.1	19.8 (17.1, 22.5)
Own team ball possession													
Mean SD	367±70	446±116	482±128	112±57	143±56	130±51	390±149	245±97	167±68	800±133	649±166	719±134	388±240
%CV (95% CI)	18.9	26	26.6	50.5	38.8	38.8	38.3	39.5	40.8	16.6	25.6	18.6	31.5 (25.3, 37.7)
Opposition possession													
Mean SD	667±121	492±105	477±128	383±110	390±117	449±103	336±83	514±98	446±94	286±89	196±90	214.±50.	404±134
%CV (95% CI)	18.1	21.4	26.8	28.7	30.1	22.8	24.7	19	21.2	31.1	45.6	23.4	26.1 (21.9, 30.3)
Individual ball possession													
Mean SD	34±22	46±29	40±27	31±30	38±27	33±21	48±13	17±11	37±23	126±49	123±52	89±48	55±37
%CV (95% CI)	64	62.9	67.8	96.6	72.9	65.2	27.8	66.3	62.1	38.6	42.1	54.7	60.1 (40.0, 70.2)
Peak 5-min period													
Mean SD	121±21	110±27	109±30	75.2±19	71±20	82±18	92±24	95±24	77±24	120±19	97±20	101±24	94±16
%CV (95% CI)	17.6	24.4	27.3	25.4	27.7	22.5	25.6	25.1	31.2	15.6	20.7	23.6	23.9 (21.5, 26.3)

Table 2: Analysis of individual match-to-match variability in high-speed running according to maximal aerobic speed.

Positional role	Fullback	Fullback	Fullback	Centre-half	Centre-half	Centre-half	Central-midfield	Central-midfield	Central-midfield	Wide-midfielder	Wide-midfielder	Centre-forward	All players
N° of match observations	(n=19)	(n=28)	(n=11)	(n=19)	(n=26)	(n=10)	(n=10)	(n=17)	(n=26)	(n=18)	(n=12)	(n=11)	(n=207)
Maximal aerobic speed (MAS)													
Distance 80-100% MAS													
Mean SD	1202±139	1024±155	1005±93	802±109	838±134	849±167	1663±170	1554±187	1051±173	887±111	1018±144	976±81	1073±275
%CV (95% CI)	11.5	15.2	9.3	13.6	16.0	19.6	10.2	12	16.4	12.5	14.2	8.3	13.2 (11.3, 15.1)
Distance >100% MAS													
Mean SD	1286±142	1189±203	1556±290	869±152	677±170	832±201	1412±192	1502±194	804±167	1760±179	1473.9±288	2071±275	1286±427
%CV (95% CI)	11.0	17.1	18.6	17.5	25.2	24.1	13.6	12.9	20.8	10.1	19.6	13.3	17.0 (14.2, 19.8)
Distance >80% MAS													
Mean SD	2487±194	2213±287	2561±313	1671±195	1515±223	1682±316	3075±260	3056±257	1855±291	2647±217	2492±348	3046±275	2358±557
%CV (95% CI)	7.8	12.9	12.2	11.7	14.7	18.8	8.5	8.4	15.7	8.2	14.0	9.0	11.8 (9.8, 13.8)
Distance peak 5-min period >80% MAS													
Mean SD	231±21	212±26	236±24	171±30	159±24	157±36	275±18	274±33	175±31	240±27	228±38	268±46	219±44
%CV (95% CI)	9.1	12.3	9.9	17.7	15	23.1	6.6	12.1	17.5	11.2	16.5	17.1	14.0 (11.4, 16.6)

Table 3: Analysis of individual match-to-match variability in changes in high-speed running distance across match halves.

Positional role	Fullback	Fullback	Fullback	Centre-half	Centre-half	Centre-half	Central-midfield	Central-midfield	Central-midfield	Wide-midfielder	Wide-midfielder	Centre-forward	All players
Number of match observations	(n=19)	(n=28)	(n=11)	(n=19)	(n=26)	(n=10)	(n=10)	(n=17)	(n=26)	(n=18)	(n=12)	(n=11)	(n=207)
Distances covered >19.8km/h													
Overall													
1st half	508±84	494±114	461±71	217±64	251±80	278±61	403±88	371±78	297±84	550±106	436±101	475±103	395±111
2nd half	487±87	415±95	471±139	241±79	250±80	269±91	342±86	369±81	302±82	541±120	384±116	425±120	375±98
% Difference in means±SD	-4.3±33.7	-16.0±27.1	2.1±22.0	11.3±43.2	-0.4±34.0	-3.5±35.5	-15.0±22.1	-0.6±31.4	1.6±39.7	-1.6±24.6	-12.0±22.9	-10.4±33.5	-4.1±8.0
%CV (95% CI)	36.1	35.8	22.9	46.4	41.8	45.4	30.0	38.7	42.7	31.1	29.8	43.9	37.1 (33.9, 41.3)
Own team ball possession													
1st half	199±61	255±94	222±60	50±30	76±31	74±28	224±93	127±58	83±40	408±74	347±91	380±79	204±126
2nd half	169±46	192±78	259±85	62±50	67±38	57±39	166±88	118±50	84±41	392±101	301±88	338±104	184±115
% Difference in means±SD	-15.2±58.3	-24.7±81.1	16.4±37.9	25.5±194.5	-12.2±52.7	-23.5±54.3	-25.7±41.9	-6.8±47.5	1.7±58.8	-4.1±26.4	-13.2±19.9	-11.0±34.9	-7.7±15.9
%CV (95% CI)	66.1	91.5	34.1	189.2	90.9	156.0	72.9	60.6	86.1	35.0	26.2	42.2	79.2 (51.1, 107.3)
Opposition ball possession													
1st half	322±121	252±75	252±46	777±57	191±74	221±45	172±37	252±76	222±77	140±50	90±50	109±44	245±179
2nd half	345±87	240±62	224±104	738±75	199±66	228±75	164±58	261±62	224±56	146±62	107±57	105±46	248.4±168
% Difference in means±SD	7.0±79.2	-4.8±38.4	-11.1±37.9	-5.0±51.5	4.5±42.9	2.9±37.5	-4.5±30.9	3.5±42.2	1.2±48.5	4.7±67.5	18.6±86.6	-3.8±83.3	1.1±7.7
%CV (95% CI)	54.7	45.4	47.7	49.3	45.4	51.6	36.4	49.5	53.9	233.2	116.3	114.4	74.8 (42.9, 106.7)
Maximal aerobic speed (MAS)													
>80% MAS													
1st half	1280±180	1187±192	1307±163	852±122	777±133	898±119	1640±120	1583±164	924±168	1358±151	1284±172	1588±213	1223±302
2nd half	1207±119	1026±197	1254±197	819±138	738±139	784±246	1435±189	1473±187	931±193	1289±174	1209±184	1458±140	1135±268
% Difference in means±SD	-5.7±19.4	-13.5±22.2	-4.0±13.8	-3.8±19.7	-5.0±20.0	-12.8±26.8	-12.5±10.7	-6.9±14.3	0.8±31.5	-5.1±18.3	-5.8±6.1	-8.2±14.6	-6.9±4.3
%CV (95% CI)	21.6	27.2	15.2	23.3	23.5	38.3	12.7	17.1	28.2	20.7	6.4	16.7	20.9 (16.2, 25.6)

Table 4: Analysis of individual match-to-match variability in changes in high-speed running across 15-minute intervals.

Positional role	Fullback	Fullback	Fullback	Centre-half	Centre-half	Centre-half	Central-midfield	Central-midfield	Central-midfield	Wide-midfielder	Wide-midfielder	Centre-forward	All players
Number of match observations	(n=19)	(n=28)	(n=11)	(n=19)	(n=26)	(n=10)	(n=10)	(n=17)	(n=26)	(n=18)	(n=12)	(n=11)	(n=207)
Distances covered >19.8km/h:													
15min intervals													
0-15mins interval	188±45	197±52	186±51	79±40	98±41	110±45	158±55	148±46	97±46	199±69	179±48	164±38	150±43
All 15min intervals	163±25	144±28	141±29	77±21	78±21	79±16	115±22	115±23	98±21	181±33	127±37	156±30	123±35
75-90min interval	155±67	136±56	184±83	73±39	90±56	121±66	127±51	130±54	110±48	169±59	131±50	113±67	128±31
% difference in means													
0-15mins vs. 75-90mins	-17.2±45.1	-30.9±39.5	-1.0±50.9	-7.4±130.5	-7.9±120.8	9.9±58.0	-19.7±51.6	-12.5±57.4	13.1±157.7	-15.2±44.2	-26.6±34.6	-31.1±55.8	-12.2±14.5
%CV (95% CI) for % difference	86.1	68.7	56.4	286.6	252.2	72.1	66.0	90.3	100.0	58.1	61.3	102.2	108.3 (64.6, 152.0)
Mean all 15mins vs. 75-90mins	-4.7±55.8	-5.5±42.3	30.4±43.8	-5.2±52.5	14.8±83.4	53.6±75.3	9.8±41.7	12.2±57.3	12.7±45.9	-6.5±43.5	2.9±30.8	-27.2±41.7	7.3±20.6
%CV (95% CI) for % difference	88.1	60.1	48.2	228.2	214.4	59.4	51.3	70.0	49.5	45.4	31.8	78.8	85.4 (48.5, 122.4)
>80% Maximal aerobic speed (MAS)													
0-15mins interval	453±86	454±78	301±59	317±70	302±64	331±64	588±59	588±108	290±72	480±72	502±92	586±71	433±120
All 15min intervals	398±41	341±51	244±65	263±37	230±38	260±44	480±51	476±49	297±54	440±45	385±68	512±61	361±102
75-90min interval	379±103	335±133	278±111	248±77	242±84	298±143	478±98	453±110	311±93	389±91	418±88	409±121	353±79
% difference in means													
0-15mins vs. 75-90mins	-16.3±36.6	-26.1±31.4	-7.7±23.8	-21.8±37.1	-19.9±20.0	-10.0±32.2	-18.7±20.2	-23.0±30.7	7.1±53.9	-18.9±26.8	-16.8±21.0	-30.3±24.8	-16.9±9.8
%CV (95% CI) for % difference	47.3	50.7	32.5	68.8	42.2	49.9	28.8	46.5	50.5	40.3	27.8	34.2	43.3 (36.7, 49.9)
Mean all 15mins vs. 75-90mins	-4.6±27.6	-1.9±36.3	13.5±27.8	-5.6±26.2	5.3±32.6	14.8±45.3	-0.3±17.5	-5.0±23.4	4.6±24.3	-11.4±21.2	8.5±15.8	-20.2±24.2	-0.2±10.2
%CV (95% CI) for % difference	35.8	44.4	32.3	42.5	36.6	53.3	21.7	31.3	26.0	30.2	15.6	35.2	33.7 (27.9, 35.5)

Table 5: Analysis of individual match-to-match variability in high-speed running across 5-minute intervals.

Positional role	Fullback	Fullback	Fullback	Centre-half	Centre-half	Centre-half	Central-midfield	Central-midfield	Central-midfield	Wide-midfielder	Wide-midfielder	Centre-forward	All players
Number of match observations	(n=19)	(n=28)	(n=11)	(n=19)	(n=26)	(n=10)	(n=10)	(n=17)	(n=26)	(n=18)	(n=12)	(n=11)	(n=207)
Mean distances covered >19.8km/h:													
5min intervals													
Peak 5min period	121±21	110±27	109±30	75±19	71±20	82±18	92±24	95±24	77±24	120±19	97±20	101±24	95±17
Following 5mins	50±30	41±29	50±40	15±15	25±18	28±15	36±22	38.9±17	25±21	44±29	37±23	49±22	35±11
All 5min periods	51±6	48±9	49±10	23±6	26±7	28±7	39±7	38±6	31±6	57±9	43±11	47±9	39±11
% difference in means													
Peak 5mins vs. following 5mins	-58.7±26.5	-63.0±29.4	-54.5±30.4	-80.6±20.3	-64.6±24.8	-65.9±15.5	-61.4±21.0	-59.1±20.1	-68.0±62.1	-63.3±26.4	-61.7±37.2	-51.0±40.9	-62.7±91.6
%CV (95% CI) for difference	90.5	175.3	129.8	208.6	194.7	63.4	112.8	84.6	221.9	158.7	83.1	84.1	134.0 (102.5, 165.5)
Mean 5mins vs. Following 5mins	-2.3±62.0	-14.1±66.0	2.4±72.2	-37.9±69.2	-2.6±72.1	1.4±44.6	-7.7±52.1	1.8±50.0	-21.2±63.1	-22.5±49.4	-13.2±31.3	4.6±55.4	-9.3±54.4
%CV (95% CI) for difference	96.2	200.1	134.5	220.6	241.7	63.4	125.3	82.8	235.7	161.8	76.4	72.3	142.6 (105.5, 180.7)
>80% Maximal aerobic speed (MAS)													
Peak 5min period	231±21	212±26	236±23	171±30	159±24	157±36	275±18	274±33	175±31	240±27	228±38	268±46	212±44
Following 5mins	119±41	117±47	134±42	74±36	76±39	74±38	155±43	153±40	105±35	124±55	115±46	133±43	112±39
All 5min periods	134±11	118±16	137±18	89±10	80±13	84±22	166±14	164±16	98±17	143±11	134±19	165±16	121±22
% difference in means													
Peak 5mins vs. following 5mins	-48.4±19.1	-44.8±20.9	-43.1±18.7	-57.0±22.0	-52.4±26.7	-53.0±24.8	-43.5±15.8	-44.0±15.6	-40.1±21.8	-48.3±22.9	-49.4±17.8	-50.4±16.1	-47.9±21.2
%CV (95% CI) for difference	47.3	61.7	34.4	69.1	81.1	81.5	36.5	33.1	59.3	63.9	53.9	41.6	53.3 (43.6, 63.0)
Mean 5mins vs. Following 5mins	-10.7±32.8	-0.5±39.6	-1.9±32.1	-17.6±42.2	-5.6±52.3	-12.5±47.3	-6.4±27.4	-6.7±25.6	6.2±40.0	-13.4±34.0	-14.1±29.0	-19.7±26.4	-8.4±38.1
%CV (95% CI) for difference	35.8	62.5	34.4	69.0	76.0	80.4	38.5	33.3	57.8	59.0	53.6	35.3	53.0 (43.3, 62.7)