Variation in Top Level Soccer Match Performance

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- elite football
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- reliability

Abstract

This study examined the influence of the opposing team, seasonal variations and the influence of first half activity on match performance in top-level soccer players. Physical performance measures were collected using the ProZone® match analysis system from 20 professional soccer players from the same team and their opponents (n = 188) during a season. Match activities (standing, walking, jogging, running, high-speed running and sprinting), distances (total distance [TD], high-intensity running [HIR] and very high-intensity running [VHIR]) and other measures including involvement with the ball and peak running speed were collected. The influence of opponent team, the level of opposition, first half physical activities on second half activities, and playing position were analysed. The main finding was that TD ($r = 0.62$, $p < 0.05$), HIR ($r = 0.51$, $p < 0.05$), and VHIR ($r = 0.65$, $p < 0.05$) of the reference team was influenced by the activity profile of the opponent teams. The TD and HIR was higher against Best opponent teams compared to Worst opponent teams ($p < 0.05$), and the TD, HIR and VHIR travelled in the first half significantly influenced the distances covered in the second half. TD, HIR and VHIR were greater at the end of the season. These results may be used to interpret meaningful changes in match performance in top level soccer.

Introduction

Soccer is the world's most popular sport played in almost every nation at the professional level [19]. There have been many studies that have described the match activity profiles of top-level soccer players [1,2,4,6,11 – 13,15 – 17,20]. In general, these studies have shown that top-level soccer players cover more total distance and/or high-intensity running compared to lower level players [2,6,13,17,20]. Other studies have shown that each playing position in top-level soccer is characterised by a typical activity profile [4,13, 20] and match performance is also influenced by the type of competition that the players are participating in [20]. For example, Mohr et al. [13] reported that defenders cover less total distance and complete less high-intensity running, while attackers and fullbacks sprinted more than midfielders and defenders in the top-level. During the second half, the total distance and high-intensity running has been shown to decline as a consequence of the fatigue induced by the first half [2,13,18,22]. Finally, previous research has also shown that the match performance measures of total distance covered and distance covered through high-intensity running of the top-level players varied throughout the season and peaked at the end of the season [13].

Most of the studies that have quantified running performance in top-level soccer players have used the manual time motion analysis method [2,7,9,13,20,23]. This method requires individual players to be filmed during match play and later have their locomotor activities manually coded during a video replay. Unfortunately, this method of analysis is both time and labour intensive [17]. Until recently these methodological limitations have prevented the broad use of time and motion analysis for evaluation of physical match performance in top-level soccer. Moreover, these limitations may also explain why other important aspects of physical match performance such as the influence of the opponent and/or their competitive abilities have not yet been investigated in top-level soccer.

The recent development of the computerised, semi-automatic video match analysis image rec-

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ognition systems now allow top-level soccer teams to quantify extensive match performance data within a few hours after the completion of a game. These advancements now permit highly detailed analysis of factors relating to physical match performance and notational analysis [4,15]. Indeed, these semi-automated systems can track every movement of every player, as well as the ball on the soccer pitch for each second during each game. The data collated by these automated systems can then be systematically integrated and analysed so that running performance and each player's involvement with the play can be precisely evaluated. In fact, these systems have now made it simple to obtain the activity profile of each player both with and without the ball, and also quantify running speeds achieved during the match. Collectively this information can be used to provide a comprehensive evaluation of the competitive physical demands of top-level soccer players [4,15]. Due to these qualities, semi-automatic video match analysis systems are now commonly used by many of the world leading soccer clubs.

Only one study [4] has analysed data collected by a semi-automated video-computerised match analysis system from a top-level soccer team and no study has collected this data during an entire season. The purpose of this study was to examine several aspects of top-level soccer running performance that have not yet been fully investigated. Accordingly, there were six discrete aims of this study. These were to: 1) examine the relationship between the match-related running performance of the opponent team on the reference team; 2) determine if the ability level of the opposing team influences match-related running performance; 3) determine if playing position within a team influences the interaction with the ball during a game; 4) verify if physical performance during the first half of a competitive match influences the physical performance during the second half of a competitive match; 5) determine match to match variations and reproducibility of match analysis data; and, 6) examine variations in match-related running performance throughout an entire competitive season. Combined, the data from this study may be used to assist coaches and scientists involved with soccer in evaluating the effects of training or tactical interventions on the basis of match running performance.

Material and Methods

Subjects and soccer match data

Objective measures of match-related physical performance were systematically collected on 20 professional top-level soccer players (age: 26.4 ± 4.3 y, body mass: 81.3 ± 7.6 kg, and height: 1.82 ± 0.05 m) from the same team. The reference team investigated in this study was a successful team that participated in a major European National League and also reached the semi-final phase in the Union of European Football Associations (UEFA) Champions League. Fourteen of the players analysed from the reference team in this study were representatives of their home nations (7 nations) and five of them were among the strongest in the world (ranked 1 – 8 on the official Fédération Internationale de Football Association [FIFA] list). All players from the reference team were observed during a whole competitive season totalling 34 official soccer matches (6 UEFA European Champions League matches, 3 National Cup games, and 25 National League matches). There were 22 "home" games and 12 "away" games analysed in this study. In addition, objective measures of match-related physical performance were also collected on players (n = 188) from every opposing team during 26 matches throughout the season.

Match analysis data

Each match was monitored using a computerised, semi-automatic video match analysis image recognition system (data were supplied by ProZone® [Leeds, England] and published with formal permission of the company). This method uses six cameras (three for each side of the pitch) and allows collection of the match analysis data of all the players involved in the game. Data from approximately 60 different match indices for each player were provided by the ProZone® proprietary software. Recent research has shown this system to be a valid motion analysis system for analysing movement patterns of footballers on a football pitch [5]. The objective measures of match running performance selected for the analysis were classified into three categories: 1) match activities, 2) match distances and 3) other match analysis measures.

Match activities

The time spent in six locomotor categories (standing [from 0 to 0.7 $km \cdot h^{-1}$], walking [from 0.7 to 7.2 $km \cdot h^{-1}$], jogging [7.2 to 14.4 $km \cdot h^{-1}$], running [from 14.4 to 19.8 $km \cdot h^{-1}$], high-speed running [from 19.8 to 25.2 $km \cdot h^{-1}$], and sprinting [> 25.2 $km \cdot h^{-1}$]).

Match distances

1) total distance covered (TD); 2) high-intensity running distance (running speed > 14.4 $km \cdot h^{-1}$, HIR); 3) very high-intensity running distance (running speed > 19.8 $km \cdot h^{-1}$, VHIR).

Other match analysis measures

1) VHIR distance with the ball ($VHIR_{WB}$) and without the ball ($VHIR_{WOB}$); 2) frequency of HIR and VHIR; 3) the highest speed recorded during the game for each player (peak speed).

Criteria of data classification for comparisons

Relationship with the activity profile and level of the opponents

The relationships between physical performance of the reference team and their opponent team were examined using the mean data collected from each player during 34 officially sanctioned matches. For each match, only the players that completed the entire game were included in the analysis. The opponent teams were divided into two groups according to their competitive level. The opponent teams that participated in the Champions League and finished in the highest eight places in the National League at the end of the competition were included in the "Best" teams group. The remaining teams were assigned to the "Worst" teams group. Total match distances data (n = 244) of the reference team were divided into two subsets according to the level classification of the opponent teams (n = 124 against the Best teams and n = 120 against the Worst teams).

Activity profile in relation to playing position

Data from 208 professional soccer players were divided into four subsets according to playing position (centre-back, fullback, midfielder and forward) for all the objective measures of match performance. Individual players were observed between 1 to 30 matches, with many opponent team players only measured once, whilst, several of the reference team players were observed 30 times. The mean data obtained from all the matches

completed by each individual player throughout the study were used for this analysis.

Effect of activity in the first half on the second half

Using the median split technique, the individual player data (n = 455) for TD during the first half were divided into two subsets on the basis of the total distance covered in the first half (i.e., "High" and "Low"). The High subset included the data of players that covered an amount of distance above the median value, and the Low subset included the data of players that covered an amount of distance below the median value. Comparisons were then made to examine if the TD for the first half (i.e., High vs. Low) influenced the TD in the second half. The same procedure and analysis was applied using the first half HIR and VHIR data.

Match-to-match variability, reproducibility and seasonal variations

Match-to-match variations of TD, HIR, and VHIR were determined from 20 players analysed in two consecutive soccer matches played within a week. Reproducibility was verified in 12 soccer players that played two matches within one week against the same opponent team. The seasonal variations were investigated comparing the mean TD, HIR, and VHIR of 16 players from the reference team during three periods of the competitive season: start (16 matches from September to November), mid (21 matches from December to February), and end (15 matches from March to May). For each period, data was collected from each of the 16 players between two to ten times, with the average value for each selected parameter of match running performance used for the analysis.

Statistical analysis

Data are presented as the mean ± standard deviation (s). Before using parametric statistical test procedures, the assumptions of normality and sphericity were verified. Statistical significance was set at $p < 0.05$.

Relationship with the activity profile and level of the opponents

The relationships between the mean TD, HIR, and VHIR of the reference team and of its opponents were examined using Pearson's product moment correlation. Unpaired *t*-test was used to compare the mean TD, HIR, and VHIR distances covered by the soccer players of the reference team against the "Best" versus the "Worst" opponents' teams. Effect sizes (d) for these differences were also determined. Effect size values of 0.2, 0.5 and above 0.8 were considered to represent small, medium and large differences, respectively [3]. To show the precision of the d measures, the 95% confidence intervals (CI) were also calculated.

Activity profile in relation to playing position

A one-way analysis of variance (ANOVA) was used to test the differences in the objective measures of match running performance (dependent variables) between the four playing positions (independent variable). To control the Type-I error rate a pseudo-Bonferroni's adjustment was used dividing the α level by the number of categories in which the objective measures of match running performance were classified (match activities, match distances and other match analysis measures). Thus, an operational α level of 0.017 ($p < 0.05/3$) was used for F values. When a significant F value was found, Bonferroni's post-hoc tests were applied. The η^2 used to interpret these results were also adjusted so that 0.01, 0.06 and above 0.15 were considered small, medium and large, respectively [3].

Table 1 Match distances covered by players of reference team against the Best and Worst opponent teams

	TD (m)	HIR (m)	VHIR (m)
Against best (n = 124)	11 097 ± 778	2 770 ± 528	902 ± 237
Against worst (n = 120)	10 827 ± 760*	2 630 ± 536*	883 ± 268
Effect size (d)	0.35 (0.10; 0.60)	0.26 (0.01; 0.51)	0.07 (– 0.18; 0.32)

TD = total distance covered; HIR = distance covered at high-intensity running; VHIR = distance covered at very high-intensity running. * $p < 0.05$; significantly lower from best group. 95% confidence intervals shown for d

Effect of activity of the first half on the second half

A two-way mixed ANOVA (2 × 2 design) was used on each dependent variable to examine the effect of the amount of physical activity completed in the first half on the subsequent second half physical performance measures. The independent variables included one between-subject factor (amount of first half match distance) with two levels (High and Low), and one within-subjects factor (time) with two levels (first and second half). ANOVAs were used to verify the null hypotheses of no differences over half times between the two groups (amount of first half match distance × time interaction). When a significant F value was found Bonferroni's post-hoc tests were applied. Effect sizes (η^2) were also calculated.

Match-to-match variability, reproducibility and seasonal variations

Match-to-match variations and reproducibility of match distances were determined using typical error as a coefficient of variation (CV) [8]. A one-way ANOVA was also used to examine the seasonal variations (independent variable) in match distance data (dependent variables). When a significant F value was found Bonferroni's post-hoc tests were applied. Effect sizes (η^2) were also calculated.

Results

Relationship with the activity profile and level of the opponents

The mean TD covered during the games by the reference team and the opposing teams were 11 019 ± 331 m and 10 991 ± 381 m, respectively. The mean distances in HIR and VHIR were 2738 ± 220 m and 903 ± 115 m for the reference team and 2636 ± 230 m, 856 ± 127 m for the opposing teams. Significant correlations were found between TD ($r = 0.62$, $p < 0.001$, CI 0.36; 0.79), HIR ($r = 0.51$, $p < 0.05$, CI 0.21; 0.72), and VHIR ($r = 0.65$, $p < 0.001$, CI 0.40; 0.81) of the reference team and its opposing teams. **Table 1** shows the TD and HIR of the reference team were higher when playing against the Best teams than against the Worst teams (all $p < 0.05$), while no significant difference was found for VHIR. The effect sizes measured between these variables were small ($d < 0.36$).

Activity profile in relation to playing position

Significant main effects of playing position were found for all the objective measures of match performance (**Table 2**).

Table 2 Objective measures of match running performance according to playing position

	(CB) Centre-backs (n = 60)	(FB) Fullbacks (n = 70)	(M) Midfielders (n = 54)	(FW) Forwards (n = 24)	Follow up tests (Bonferroni)	η^2
Match activities						
▶ standing (s)	297 ± 101	263 ± 93	238 ± 76	310 ± 77	(CB = FW > CM) = FB*	0.08
▶ walking (s)	3549 ± 213	3241 ± 209	3103 ± 207	3534 ± 210	CB = FW > FB > CM*	0.45
▶ jogging (s)	1458 ± 155	1601 ± 156	1726 ± 174	1361 ± 160	CM > FB > CB = FW*	0.38
▶ running (s)	278 ± 62	411 ± 72	467 ± 76	321 ± 59	CM > FB > FW = CB*	0.55
▶ high-running (s)	76 ± 24	123 ± 26	118 ± 24	95 ± 18	FB = CM > FW > CB*	0.42
▶ sprinting (s)	18 ± 10	31 ± 12	24 ± 12	27 ± 10	FW = (FB > CM) > CB*	0.19
Match distances						
▶ TD (m)	9995 ± 652	11233 ± 664	11748 ± 612	10233 ± 677	CM > FB > FW = CB*	0.55
▶ HIR (m)	1885 ± 467	2892 ± 488	3051 ± 445	2259 ± 363	CM = FB > FW > CB*	0.54
▶ VHIR (m)	605 ± 209	997 ± 221	904 ± 223	778 ± 167	FB = CM > FW > CB*	0.37
Other measures						
▶ $VHIR_{WB}$ (m)	102 ± 96	427 ± 198	356 ± 221	500 ± 170	FB = (FW > CM) > CB*	0.41
▶ $VHIR_{WOB}$ (m)	467 ± 133	530 ± 121	514 ± 166	238 ± 88	FB = CM = CB > FW*	0.31
▶ HIR (No)	377 ± 87	553 ± 96	589 ± 89	441 ± 75	CM = FB > FW > CB*	0.50
▶ VHIR (No)	72 ± 22	114 ± 25	117 ± 25	91 ± 17	CM = FB > FW > CB*	0.40
▶ peak speed ($km \cdot h^{-1}$)	31.7 ± 1.5	32.3 ± 1.0	3.8 ± 1.4	32.1 ± 0.9	(FW = FB > CB) = CM*	0.06

TD = total distance; HIR = high-intensity running distance; VHIR = very high-intensity running distance; $VHIR_{WB}$ = very high-intensity running distance with the ball; $VHIR_{WOB}$ = very high-intensity running distance without the ball; HIR (No) = frequency of HIR; VHIR (No) = frequency of VHIR; Peak speed = highest speed recorded during the game. * $p < 0.05$; η^2 = effect size

Time spent in various match activities by position

Midfielders spent less time standing than centre-backs and forwards (20% and 23% less, respectively). Additionally, midfielders spent less time walking (from 4% to 13%) than the other three playing positions. Midfielders also spent more time in the jogging and running zones. In contrast, both forwards and centre-backs spent less time than the two other playing positions in the jogging and running zones, respectively. The highest values recorded for time spent in the high-speed running zone were performed by fullbacks and midfielders, who spent more time in this zone than the forwards (19%) and centre-backs (38%), respectively. Fullbacks spent more time sprinting than centre-backs and midfielders (23% to 42%, respectively), whilst forwards sprinted more than centre-backs (33%).

Match distances

Midfielders covered 4, 13 and 15% more TD than the fullbacks, forwards and centre-backs, respectively. Midfielders and fullbacks covered more HIR distance (from 22% to 38%) compared to forwards and centre-backs. Similarly, the highest VHIR values were found in midfielders and fullbacks (from 14% to 39% higher than the other playing positions).

Other match analysis measures

Forwards covered a similar $VHIR_{WB}$ to fullbacks, but higher than midfielders and centre-backs. However, the forwards also completed significantly lower $VHIR_{WOB}$ activity than all other positions. Fullbacks covered more $VHIR_{WB}$ than midfielders and centre-backs (17% and 76%, respectively), while the $VHIR_{WOB}$ was similar between these three playing positions. The frequency of HIR and VHIR was higher for midfielders and fullbacks than for forwards and centre-backs (from 20% to 38%). The peak speeds measured during the matches for fullbacks was significantly higher (2%) than those of centre-backs.

Large effect sizes ($\eta^2 > 0.18$) were found for all the objective measures of match performance, with the exception of peak speed and time spent standing (medium; $\eta^2 = 0.06$ and 0.08 respectively).

Effect of activity in the first half on the second half

A significant interaction was found for first half match distance × time (**Fig. 1**). Players that covered the larger amount of TD, HIR or VHIR during the first half significantly decreased match distances in the second half. In contrast, players that covered the smaller amount of TD, HIR or VHIR in the first half did not decrease their performance in the second half. Moreover, VHIR increased during the second half in the players that covered less VHIR in the first half. Effect sizes were also moderate for HIR and VHIR ($\eta^2 = 0.08$ and 0.10, respectively), and small for TD ($\eta^2 = 0.04$).

Match-to-match variations, reproducibility and seasonal variations

Match-to-match variations

The CV for match distances was 2.4 (1.9; 3.6), 6.8 (5.3; 10.5) and 14.4 (11.6; 23.5)% for TD, HIR and VHIR, respectively (**Table 3**).

Reproducibility

Lower CVs were found for reproducibility of TD and HIR (0.9 (0.7; 1.6) and 4.3 (3.1, 7.7)%, respectively), while for VHIR CV was similar to match-to-match variations (13.9 (10.3, 26.6)%).

Seasonal variations

Significant main factor for time was found for seasonal variations in TD, HIR and VHIR, with large effect sizes ($\eta^2 = 0.35$, 0.42 and 0.41, respectively). Follow up tests showed that TD, HIR and VHIR distances covered at the end of the season were higher than at the beginning of the competitive season (**Table 3**). Additionally, TD at the mid-season was higher than at the start of the competitive season. Moreover, HIR and VHIR were also higher at the end of the season compared to the mid-season.

Discussion

The main findings of this study were that a top-level soccer team's physical performance during a match performance is re-

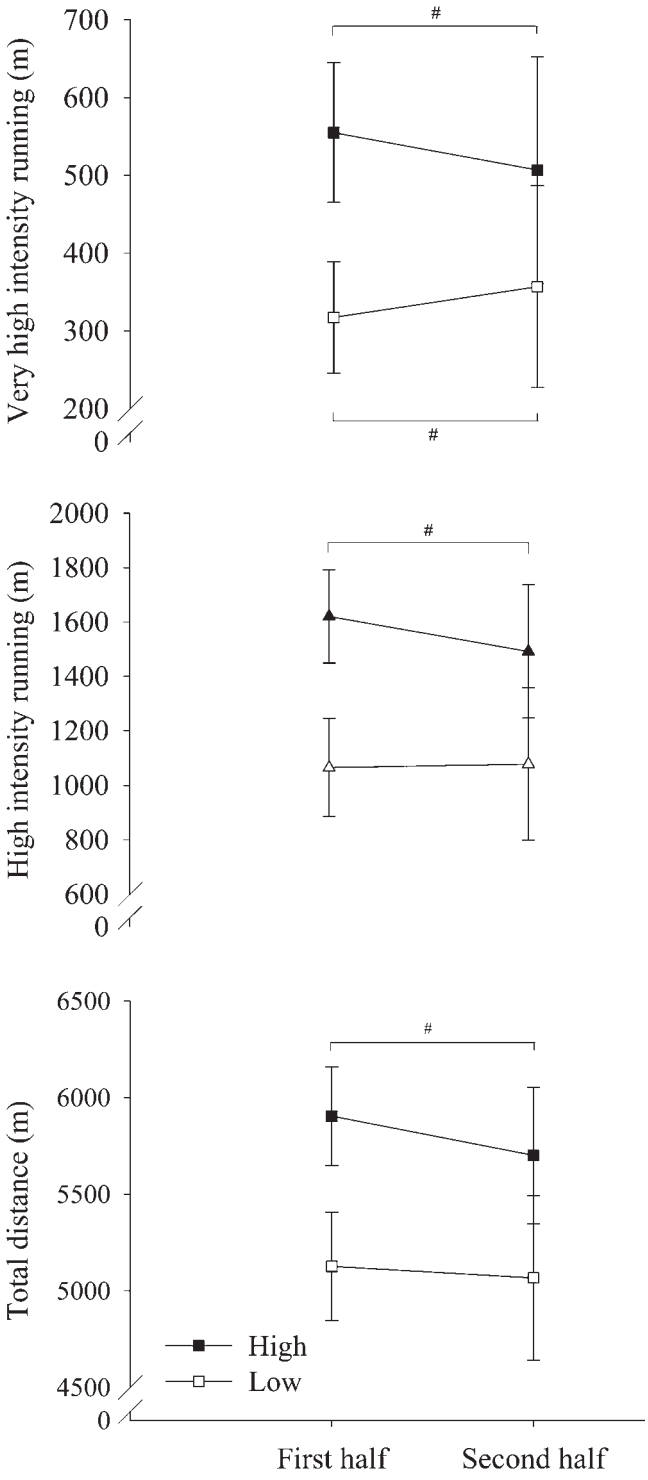

Fig. 1 Effects of the amount of first half activity on the second half activity. Interactions were significant for all three variables. High, players that covered in the first half time match distances above the median value of pooled data; Low, players that covered in the first half time match distances below the median value of pooled data; # $p < 0.05$ (Bonferroni's post hoc test).

lated to the activity completed by the opponent team and the competitive level of that team. In addition, the present results demonstrate for the first time, that the decrement in physical performance during the second half is related to the activity completed during the first half, and that both the player's match activity profile and their interaction with the ball is related to their playing position.

Table 3 Seasonal variations of match distances in a group of 16 top-level soccer players

	TD (m)	HIR (m)	VHIR (m)
Start of the competitive season	10617 ± 769	2456 ± 533	813 ± 231
Mid of the competitive season	10827 ± 616†	2544 ± 441	829 ± 193
End of the competitive season	10921 ± 753†	2738 ± 527†#	977 ± 213†#
Effect size (η^2)	0.35	0.42	0.41

TD = total distance covered; HIR = distance covered at high intensity running; VHIR = distance covered at very high intensity running. † $p < 0.017$; significantly higher from start. # $p < 0.017$; significantly higher from mid

Although some authors have already suggested that match running performance and/or competitive level of a team could be related to the activities performed by the other team [2,13], the present study was the first to demonstrate an association between physical performance of the reference team during a match and the physical performance of the opponent team. In this study, players travelled further TD and completed more HIR when playing against higher quality opponents (i.e., the best national and international teams) in comparison to lower quality opponents. However, the small effect sizes for these measures suggest that the effect of the level of opponent team's competitive ability on overall fatigue or required work rate is relatively small. Nonetheless, the present data indicates that top-level soccer players should be physically prepared so that they can cover greater TD and travel slightly further at higher intensities when competing against higher quality opponents.

The coefficient of determination measured in this study indicated that 26 to 42% of the variance in distances covered was explained by the physical performance of the opposing team. However, care must be taken when interpreting this result because relatively large confidence limits were found for the correlation coefficient between the distance covered of the reference team and opposing teams. Indeed, the large confidence limits show that the relationship could range from trivial to very strong [1]. However, since the confidence limits do not exceed zero, it appears that this correlation is reliable. This result has important implications for coaches and scientists who use time and motion analysis to assess the effects of tactical changes or particular training interventions on performance in soccer [7,9]. We suggest that this effect be taken into account as a confounding variable when coaches or scientists use time and motion analysis data as surrogate outcome measures of changes in fitness and/or tactics.

Each playing position has different tactical requirements in relation to the movement of the ball throughout a match. The present results demonstrated that forwards completed a similar amount of VHIR as midfielders. Detailed analysis of this data showed that forwards covered a significantly greater portion of VHIR distance (~64%) with the ball in comparison to the fullbacks and midfielders (~40%) ($p = 0.009$). Furthermore, centrebacks completed the lower VHIR distance of any position during a match and the greater proportion of this activity was performed without the ball (77% of total VHIR). These findings provide new information that can be used to develop soccer-specific performance tests and/or specific training strategies. For example, this data may be used as the basis for developing position-

specific small-sided games that allow for the concurrent training of technical-tactical skills and physical abilities [9,21].

Centre-backs completed the lower amount of TD and higher intensity activities (high-running, sprinting, HIR and VHIR). Midfielders spent more time jogging and running, and covered a greater TD. Fullbacks and midfielders covered the greater amount of HIR and VHIR and spent more time at high-speed running intensity compared to the other two playing positions. Additionally, fullbacks spent more time sprinting than centre-backs and midfielders. Although we found a significant main effect for playing position for the match activities of standing and peak running velocity, the effect sizes were moderate ($\eta^2 = 0.06$ and 0.08 respectively) suggesting that these measures of performance are poorly differentiated between playing positions. In contrast, the effects sizes for all other match activities were very large, indicating that positional requirements in match play greatly influence the recruitment of different locomotor activities. Although many of the match activity measures used in this study have previously been investigated in relation to a players tactical role or playing position within top-levels teams [2,4,6,13,20], various methodological differences between these studies make accurate comparison of these studies difficult. Specifically, the various previous studies on top-level soccer players have used different match analysis techniques, different definitions for running speed ranges in each locomotor category and varied sample sizes, all of which limit the ability to precisely evaluate the differences between these studies. Nevertheless, the present findings add to the existing literature as this study collected data from a large number of top-level soccer players (208 professional soccer players). This large sample size considerably increased the statistical power and consequently the likelihood of detecting significant differences between playing positions. For this reason, we suggest that the differences between the playing positions be evaluated using the magnitude of the differences and the effect sizes.

It is generally accepted that physical performance declines during a match as a consequence of increased fatigue towards the end of the game [2,13,14,18,22]. Our findings further confirm most previous research that shows that the fatigue induced by the physical activity completed during the first half is related to the physical activity completed during the second half. Indeed, the present results demonstrated that when players were required to carry out more physical activity in the first half, the physical performance indicators of TD, HIR and VHIR were all decreased in the second half. In contrast, when a smaller amount of physical activity was completed during the first half, TD and HIR travelled did not change and VHIR even increased during the second half. Importantly, we observed that larger whole match TD, HIR and VHIR were achieved by players whose physical demands were higher during the first half of the match. These findings may have implications for the effective use of substitutes during match play.

Match-to-match variations in match distance measures of the manual time and motion analysis technique have been described in previous research from a smaller sample of top-level soccer players [13]. The match-to-match variation of the TD measures recorded using the semi-automated, computerised match analysis system in this study are slighter less than the previous research on top-level soccer players that showed a CV of 3.1% for TD and 9.2% for HIR [13]. In this study we have extended previous research by examining the match-to-match variation of a new measure of VHIR (CV, 14.4%). This new measure is potentially very important as several previous investigators have suggested that high intensity activity during a match is a very important measure of physical performance during a soccer match [2,9–11,13]. Furthermore, since VHIR is usually undertaken during close involvement with "the play" during a soccer match, and previous studies have shown that higher intensity activities are completed more often at higher playing levels [13], we suggest that it may even be more sensitive to physical performance during a match than high intensity activity measures.

In both the present and previous research [13], match-to-match variations of important physical performance measures have been determined using the data of two games that were played against different opponent teams within one to three weeks of each other. This method of determining match-to-match variation calculates the between-opponent variation of the key physical performance measures. Results of this study suggest that some of the variation in the match-to-match performance measures can be attributed to the influence of different opponent teams with factors such as playing styles, fitness characteristics and tactics being the likely cause of the increased variance. In this study we also measured the within-opponent variation (i.e., reproducibility) of the important physical performance measures from two matches that were played less than a week apart with the same opponents. The results of this demonstrated that the variation in these measures was reduced with this approach. The likely explanation for the improved reliability in these measures was that there were only small differences in starting team players and tactics adopted.

The reproducibility data for TD and HIR in this study are lower than match-to-match variations reported in this and other previous research on top-level soccer teams [13]. These results demonstrate that the variability in these physical performance measures is lower when calculated from matches involving the same opponents. Notably, however, the variability in VHIR was similar between the reproducibility and match-to-match variation analysis. Since we also found that the distance covered by VHIR was not influenced by the competitive level of the opponents (see **Table 1**) we suggest that VHIR is highly variable and that factors that affect the level of competitiveness of the opponent do not independently influence this match activity.

Finally, in agreement with previous research [13] we found that important measures of physical performance (TD, HIR and VHIR) increased during the competitive season. Specifically, TD, HIR and VHIR were 2.9%, 11.5% and 20.2% respectively, with all recorded higher at the end of the competitive season in comparison to the early season measures. Additionally, TD measures significantly improved in comparison to the start of the season. We also observed that HIR and VHIR increased significantly during the second half of the season. Factors that explain this increase in match-related physical performance may be changes in tactics, team work, improved fitness, or specific adaptations to competitive match play during the season.

Conclusion

The results of this study provide important new information for coaches and scientists of top level soccer. Specifically, this study demonstrated that performance during match-play is related to the physical activity completed by the opponent teams as well as their competitive level, and this should be taken into account es-

pecially when evaluating the effects of training intervention on match running performance. Our results also showed that the decrement TD, HIR and VHIR during the second half is not a systematic phenomenon but is associated with the amount of activity completed in the first half. Furthermore, the present data also shows that match-related physical performance differs between playing position in relation to the interaction with the ball. It is suggested that the match-to-match variation, reproducibility and seasonal variation data in this study be used when interpreting changes in match performance of top-level soccer players. We also propose that these data can be used to interpret meaningful changes in match-related physical performance for individual players and teams and also to determine the appropriate sample size needed for training studies aimed to improve soccer performance.

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