Physical and technical activity of soccer players in the French First League – with special reference to their playing position

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Abstract

Background: The aim of this study was to analyze the physical and technical activities of elite soccer players from the French First League, according to their playing positions.

Methods: During the 2005-2006 season, 3540 professional soccer players’ activities were recorded and analysed during competitive matches played by means of a semi-automatic video system (Amisco ©). Physical and technical variables were analyzed according to their specific playing positions. The players were classified into 6 positional roles: central defenders (CD), full-backs (FB), central defensive midfielders (CDM), wide midfielders (WM), central attacking midfielders (CAM), and forwards (FW). Match performance variables analysed included: (a) physical activity: total distance covered, distances covered at high-intensities both with and without possession of the ball; (b) technical actions: heading and ground duels, passing, time in possession and ball touches.

Results: The total distances covered ranged from 10425.9m to 12029.5m, with especially 235.4m to 290.4m in sprinting. In the offensive phase, FW covered ~4 times greater total distances in sprinting than CD and FB (p <0.001). The technical analysis showed that the players had the possession of the ball between 55.5sec and 74.2sec per match played and they had no more than 2.2 ball touches per individual possession. More specifically, midfielders (CDM, WM and CAM) performed successful passes ranging from 75% to 78%, whereas lower values were found for the FW (71%) and CD (63%) respectively.

Conclusions: Soccer at the elite level requires that the players have a high aerobic capacity and that they are able to perform many high-intensity actions, especially the capacity for repeated sprints. Although these main findings showed the characteristics of French elite soccer, the players have to be skilful with their few ball possessions. In conclusion, elite soccer is characterized by the ability of the players to repeat high-intensity actions, but almost to be able to lose a small part of their ball possessions and to realize quickly the technical actions during the matches played.

Keywords: fitness training, high-level football, specific training, aerobic capacity, repeated sprint ability, RSA

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Introduction
Performance in soccer has been described as the interaction of several factors, such as the technical, tactical, physical and mental aspects. The coach and scientist need to develop their knowledge of these different factors during competitive matches, with special reference to the playing position. To obtain such information and to collect data, different methods have been previously proposed in the literature. The most frequently used methods are visual evaluation and the semi-automatic video analysis. The semi-automatic video analysis provides more precise information than visual evaluation and it has been validated to analyze the physical and technical actions during soccer matches. More specifically, it allows the monitoring of total distance covered by the players at different intensities and describes their technical actions. This system, based on numerous calibrated cameras, allows the follow-up of all players on the pitch during the match, both with or without ball possession. Consequently, the coach and scientist can record simultaneously the physical, technical and tactical data.

Various studies using semi-automatic video analysis have previously analysed physical activity according to playing position. Indeed, Barros et al. described the activity of 112 players belonging to different teams in the first Brazilian championship; Mohr et al. examined 42 professional Italian soccer players; Di Salvo et al. have recorded 300 players’ game analysis from the same team during twenty matches played in the Spanish Liga; and Bradley et al. and Di Salvo et al. respectively quantified the players’ activity from the English Premier League in a large sample.

The main findings were that the central defenders (CD) covered the lowest total distance, while the forwards (FW) performed the highest number of sprints. Moreover, it has been reported that the total sprint distance did not decrease in the second half when compared with the first half, whereas the total distance covered decreased from 7% to 9% in the second half. However, Di Salvo et al. showed that the high-speed distance (19.8 - 25.2 km/h) and total sprint distance (>25.2 km/h) decreased during the second half, with the highest values recorded for the wide midfielder (WM) and FW. Independent of the playing position, the total distance covered at high intensity in the last 15min of a match played was ~20% lower than that recorded during the first 15min period.

The high intensity runs and sprinting activities have been shown to be the determining factors of the soccer player’s performance in the English Premier League. Nevertheless, all of these studies using the semi-automatic analysis video system was based on a small sample, and/or examined players from a few teams in one specific league. It is therefore difficult to compare these different data because of the differences in the thresholds used to evaluate the distances run at high intensities. Moreover, to these authors’ knowledge, there have been no studies that have combined the physical analysis with the technical and tactical activities. Therefore the present study will assist in clarifying and specifying the profile and characteristics of a large sample of soccer players from a similar league, with special reference to the playing position that constitutes a key factor for individualising the training loads.

Consequently, the aim of the present investigation was to examine both the technical and physical activities of a large sample of players from the French First League, with special reference to their playing positions. The results will provide the coach and scientist with the physical and technical requirements for French elite soccer. These findings could...
constitute a useful tool for both for the individualisation of training according to playing position in professional soccer, and provide a model for the planning of training in amateur soccer.

Methods

Subjects
A total of 5938 observations of players in the French First League for the 2005/2006 season who had participated in all the matches played were analysed. The players were classified into 6 positional roles: central defenders (CD, n=1000), full-backs (FB, n=756), central defensive midfielders (CDM, n=952), wide midfielders (WM, n=202), central attacking midfielders (CAM, n=166), and forwards (FW, n=464).

Measurement
Measurements were undertaken with the Amisco Pro® system (Nice, France) by using a passive tracking match validated by Zubillaga et Gorospe, 13 and Carling et al. 15 This semi-automatic match analysis system included 8 stable cameras that were calibrated and synchronized prior to each game. All the cameras were placed in high positions around the pitch. The data were recorded at a frequency of 25 measures per second (25Hz), which allowed a simultaneous analysis of all players’ movements, with or without the ball, and therefore the physical, technical and tactical analyses could be combined. The performance profiles of players according to their individual position were determined.

The physical parameters recorded were: the total distance covered, the total distance covered while sprinting (VHIR, >24kmh⁻¹), the total distance covered in high intensity runs (HIR, 21-24kmh⁻¹) and the percentage of ground duels or heading duels won. The technical parameters monitored included: the percentage of successful passes, total duration of individual ball possession, and the number of ball touches per individual possession.

Statistical analyses
All values were expressed as mean values ± standard deviation (mean ± SD). The normal distribution of the data was checked using the Kolmogorov-Smirnov test, and the statistical analysis of variance between groups was verified by Hartley’s test (or the Fmax test). A two-way analysis of variance (ANOVA) with repeated measures was used to compare the distance covered according to two factors: playing positions with six levels (CD, FB, CDM, WM, CAM and FW) and the distances covered at two threshold intensities with two levels (21-24kmh⁻¹ and >24kmh⁻¹). With regard to the technical performance, a one-way ANOVA was used to compare the technical aspects according to playing position with six levels (CD, FB, CDM, WM, CAM and FW).

The significant main effects of each factor were followed up with the post hoc Bonferroni-corrected multiple comparisons test. The level of significance was set at p <0.05. The inter-subject coefficient of variation (CV) for each parameter was also calculated. The results were presented in two parts: (a) the common trend of the French players; and (b) the characteristics and the requirements for the different playing positions examined.

Results

Common trends
The total distance covered by the players ranged from 10425.9m to 12029.5m during competitive match-play (Table 1), including from 4.1% to 5.4% of total distance in VHIR and HIR, which corresponded to less than 590m covered at a running speed greater than 21kmh⁻¹ (Figure 1 and Table 2). The highest value of the individual ball possession was 74.3sec per match played. Players presented a number of ball touches by individual possession ranging from 1.9 to 2.2 ball touches, and the percentage of successful passes ranged from 63% to 78%.
### Table 1: Physical and technical demands of elite soccer players during the 2005-2006 season of the French First League

<table>
<thead>
<tr>
<th>Position</th>
<th>N</th>
<th>Total distance covered (m)</th>
<th>Percentage of duels won</th>
<th>Ball possession</th>
<th>% successful passes</th>
<th>Number of ball touches per individual ball possession</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>In sprinting &gt;24kmh⁻¹</td>
<td>In HIR 21-24 kmh⁻¹</td>
<td>In the air</td>
<td>On the ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>%successful</td>
</tr>
<tr>
<td>Central defenders (CD)</td>
<td>1000</td>
<td>10425.9 ± 808.4</td>
<td>199.4 ± 65.6</td>
<td>230.2 ± 55.9</td>
<td>62.6%***</td>
<td>57.3%***</td>
</tr>
<tr>
<td>Full-backs (FB)</td>
<td>756</td>
<td>10655.5 ± 860.0</td>
<td>241.3 ± 69.9</td>
<td>274.1 ± 62.9</td>
<td>61.1%***</td>
<td>56.0%***</td>
</tr>
<tr>
<td>Central defensive midfielders (CDM)</td>
<td>952</td>
<td>11501.3 ± 901.2</td>
<td>220.9 ± 76.2</td>
<td>302.3 ± 68.9</td>
<td>50.8%</td>
<td>51.2%</td>
</tr>
<tr>
<td>Wide midfielders (WM)</td>
<td>202</td>
<td>12029.5 ± 977.5</td>
<td>235.4 ± 85.0</td>
<td>335.7 ± 64.0</td>
<td>46.9%</td>
<td>49.6%</td>
</tr>
<tr>
<td>Central attacking midfielders (CAM)</td>
<td>166</td>
<td>11726.4 ± 984.4</td>
<td>234.6 ± 71.7</td>
<td>334.6 ± 62.3</td>
<td>41.1%$$</td>
<td>48.0%</td>
</tr>
<tr>
<td>Forwards (FW)</td>
<td>464</td>
<td>10942.7 ± 978.5</td>
<td>290.4 ± 75.2</td>
<td>300.1 ± 57.1</td>
<td>38.1%$$</td>
<td>46.2%$$</td>
</tr>
</tbody>
</table>

***: significant greater values than the others playing positions
**: p < 0.01
***: p < 0.001
$:$ significant lower values than the others playing positions
$^s$: p ≤ 0.05
$^$: p < 0.01
$$^s$: p ≤ 0.05
$$^$: p < 0.01

*HIR: High intensity runs (21-24kmh⁻¹)
Figure 1: Total distance covered in sprinting and in high intensity runs by the elite French soccer players

HIR: High intensity runs (21-24 km/h)

***: significant greater values than the others playing positions
**p<0.01
***p<0.001

$: significant lower values than the others playing positions
$\$$p<0.001
Table 2: Proportion of the total distance covered in sprinting (>24kmh⁻¹) and in high intensity runs (21-24kmh⁻¹) according to the total distance covered by the elite French soccer players

<table>
<thead>
<tr>
<th>Position</th>
<th>In sprinting</th>
<th>In HIR</th>
<th>In sprinting + HIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central defenders (CD)</td>
<td>1,9$$$$</td>
<td>2,2$$$$</td>
<td>4,1$$$$</td>
</tr>
<tr>
<td>Full-backs (FB)</td>
<td>2,3***</td>
<td>2,6$</td>
<td>4,8</td>
</tr>
<tr>
<td>Central defensive midfielders (CDM)</td>
<td>1,9$$$$</td>
<td>2,6$</td>
<td>4,6</td>
</tr>
<tr>
<td>Wide midfielders (WM)</td>
<td>2,0$$$$</td>
<td>2,8***</td>
<td>4,8</td>
</tr>
<tr>
<td>Central attacking midfielders (CAM)</td>
<td>2,0</td>
<td>2,9***</td>
<td>4,9</td>
</tr>
<tr>
<td>Forwards (FW)</td>
<td>2,7***</td>
<td>2,7**</td>
<td>5,4***</td>
</tr>
</tbody>
</table>

*HIR: High intensity runs (21-24kmh⁻¹)

***: significant greater values than the others playing positions
**: p < 0.01,
*: p < 0.001
$: significant lower values than the others playing positions
$$$: p < 0.001

**Characteristics according to position**

The midfielders presented the greatest total distance covered (11501.3m and 12029.5m) whereas FW covered the greatest distance in sprinting (p <0.001, i.e. 290.4m) (Table 1). During the offensive phase (when the team has ball possession), FW performed ~66% of their total distances in sprinting, which was ~4 times more than the distance covered by the CD (Table 3). However, CD and FB won the highest number of ground duels than the other playing positions (57.3 and 56.0%, respectively, and p<0.001 compared to the other playing positions) or heading duels (62.6 and 61.1%, respectively, and p<0.001 compared to the other playing positions).

The technical analysis showed that FW lost a significantly greater number of their duels than the other playing positions (p< 0.001). FW showed the greater ratio of ball lost in possession than the other playing positions (p< 0.001). Although CD had the lowest values of successful passes compared to other positions (p< 0.001), they had the lowest ratio of ball lost in possession (p< 0.001 with CAM, WM and FW; p< 0.01 with CDM).

**The coefficients of variation (CV)**

Homogeneity of values was weak in the analysis of the total distance covered (CV ranged from 7.8 to 9.0). However, the other parameters showed CV ranged from 14.0 (number of possessions of WM) to 36.1 (total distance in sprinting of WM), which could be described as a weak homogeneity.
Table 3: Distance covered in offensive situations and defensive situations and at different intensities

<table>
<thead>
<tr>
<th>Player Position</th>
<th>Total distance covered (m)</th>
<th>Total distance covered in sprinting (&gt;24kmh⁻¹)</th>
<th>Total distance covered in HIR (21-24kmh⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In offensive phase</td>
<td>In defensive phase</td>
<td>In offensive phase</td>
</tr>
<tr>
<td>Central defenders (CD)</td>
<td>3342.7 ± 670.8</td>
<td>4001.1 ± 614.5</td>
<td>50.0 ± 40.5</td>
</tr>
<tr>
<td></td>
<td>± 670.8</td>
<td>± 614.5</td>
<td>± 40.5</td>
</tr>
<tr>
<td>Full-backs (FB)</td>
<td>3498.8 ± 673.4</td>
<td>4048.1 ± 625.2</td>
<td>100.6 ± 48.9</td>
</tr>
<tr>
<td></td>
<td>± 673.4</td>
<td>± 625.2</td>
<td>± 48.9</td>
</tr>
<tr>
<td>Central defensive</td>
<td>3941.3 ± 759.8</td>
<td>4281.3 ± 804.8</td>
<td>103.2 ± 59.4</td>
</tr>
<tr>
<td>midfielders (CDM)</td>
<td>± 759.8</td>
<td>± 804.8</td>
<td>± 59.4</td>
</tr>
<tr>
<td>Wide midfielders (WM)</td>
<td>4357.9 ± 777.0</td>
<td>4302.9 ± 744.0</td>
<td>136.5 ± 61.8</td>
</tr>
<tr>
<td></td>
<td>± 777.0</td>
<td>± 744.0</td>
<td>± 61.8</td>
</tr>
<tr>
<td>Central attacking</td>
<td>4121.6 ± 779.0</td>
<td>4210.5 ± 910.0</td>
<td>130.1 ± 54.7</td>
</tr>
<tr>
<td>midfielders (CAM)</td>
<td>± 779.0</td>
<td>± 910.0</td>
<td>± 54.7</td>
</tr>
<tr>
<td>Forwards (FW)</td>
<td>4045.6 ± 635.4</td>
<td>3565.1 ± 762.0</td>
<td>208.5 ± 63.8</td>
</tr>
<tr>
<td></td>
<td>± 635.4</td>
<td>± 762.0</td>
<td>± 63.8</td>
</tr>
</tbody>
</table>

HIR: High intensity runs (21-24kmh⁻¹)
Characteristics of French high-level soccer

Available at URL: [http://www.ismj.com](http://www.ismj.com)

Figure 2: Number of ball touches per individual possession according to playing position for the elite French soccer players

- **$$**: significant greater values than the others playing positions
- **$$**: $p < 0.001$
- **$$**: significant lower values than the others playing positions
- **$$**: $p < 0.001$

**Discussion**

The main findings of the present study allowed the identification of a common trend for French elite soccer players. More specifically, the profile of each playing position was determined and thus the present results could provide precise information to the coach both for the individualization of training according to playing position in professional soccer, and for direction in training in the amateur game.

**Common trend throughout the different playing positions**

The players of the French First League covered a total distance of at least 10425.9m in all the matches analyzed during the 2005-2006 season. This result was similar to the findings reported by Stølen et al. 1, but 2% lower than players from the Spanish Liga and those who participated in the European Championships League 10. Playing in the European championships required more time-motion characteristics, and the stakes for this competition could be one of the factors that motivated the players to cover greater distances than those values recorded from the local championships. Consequently, those findings revealed the importance of good aerobic capacity as found in the elite players, which is a key factor related to performance in elite soccer. Moreover, the importance was stressed in other studies that the performance in elite soccer depends both on the capacity to maintain a higher aerobic performance and the ability to run repeated sprints without a drop in performance 16. Brown et al. 17 showed a significant relationship between the ability to run repeated sprints and a player’s VO2max. However, the improvement in the players’ VO2max resulted a greater ability to repeat sprints and a quicker recovery between these actions 17, 18. Thus the players could maintain their sprint performance throughout the match which in turn increased their overall performance 19. It has been demonstrated that the use of intermittent exercises at a very high intensity improves aerobic and anaerobic qualities simultaneously 7, 20, 21. Consequently, it is suggested that intermittent exercises in training sessions be included in order to optimize the physical performance of the players during training, which would approach the intensity found in playing matches. Indeed, intermittent exercises allow the improvement of VO2max 22, 23; the development of oxidative, glycolytic and mitochondrial enzymes 24; the increase of muscular glycogen stock and buffering capacity for bicarbonate and phosphates 25, the decrease of reaction time and the improvement of power 26. In this context, this method, combined with the repetition of sprints 27, 28, 29, could recreate the physical activities that elite players encounter during a match 30.
Bangsbo has estimated the intensity of playing in elite matches as about 70% of VO2max, while Stølen et al. reported intensities of between 80% and 90% of HRmax. Consequently, it has been concluded that the elite player must have a high VO2max of between 54.5 and 65.7 ml/min/kg.

Previous authors reported that the distance covered decreased from 1-8% between the first and the second halves of a game in professional soccer players. This decrease could be due to fatigue and a reduction of aerobic performance. However, the coaches must be aware of these decreases because it could result in a decrease in the quality of the technical actions performed by the players. In fact, the repetition of sprints and HIR could explain some of the fatigue observed during matches. The present study showed that the players of the French First League covered between 429.6 and 590.5m in sprinting and their HIR ranged from 4.1% to 5.4% of the total distance covered. These results were lower than those presented by Bradley et al., Di Salvo et al., and Mohr et al., but they were more homogeneous than those observed in other investigations reporting a larger total distance covered in sprinting, ranging from 1% to 11%. However, the total distance covered in sprinting was described as dependent on the match moment and the playing position. Therefore Hawkins showed that the total distance covered in sprinting decreased by up to 30% in the second half as compared with the first half. In contrast, Di Salvo et al. showed no difference between the two halves in one of the best European teams, whereas these same authors observed a decrease of the total distance covered in sprinting during the second half of a match, particularly for the WM and FW positions in a top Spanish Liga team. More specifically, Bradley et al. found a ~20% decrease of the HIR in the last 15min of a match compared with the first 15min period of the match in players from the English Premier League.

The technical analysis showed that the players had individual ball possession for between 44.6sec and 74.3sec, whereas total ball possession did not exceed 56.5 possessions during all the matches played throughout the 2004-2005 season. These results confirmed the importance of player activity without the ball. Moreover, the players did not perform a high number of ball touches by individual players (ranging from 1.87 and 2.23 touches) and thus it appears that elite soccer requires the ability to perform technical actions quickly. It is suggested that this characteristic constitutes a key factor in differentiating the playing level, especially between elite, professional, amateur and youth soccer players.

In modern elite soccer, players are required to perform high intensity actions both with and without the ball. They have to maintain a high proportion of their anaerobic performances during a match, but if their sprint or HIR performances decrease during the match, their technical actions could be less qualitative, resulting in a greater number of balls lost. These decreases in physical activity could also increase the total duration and number of ball touches through individual possessions because the players may show greater fatigue, which could affect their technical actions, the ability to play quickly, and the capacity of perception of the environment.

Characteristics according to the playing positions

During a match, the coaches use a playing organization and playing system with a precise definition of the offensive and defensive phases of a match. This organization includes the physical and technical requirements for every playing position and thus for each player. The present study shows these requirements for all the different playing positions. It was shown that FW covered a significantly lower total distance than midfielders (p <0.001 with WM, p <0.05 with CDM and CAM) which is in accordance with the results of Rampinini et al. and Di Salvo et al. Nevertheless, the total distances covered in sprinting and in HIR were different from those reported by these authors. Indeed, it has been demonstrated that FW had the highest percentage of sprint distance and HIR expressed as a percentage of total distance. They also covered the highest absolute distances in sprinting than in other positions (p <0.001). These findings were different to those of Rampinini et al. and Di Salvo et al., probably as a result of the differences in the characteristics of the league analyzed. Indeed, the present study investigated the players from the French First League, whereas the other studies evaluated players from the Italian League and the Spanish Liga respectively. It is suggested that the different country, and thus the different soccer leagues, require different physical characteristics according to playing position. The coaches and fitness coaches have to favour the solicitation of the HIR and sprint...
actions of their defenders, allowing countering of the FW. Otherwise, training sessions for FW will be based on repeated sprint ability (RSA) and short intense intermittent exercises. According to the results of the present study, RSA training should include between 350 and 400m of sprints, with varying distances to allow energetic adaptations. Nevertheless, the RSA and intermittent exercises should be applicable for all players because they represent a percentage of sprint distance ranging from 4.1% to 5.4% of the total distance covered. The present study provides more precise values, while these values were reported in a larger context (ranging from 1 to 11% of total distance covered). Even though ~5% seems relatively negligible, Stolten et al. insisted on the importance of high intensity exercises, explaining that the majority of decisive actions during a match were performed with high intensity efforts, such as sprinting for shooting at goal, or sprinting for tackling the ball. Therefore it would be erroneous to consider the 5% as negligible, and thus training the RSA appears to be crucial in soccer.

The intermittent efforts could be individualized according to playing position and the total distance covered in sprinting. The results of this present study show that the CD should perform more 30sec - 30sec or 20sec - 20sec intermittent training because these develop both the aerobic and anaerobic energetic systems, which are less important for the other positions. However, FB, CDM and FW players should be trained on the basis of 15sec - 15sec, 10sec -10sec or 5sec - 25sec, and the RSA, because they cover a greater total distance in sprinting and the number of sprints. WM and the CAM perform both greater total distance covered (p <0.001) and achieve a higher percentage of sprint and HIR. In fact, their training load should be individualized by both RSA and intermittent exercises (from 30sec - 30sec to 5sec - 20sec) to develop aerobic and anaerobic capacities.

It has been found that FW lose the greater number of balls and duels, and succeed less in their dribbling when compared to WM (p<0.001). These results could be explained by the fact that FW are positioned in a dense zone, but also because the defenders are often in numeric superiority. Moreover, FW are often playing with their backs to the goal, so they receive the ball with a defender marking them. Thus it is generally difficult to control the ball and to turn to the goal, whereas it is easier for the defender to intercept the ball when he is positioned to the front of the game.

Furthermore, the training for all playing positions should include duels, in order to cultivate this frame of mind. It has been claimed that the teams who win the greater number of duels in external zones will win the match. Consequently, the technical staff should direct the training of FB and WM for small-sided games and duels in order to better prepare them for their specific requirements.

During the defensive and offensive phases, the function of CD and FB implies a minimum of risks, to be successful in passing and therefore to lose fewer balls compared to the other positions (p<0.01). The CD rarely touch the ball and often play fewer than two touches in individual possession to increase the speed of the play or because FW applies pressure on them.

However, CD has a lower percentage of successful passes than the other positions (p<0.001). The CD often achieve more long passes which could be imprecise, intercepted or lost in aerial duels. CAM, WM and FW can take most of the risks because they are far from their goal, which explains why they lose a greater number of balls and have the lowest percentage of successful dribbles. They have a greater duration of ball possession and perform a greater number of ball touches through possession than WM, FB and CD (p <0.001). One of their functions is to unbalance the opponent by actions such as the dribble. Their characteristics have been defined by a high technical ability that allows them to destabilize the opposing team’s defenders, to create free spaces and to shoot for the goal in a very dense zone of players. Rampinini et al. indicated that the decrease of technical performance as a percentage of successful passes during a match would be correlated to the score of the match; in this case, it would explain a defeat. It is therefore important to work on the specific technique of the CAM and WM to minimize their technical errors, which could negatively influence their team’s performance.

The characteristics of the CDM present the highest physical and technical demands on the players. Indeed, they require the ability to repeat sprint bouts, to cover a greater total distance, to win more than 50% of their duels, to realize a maximum of successful passes, to perform successful dribbles, with these actions of their defenders, allowing countering of the FW. Otherwise, training sessions for FW will be based on repeated sprint ability (RSA) and short intense intermittent exercises. According to the results of the present study, RSA training should include between 350 and 400m of sprints, with varying distances to allow energetic adaptations. Nevertheless, the RSA and intermittent exercises should be applicable for all players because they represent a percentage of sprint distance ranging from 4.1% to 5.4% of the total distance covered. The present study provides more precise values, while these values were reported in a larger context (ranging from 1 to 11% of total distance covered). Even though ~5% seems relatively negligible, Stolten et al. insisted on the importance of high intensity exercises, explaining that the majority of decisive actions during a match were performed with high intensity efforts, such as sprinting for shooting at goal, or sprinting for tackling the ball. Therefore it would be erroneous to consider the 5% as negligible, and thus training the RSA appears to be crucial in soccer.

The intermittent efforts could be individualized according to playing position and the total distance covered in sprinting. The results of this present study show that the CD should perform more 30sec - 30sec or 20sec - 20sec intermittent training because these develop both the aerobic and anaerobic energetic systems, which are less important for the other positions. However, FB, CDM and FW players should be trained on the basis of 15sec - 15sec, 10sec -10sec or 5sec - 25sec, and the RSA, because they cover a greater total distance in sprinting and the number of sprints. WM and the CAM perform both greater total distance covered (p <0.001) and achieve a higher percentage of sprint and HIR. In fact, their training load should be individualized by both RSA and intermittent exercises (from 30sec - 30sec to 5sec - 20sec) to develop aerobic and anaerobic capacities.

It has been found that FW lose the greater number of balls and duels, and succeed less in their dribbling when compared to WM (p<0.001). These results could be explained by the fact that FW are positioned in a dense zone, but also because the defenders are often in numeric superiority. Moreover, FW are often playing with their backs to the goal, so they receive the ball with a defender marking them. Thus it is generally difficult to control the ball and to turn to the goal, whereas it is easier for the defender to intercept the ball when he is positioned to the front of the game.

Furthermore, the training for all playing positions should include duels, in order to cultivate this frame of mind. It has been claimed that the teams who win the greater number of duels in external zones will win the match. Consequently, the technical staff should direct the training of FB and WM for small-sided games and duels in order to better prepare them for their specific requirements.

During the defensive and offensive phases, the function of CD and FB implies a minimum of risks, to be successful in passing and therefore to lose fewer balls compared to the other positions (p<0.01). The CD rarely touch the ball and often play fewer than two touches in individual possession to increase the speed of the play or because FW applies pressure on them.

However, CD has a lower percentage of successful passes than the other positions (p<0.001). The CD often achieve more long passes which could be imprecise, intercepted or lost in aerial duels. CAM, WM and FW can take most of the risks because they are far from their goal, which explains why they lose a greater number of balls and have the lowest percentage of successful dribbles. They have a greater duration of ball possession and perform a greater number of ball touches through possession than WM, FB and CD (p <0.001). One of their functions is to unbalance the opponent by actions such as the dribble. Their characteristics have been defined by a high technical ability that allows them to destabilize the opposing team’s defenders, to create free spaces and to shoot for the goal in a very dense zone of players. Rampinini et al. indicated that the decrease of technical performance as a percentage of successful passes during a match would be correlated to the score of the match; in this case, it would explain a defeat. It is therefore important to work on the specific technique of the CAM and WM to minimize their technical errors, which could negatively influence their team’s performance.

The characteristics of the CDM present the highest physical and technical demands on the players. Indeed, they require the ability to repeat sprint bouts, to cover a greater total distance, to win more than 50% of their duels, to realize a maximum of successful passes, to perform successful dribbles, with these...
technical actions performed at a high intensity (2.1 ball touches per individual possession). A ball lost by the CDM is very dangerous for the team because the opposing players are very close to the goal and have an unbalanced defence. The training of CDM should include physical exercises based on intermittent exercises and technical actions realized at high intensities. Dellal et al. 39 have shown that some small-sided games allow reaching HR responses similar to those achieved in intermittent exercises at high intensity. However, these authors reported that the control of player activities during the small-sided games was difficult because values indicated weak homogeneities between playing positions, which were also confirmed in previous studies 10, 41, 42.

This homogeneity of the results was also one of the limitations of the present study when player activities during a match were analysed. The results of the present study show the physical and technical demands of the elite soccer players according to their precise playing positions. Consequently, the coaches will be able to adjust training and individualize the workload according to the requirement for and the function of all playing positions. However, these findings must be combined with a tactical analysis, referring in particular to the different organisation and play systems applied by the technical staff. Although it would be interesting to constitute a database of the different physiological and physical effects of a soccer match, the professional technicians need more precise data on their own players, their own organization and play system. Thus the training could be directed according to the physical, technical and tactical requirements of their own players.

Moreover, the analyses in this present study include the entire duration of matches, all the dead time (injuries, free kicks, goals, throw-ins, etc), as well as those from most previous studies 2-14. However, Jacquet et al. 37 showed that the real total duration of a match varied from between 49min and 68min in some international competitions if the dead time was excluded. To these authors’ knowledge, the real total duration (the effective duration) of a match was never used in a time-motion analysis despite the fact that it could modify the analysis of the physical requirements during a match. It could be suggested that the effective total duration of a match is high, and that the physical demands could thus be important. Dellal et al. 43, in a preliminary study, showed a proportional increase of the total distance covered, the number of sprints and the high intensity actions performed, in relation to the effective total duration of a match. Consequently, the technical staff should analyze the activity of the players according to the effective total duration of the match. They may find that the percentage of distance covered in sprinting and in HIR is more important than the findings reported up until now 9, thus providing a new method of analyzing match information and the training programmes.

Conclusions
The analyses of the time-motion features and the technical actions of matches provide greater precise information and allow for adjustments to be made in the training of elite players based on their playing positions. This type of analysis provides some global indications, especially with a weak homogeneity of the values recorded. Although the knowledge of the technical and physical demands of the different playing positions during a match are essential for giving direction to the training of elite soccer players, the coaches need more precise information in the formulation of their own tactical plan and play system for their team.

In this context, the future investigation of technical and physical demands during a match should be combined with analyses of the tactical aspects, such as the organization or the precise function of the players in the offensive and defensive phases. It is suggested that the following questions need to be examined:

- What are the physical and technical activities of the players when the coaches use a precise play system such as a 4-3-3?
- Would the activity of the players vary if the play system was modified?

Consequently, thanks to such analyses, the knowledge of the physical and technical demands of a match can be improved according to playing position and the precise tactical plan. All future analyses need to refer to the tactical plan and the total effective duration of a match, for use by the elite players and their coaches.
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