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# High-intensity physical performance parameters in soccer

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**Abstract**

**Introduction. High-speeds distances covered during a soccer match are considered a good indicator of team success, especially for some playing positions. These distances vary markedly among different playing positions, and match congestion typically results in a reduction of high-intensity activities. However, the different playing levels might influence those results. Aim of Study. 1) To analyze the differences in the total distance covered during the match, and the high-intensity physical performance parameters between the various playing positions in the four highest-ranking teams in the 2018 FIFA World Cup. 2) To follow the evolution of those parameters throughout the competition. Material and Methods. Match data, reported by FIFA, of the four teams classified for the semi-finals in the 2018 World Cup were used. Differences between the different playing positions and the different phases were analyzed. Results. The distances covered at high speeds and the number of sprints performed during a soccer match may differentiate team performance. The distance covered at 20-25 km/h, at speeds exceeding 25 km/h, and the total number of sprints were significantly lower ($p < 0.05$) for central defenders; they were higher for the wide-midfielders, though not significantly likely due to the low sample size. No significant differences were observed between the different phases in most of the study variables. Conclusions. Understanding the differences between the different playing positions in the highest-ranking teams of the competitions may help coaches to carefully design players' rotations and include different soccer-specific drills for each playing position to contribute to team success. Together with a good technical and tactical strategy, promoting post-match recovery may be the key for team success.**

**KEYWORDS: recovery, sprints, high running speed, congested matches.**

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## Introduction

Aside from technical demands, understanding the physical requirements of elite soccer players has received growing interest in the last decades [7, 8, 11]. A professional soccer player covers on average 9-12 km throughout a match [12, 17], but that amount varies depending on the playing position and the running speed [6, 18, 21, 24].

Sprinting, along with other physical attributes, is a desirable attribute associated with success in a soccer match [5, 14, 22], and the distance covered at high speeds seems to be a better indicator of success than the total distance covered, especially for some playing positions [2, 19]. According to Ugalde-Ramirez [24], high-speed running performed by players of lateral positions may differentiate team performance.

Different game tactics during a soccer match can affect the physical demands of the players [9], including the number of sprints performed during the match, the amount of distance covered at high speeds, and the maximum speed achieved. In any case, excluding

goalkeepers, professional soccer players perform on average more than 20 sprints per match [21, 24], cover more than 200 m at sprinting speeds [3], and reach top speeds of approximately 30 km/h [17, 24].

Previous studies reported that total distance covered during a match and distances covered at high or very high running intensities vary widely among the different playing positions [7, 11, 17, 21, 24]. Data analyzed in those studies included several or all teams in one of the strongest leagues in the world [7, 17, 21], data from 58 teams playing in the European Champions League and the UEFA Cup [11], and data from all matches of the 2018 FIFA World Cup [24]. However, the highest-ranking teams of those leagues and competitions were not analyzed separately to determine if there were differences between those teams and the other participating teams.

As the match progresses, the amount of high-intensity running usually decreases as a result of fatigue, regardless of playing position or level [7, 19]. Similar results were reported for the total distance covered and the number of sprints [21, 24]. Additionally, Palucci et al. [20] concluded that during a congested match (when the team played two times a week), the players presented a reduced number of high-intensity activities than during a non-congested match. Kovács et al. [16] also observed that in the play-off stage of the 2015-2016 Future Talents Cup International tournament match congestion resulted in a reduction in the total distance covered.

To our knowledge, no study has investigated the possible effect of fatigue on physical performance parameters during the FIFA World Cup, during which all matches are played within one month and players may not achieve a full recovery between matches. Therefore, the purpose of this study was two-fold: 1) To analyze differences in the total distance covered during the match, and high-intensity physical performance parameters between the various playing positions in the four highest-ranking teams in the 2018 FIFA World Cup; 2) To follow the evolution of those parameters throughout the competition.

## Material and Methods

*Design and participants*

In this study, match data reported by FIFA for the 2018 FIFA World Cup was used [15]. The four teams that qualified for the semi-final matches were analyzed.

Due to level differences between the first and last classified of each group at the beginning of the competition, players from the strongest teams do not always play at full capacity. Therefore, only data from round of 16, quarter-finals and semi-finals were used for subsequent analysis. Players who performed at least 90 minutes during the game were selected for analysis, excluding goalkeepers. The players were classified into five different playing positions: central defenders, wide defenders, central midfielders, wide midfielders, and center-forwards. The study followed the ethical guidelines of the Declaration of Helsinki.

*Measures*

FIFA [15] reported 14 different physical activities for each player during the entire match, the first half, and the second half. For the purposes of this study only five of them over the duration of the entire match were used: total distance covered, distance covered at zone 4 (20-25 km/h), distance covered at zone 5 (>25 km/h), top speed, and total number of sprints. The data were obtained with a reliable real-time optical tracking system at 25 frames per second [23, 24].

*Statistical analysis*

Statistical analysis was performed using the SPSS software package for Windows, v. 22.0 (SPSS Inc., USA). To determine differences between the different playing positions, data from the four teams and the three phases were pooled and the means and standard deviations of all variables were calculated. Data were tested for normality using the Shapiro–Wilk test. When this condition was fulfilled, one-way ANOVA with Bonferroni post-hoc tests was performed to determine significant differences between the five playing positions. When data were not normally distributed, the Kruskal–Wallis H tests with Dunn's post-hoc tests and Bonferroni correction were performed. To explore the differences of one group across the different phases of the competition data from the four teams were pooled and one-way ANOVA with Bonferroni post-hoc tests was performed. Results were considered statistically significant at $p \leq 0.05$.

## Results

*Differences between playing positions*

Table 1 shows the means and standard deviations of all study variables, calculated with pool data from the four teams and the three phases and taking into consideration the specific playing positions. Significant differences between positions are also shown in Table 1. No significant differences were found for the top speed, whereas a significant effect of playing position was observed for the other variables. Post-hoc tests revealed

**Table 1.** Descriptive statistics and differences between the different playing positions

| Variables | Central defenders | Wide defenders | Central midfielders | Wide midfielders | Centre-forwards |
|---|---|---|---|---|---|
| | n = 31 | n = 17 | n = 25 | n = 9 | n = 16 |
| Total distance (m) | 9141.97 ± 475.41[b,c] | 10099.94 ± 828.44[a] | 10745.84 ± 893.54[a,d,e] | 9554.33 ± 1019.55[c] | 9641.19 ± 839.68[c] |
| 20-25 km/h distance covered (m) | 344.19 ± 97.50[b,c,d,e] | 583.65 ± 170.00[a] | 572.76 ± 150.31[a] | 609.67 ± 163.18[a] | 528.81 ± 126.89[a] |
| >25 km/h distance covered (m) | 124.87 ± 75.47[b,c,d,e] | 257.76 ± 124.98[a] | 177.64 ± 98.23[a] | 326.89 ± 85.28[a] | 297.69 ± 107.63[a] |
| Top speed (km/s) | 28.40 ± 2.55 | 29.00 ± 1.94 | 28.60 ± 2.19 | 30.83 ± 1.61 | 28.76 ± 2.43 |
| Number of sprints | 21.45 ± 7.63[b,c,d,e] | 37.59 ± 11.43[a] | 31.88 ± 9.98[a] | 40.11 ± 9.09[a] | 32.75 ± 8.99[a] |

[a] significantly different from central defenders ($p < 0.05$); [b] significantly different from wide defenders ($p < 0.05$); [c] significantly different from central midfielders ($p < 0.05$); [d] significantly different from wide midfielders ($p < 0.05$); [e] significantly different from centre-forwards ($p < 0.05$)

that the distance covered at 20-25 km/h, at speeds exceeding 25 km/h and the total number of sprints were significantly lower ($p < 0.05$) for central defenders than for the other playing positions. Additionally, the total distance covered was also significantly lower for central defenders than for wide defenders and central midfielders, while it was significantly higher for central midfielders than for wide midfielders and center-forwards.
The distance covered at 20-25 km/h, at speeds exceeding 25 km/h and the total number of sprints were greater for wide midfielders, but the differences were not significant likely due to low sample size.

*Differences between phases of the competition*
Table 2 shows the means and standard deviations of all the study variables in each phase of the competition, calculated with pool data from the four teams, both depending on the specific playing position and regardless of this position. Significant differences between the phases are also shown in Table 2. No significant differences were observed between the different phases in any of the study variables, whether the players were grouped or classified by position, except for the top speed of the center-forwards, which significantly increased ($p < 0.05$) from round of 16 to the quarter-finals.

## Discussion

The first purpose of this study was to analyze differences in the total distance covered during the match and in the high-intensity physical performance parameters between the different playing positions in the four highest-ranking teams of the 2018 FIFA World Cup.

**Table 2.** Descriptive statistics and differences between different phases of the competition

| Variables | Phase of the competition | All players | Central defenders | Wide defenders | Central midfielders | Wide midfielders | Centre-forwards |
|---|---|---|---|---|---|---|---|
| | | n = 32,31,35 | n = 11,10,10 | n = 5,6,6 | n = 8,8,9 | n = 3,1,5 | n = 5,6,5 |
| Total distance (m) | round of 16 | 9652.25 ± 1003.97 | 9149.18 ± 512.90 | 10076.80 ± 1137.06 | 10448.13 ± 969.79 | 8959.133 ± 1271.30 | 9476.80 ± 907.10 |
| | quarter-final | 9899.29 ± 909.24 | 9206.60 ± 406.95 | 10302.83 ± 845.14 | 10729.13 ± 912.79 | 8918.00 | 9707.33 ± 536.53 |
| | semi-final | 9952.40 ± 1031.44 | 9069.40 ± 533.79 | 9916.33 ± 597.67 | 11025.33 ± 817.13 | 10056.60 ± 767.46 | 9726.20 ± 1188.25 |
| 20-25 km/h distance covered (m) | round of 16 | 478.59 ± 163.73 | 339.09 ± 72.19 | 606.40 ± 239.53 | 534.25 ± 131.98 | 544.67 ± 109.37 | 529.00 ± 119.67 |
| | quarter-final | 500.77 ± 173.12 | 341.50 ± 116.91 | 607.33 ± 152.90 | 590.88 ± 175.29 | 537.00 | 533.50 ± 99.65 |
| | semi-final | 514.86 ± 181.26 | 352.50 ± 110.04 | 541.00 ± 140.82 | 590.89 ± 153.21 | 663.20 ± 197.99 | 523.00 ± 183.21 |

| Variables | Phase of the competition | All players | Central defenders | Wide defenders | Central midfielders | Wide midfielders | Centre-forwards |
|---|---|---|---|---|---|---|---|
| | | n = 32,31,35 | n = 11,10,10 | n = 5,6,6 | n = 8,8,9 | n = 3,1,5 | n = 5,6,5 |
| >25 km/h distance covered (m) | round of 16 | 198.34 ± 130.36 | 126.36 ± 100.33 | 309.20 ± 138.29 | 190.50 ± 119.29 | 354.22 ± 80.70 | 164.80 ± 99.29 |
| | quarter-final | 184.32 ± 105.51 | 116.60 ± 48.58 | 260.50 ± 152.79 | 171.38 ± 96.87 | 292.00 | 220.33 ± 76.06 |
| | semi-final | 197.09 ± 109.22 | 131.50 ± 72.90 | 212.17 ± 78.66 | 171.78 ± 89.66 | 317.40 ± 101.53 | 235.40 ± 151.16 |
| Top speed (km/h) | round of 16 | 29.14 ± 2.87 | 28.88 ± 2.64 | 29.90 ± 2.19 | 29.33 ± 3.36 | 31.95 ± 2.28 | 26.98 ± 2.54* |
| | quarter-final | 29.08 ± 1.80 | 28.56 ± 2.02 | 29.35 ± 2.06 | 28.34 ± 1.38 | 30.17 | 30.48 ± 1.06* |
| | semi-final | 28.34 ± 2.15 | 27.72 ± 3.01 | 27.89 ± 1.23 | 28.17 ± 1.42 | 30.29 ± 1.09 | 28.48 ± 2.42 |
| Number of sprints | round of 16 | 29.22 ± 11.34 | 20.45 ± 5.75 | 38.20 ± 15.64 | 30.25 ± 8.80 | 38.00 ± 10.44 | 32.60 ± 9.71 |
| | quarter-final | 30.81 ± 11.48 | 21.70 ± 9.02 | 40.17 ± 11.99 | 32.50 ± 9.96 | 35.00 | 33.67 ± 8.52 |
| | semi-final | 31.31 ± 11.41 | 22.30 ± 8.60 | 34.50 ± 7.66 | 32.78 ± 11.84 | 42.40 ± 9.71 | 31.80 ± 10.76 |

* significant differences between round of 16 and quarter-final phases ($p < 0.05$)

Our main finding is that, excluding top speed, the high-intensity physical performance parameters were significantly lower for the central defenders than for the rest of the playing positions, while it was higher, but not significantly, for the wide midfielders.

Our results are not consistent with those reported by Di Salvo et al. [11] or Ugalde-Ramirez [24]. Di Salvo et al. [11] measured the total number of sprints in 67 European matches (the European Champions League and the UEFA Cup) from 2002 to 2006. The data of 20 different countries were analyzed and the total number of sprints differed between all the positions except wide defenders and center-forwards. In addition, the number of sprints was substantially smaller in all playing positions when compared to the present study. Ugalde-Ramirez [24] analyzed the data reported by FIFA for the 2018 World Cup and found no significant differences in the high-intensity physical performance parameters between the different playing positions.

Findings in this study, however, are very similar to those observed by Bradley et al. [7], Mallo et al. [17] and Rivilla-García et al. [21]. Bradley et al. [7] collected match performance data from players in the English FA Premier League. While they did not report significant differences between the different playing positions, their data clearly showed that the distances covered at 20--25 km/h and at speeds exceeding 25 km/h were smaller for central defenders and greater for wide midfielders, with no differences observed between the other positions in the study [7]. Mallo et al. [17] analyzed 111 matches of the Spanish First Division League and they observed that the distance covered at very high-intensity running was significantly smaller for central defenders and central midfielders, while it was greater, but not significantly, for wide midfielders. Rivilla-García et al. [21] calculated the number of sprints and the sprint distance per match with the data from 380 matches of the Spanish First Division in the 2013-2014 season. They concluded that the sprint distance per match and the number of sprints performed were significantly lower for central defenders and central midfielders, and higher, although non-significantly, for wide midfielders and wide defenders.

The discrepancies and similarities of the present study compared to previous studies can be attributed to the teams and the players analyzed. In this study only the four highest-ranking teams of the 2018 FIFA World Cup were analyzed, while Di Salvo et al. [11] used the data of 20 different countries and 67 European matches and Ugalde-Ramirez [24] used all data from the 2018 World Cup. This indicates that the high-intensity physical performance parameters do not adhere to the same pattern for the highest-ranking teams compared to the other teams participating in European and World soccer competitions. However, the physical characteristics as well as the physical and physiological demands of many players in the English FA Premier League and the Spanish First Division, being two of the strongest leagues in the world, must be similar to those for the best teams of our study, which explains the similar results found.

It was also observed that central defenders covered less distance per match than the other playing positions, but differences were only significant with central midfielders and wide defenders. For this parameter, our

results are not in line with those reported by Bradley et al. [7], Mallo et al. [17] or Rivilla-García et al. [21]. Furthermore, the total distance covered in the different playing positions differs from many studies [4, 7, 10, 17, 21], and also varies between them. These different results suggest that the success of a soccer match is not affected by the total distance covered. However, soccer match success may rely on high-intensity performance parameters and, of course, on a superior technical and tactical strategy, as it is suggested by Di Salvo et al. [13] and Abbott et al. [1].

The second purpose of this study was to analyze the evolution of the total distance covered during the match and the high-intensity physical performance parameters of the four highest-ranking teams throughout the 2018 FIFA World Cup, from round of 16 to semi-finals. According to some authors [16, 20], match congestion may reduce the total distance covered and the number of high-intensity activities during the match. However, no significant differences were observed between the different phases, except for the top speed of the center-forwards. These results show that the highest-ranking teams of the 2018 FIFA World Cup suffered no detrimental effects on high-intensity physical performance parameters, even if the three matches analyzed were played within 10 days. Along with a superior technical and tactical strategy, this may be evidence why those four teams classified for the semi-finals.

## Conclusions

The findings of this study confirm that the distances covered at high speeds and the number of sprints performed during a soccer match may differentiate team performance, especially in some playing positions. Our results show that the wide midfielders of the highest-ranking teams in the 2018 FIFA World Cup covered more distance at speeds exceeding 20 km/h and performed a higher number of sprints than the rest of the players. Understanding these differences may help coaches to carefully design players' rotations and include different soccer-specific drills for each playing position to contribute to team success. The findings of this study also revealed that the highest-ranking teams in the 2018 FIFA World Cup did not experience detrimental effects on high-intensity physical performance parameters due to congested matches. Together with a good technical and tactical strategy, promoting post-match recovery may be the key for team success.

## Conflict of Interest

The authors declare no conflict of interest.

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