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Variation in Match Physical Performance in Turkish Super League Soccer Players by Position Across Four Seasons

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ABSTRACT

This study examined variations in match physical performances of Turkish Super League soccer players over four consecutive seasons, considering playing position. Data were derived from 1224 different match indices for 17997 observations of 25 different teams. These data were collected over the four seasons from 2015–16 to 2018–19 utilizing a multi-camera computerized tracking system. Playing positions were categorized as follows: central defender (CD), external defender (ED), central midfielder (CM), external midfielder (EM), and forward (FWR). The data analysed covered total distance, as well as distances covered in the following conditions: high-speed running (HSR, 20-23.9 $km.h^{-1}$), sprinting (> 24 $km.h^{-1}$), high metabolic power (HMP; from 20 to 35 $W \cdot kg^{-1}$), elevated metabolic power (EMP; from 35 to 55 $W \cdot kg^{-1}$), and maximal metabolic power (MMP; > 55 $W \cdot kg^{-1}$). Players in the CM position were found to cover a significantly greater total distance, as well as significantly greater HMP and EMP distances than all other positions. In contrast, those in EM and ED positions engaged in significantly greater high-speed running and sprint distance than all other positions ($p<0.05$). Decreases were found in the distances covered in the different running speed zones and metabolic power zones for all positions over the seasons from 2015–16 to 2018–19. These findings show that the positional roles of the players entail different physical demands. Therefore, it is recommended that coaches consider the physical demands of the positions and seasonal variation when creating training programs for players.

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INTRODUCTION

Match performance in elite soccer is based on the players' different physical, mental, technical, and tactical capacities and cognitive skills (Brito Souza et al., 2020; Roca et al., 2013; Sarmento et al., 2018). The increase in the number of matches and high-intensity activities in soccer has made it necessary for players to be more physically developed. To improve physical capacities, it is necessary for coaches to accurately determine not just internal load (heart rate, blood lactate, and rating of perceived exertion) but also external load (distance covered in different speed zones) induced by matches and training. Thanks to new technologies such as GPS and multi-camera computerized tracking systems, it is straightforward to determine distances covered and estimated energy expenditure by players in matches and training (Buchheit et al., 2015; Carling, 2013). In this way, training plans can be created that align with the structure of matches and the consequent demands on players during matches.

Examining the demands of a match, it is important for soccer players to develop high levels of aerobic endurance, attributable to walking, jogging, low-intensity running, and overall playing time during matches, as well as anaerobic endurance needed for high-intensity activities such as running, jumping, sudden changes of direction, acceleration, deceleration, and sprinting (Morgans et al., 2014). Elite players cover an average distance of 8600–14200m during matches (Di Salvo et al., 2007; Rienzi et al., 2000; Rivilla-García et al., 2019). At least 10 % of the distance covered involves high-speed running and sprinting (Andrzejewski et al., 2016; Stølen et al., 2005). Distances also vary by position, with central midfielders, on average, covering greater total distances than central defenders, wide defenders, and attackers (Rampinini et al., 2007), while a greater proportion of the distance covered in matches by attackers involves sprinting compared to defenders and midfielders.

Although the traditional running speed-based approach (distance covered in high-speed running or sprinting) is considered valid for evaluating high-intensity activities in a match, it does not fully represent the physical demands of soccer, as it does not include acceleration phases, especially in high-intensity running and high-energy activities performed without reaching high speeds (Coutts et al., 2015; Kempton et al., 2015). For example, during a match, players also perform acceleration and deceleration activities around 500-700 times (Castagna et al., 2017). Therefore, to understand the demands of the players during the match, the distance of players have covered at different speed zones in the match as well as the metabolic power can be estimated. This estimate involves a theoretical model based on calculating metabolic power, estimation of energy consumption used in accelerations and

decelerations performed in a soccer drill or match (Coutts et al., 2015). Manzi et al. (2014) showed large to very large correlations between match metabolic power categories and aerobic fitness components in elite male soccer players. In recent years, this theoretical model has been used in team sports such as soccer (Hoppe et al., 2017; Venzke et al., 2023), rugby (Dubois et al., 2017), and hockey (Polglaze et al., 2018) to monitor training load.

Many studies in the literature have compared the distances covered by soccer players in different playing positions across different leagues including the English Premier League (Di Salvo et al., 2013; E. Rampinini et al., 2007), Serie A in Italy (Rampinini et al., 2009), the German Bundesliga (Andrzejewski et al., 2016), La Liga in Spain (Lago-Peñas et al., 2023; Rivilla-García et al., 2019), the French First League (Dellal et al., 2010), the Russian Premier League (Morgans et al., 2022) and the Chinese Super League (Gai et al., 2019). Only one study with small sample size, Akyildiz et al. (2022) compared the distance covered in running speed and metabolic power zones of players playing in different positions in two teams in the Turkish Super League. However, studies up to this point have not compared all players in the Turkish Super League. There is also no comprehensive study in the literature comparing metabolic power demands of soccer players in different playing positions, or from a longitudinal perspective over several seasons. The present study aimed to address the resulting lack in our knowledge by comparing the metabolic power demands and distances covered at different speed zones for different positions and to do this over four seasons to determine the extent of variation seen in Turkish Super League soccer players. It was hypothesized that there would be differences in metabolic power variables and distances covered at different speed zones according to position and that these might vary over the seasons.

METHODS

Participants

A computerized multiple-camera tracking system was used to evaluate the match physical performance. Match physical performance data were collected from the 2015-16 season (age: 27.3 ± 1.1 years; ball possession time: 51:22 ± 4:22 min), 2016-17 season (age: 27.4 ± 1.2 years; ball possession time: 52:26 ± 4:32 min), 2017-18 season (age: 28.1 ± 1.1 years; ball possession time: 53:48 ± 4:10 min), and 2018-19 season (age: 28.3 ± 1.2 years; ball possession time: 53:31 ± 4:47 min) of the Turkish Super League. Data were derived from 1224 different matches based on 17997 observations of 25 different teams. Data was only examined for players who played the full 90 minutes of the match, excluding those who were substituted or

were substitutes themselves. Playing positions were categorized as central defender, external defender, central midfielder, external midfielder, and forward (see Table 1). The study was approved by the Pamukkale University ethics committee (Number: 217385 and year: 2022).

Table 1
Number of Observations by Playing Position for Each Season

Positions	2015-2016 Season	2016-2017 Season	2017-2018 Season	2018-2019 Season	Total
Central Defenders (no)	1097	1115	1114	1045	4371
External Defenders (no)	1139	1057	1072	1108	4376
Central Midfielders (no)	1141	1304	1306	1356	5107
External Midfielders (no)	515	573	593	638	2319
Forwards (no)	448	478	416	482	1824
Total (no)	4340	4527	4501	4629	17997

Note. no: Number of Observations

Procedures

Match Analysis System

Match performance data were collected by using a computerized multiple-camera tracking system (Sentioscope®, Sentio, Turkey). This system uses two high-definition internet protocol cameras to record action on the soccer field; one camera is adjusted to capture the left half, and the other is adjusted to capture the right half. This system allows the collection of the data of all the players involved in the match. Baysal and Duygulu (2016) have demonstrated that Sentioscope® is an effective tracking system for examining soccer players' movement patterns on a soccer field.

Match Performance Parameters

The data were analysed according to total distance and 2 speed zones: High-speed running (HSR, 20-23.9 km.h^{-1}), and sprinting (> 24 km.h^{-1}). In addition, three metabolic power categories were defined: high metabolic power (HMP; from 20 to 35 W·kg^{-1}), elevated metabolic power (EMP; from 35 to 55 W·kg^{-1}), and maximal metabolic power (MMP; > 55 W·kg^{-1}; Osgnach et al., 2010).

Data Analysis

All data are reported as means and standard deviations. Before using parametric tests, the assumption of normality was verified using the Shapiro-Wilk test. A one-way analysis of variance (ANOVA) was performed on each dependent variable (total distance, HSR, sprinting, HMP, EMP, and MMP), including the objective measures of match running performance across the five playing positions and the four completed seasons. Where a significant difference was detected, the Tukey HSD post hoc test for pairwise comparisons was conducted. The level of statistical significance was set at $p < 0.05$. Effect size (ES) was also calculated to determine the meaningfulness of the difference, with magnitudes classified as trivial (<0.01), small (0.01), moderate (0.05), and large (> 0.15; Cohen, 1988).

RESULTS

Positional Differences in Match Distances

The total distances covered at different speed zones according to the different playing positions are shown in Table 2. The results show significant differences between the different playing positions in terms of total distances covered, HSR distances, and sprint distances ($F = 1876.3$; $p = 0.001$; large effect: 0.293; $F = 1819.3$; $p = 0.001$; large effect: 0.287; $F = 1481.2$; $p = 0.001$; large effect: 0.247, respectively). CM covered significantly higher total distance than EM, ED, FWR and CD (4.0%, 4.9%, 7.9% and 10.2% more, respectively). At the same time, EM covered significantly higher HSR distance than ED, FWR, CM, and CD (7.5%, 13.0%, 16.2%, 39.8%, respectively) as well as significantly higher sprint distances than ED, FWR, CM, and CD (11.1%, 17.0%, 33.7%, 46.3%, respectively).

Positional Differences in Match Metabolic Power Distances

Total covered distances at different metabolic power zones for various playing positions are also shown in Table 2. These reveal significant differences between the different playing positions in terms of distances covered at HMP ($F = 2225.6$; $p = 0.001$; large effect: 0.331), EMP ($F = 1608.7$; $p = 0.001$; large effect: 0.263), and MMP ($F = 1144.2$; $p = 0.001$; large effect: 0.202). CM significantly covered distance at higher HMP than ED, EM, FWR, and CD (13.6%, 14.2%, 22.7%, 25.4%, respectively) as well as significantly higher distances at EMP than EM, ED, FWR, and CD (4.3%, 5.7%, 12.1%, 26.5%, respectively). MMP distances, EM covered significantly more than FWR, ED, CM, and CD (6.7%, 8.6%, 18.1%, 31.3%, respectively).

Table 2
Mean Covered Distances at Different Speeds Zones and in Different Metabolic Power Zones for Each Playing Position

Variables	CD (1)	ED (2)	CM (3)	EM (4)	FWR (5)	POST HOC	ES
Total Distance (m)	9816.0±504.6	10399.2±596.1	10933.0±668.9	10494.6±756.1	10072.9±852.0	3> 1, 2, 4, 5; 4> 1, 2, 5; 2> 1, 5; 5>1*	0.293
High Speed Running (HSR) Distance (m)	503.4±139.5	773.4±194.6	700.6±188.8	836.1±198.0	727.3±178.2	4> 1, 2, 3, 5; 2> 1, 3, 5; 5>1, 3; 3>1*	0.287
Sprint Distance (m)	178.0±73.6	294.8±103.2	220.0±90.2	331.6±114.7	275.3±97.6	4> 1, 2, 3, 5; 2> 1, 3, 5; 5>1, 3; 3>1*	0.247
High Metabolic Power Distance (m)	1379.1±187.4	1596.3±249.1	1847.8±291.3	1585.5±275.3	1428.1±277.7	3> 1, 2, 4, 5; 2> 1, 5; 4> 1, 5; 5> 1*	0.331
Elevated Metabolic Power distances (m)	535.3±95.4	687.1±129.8	728.5±137.3	696.9±126.7	640.6±127.4	3> 1, 2, 4, 5; 4> 1, 2, 5; 2> 1, 5; 5> 1*	0.263
Max Metabolic Power distance (m)	300.4±80.1	399.6±93.3	358.1±95.1	437.4±101.3	407.9±103.2	4> 1, 2, 3, 5; 5> 1, 2, 3; 2 >1; 3> 1*	0.202

Note. Central Defenders: CD; External Defenders: ED; Central Midfielders: CM; External Midfielders: EM; Forwards: FWR; * $p<0.05$

Seasonal Variations in Match Distances

Figure 1 shows variations across the four seasons for the different playing positions examined in terms of total distance covered and distance covered in HSR and sprinting zones. If we consider this position by position, CD covered significantly higher total distance (F = 28.392, p = 0.001, small effect: 0.019), HSR distance (F = 51.597, p = 0.001, small effect: 0.034), and sprint distance (F = 27.182, p = 0.001, small effect: 0.018) in the 2015-16 and 2016-17 seasons compared to the 2017-18 and 2018-19 seasons.

Looking at the picture for ED, they covered significantly higher total distances (F = 5.031, p = 0.002, trivial effect: 0.003) in the 2016-17 season than in the 2015-16 and 2017-18 seasons. They also covered significantly higher HSR distances (F = 19.944, p = 0.001, small effect: 0.013) and sprint distances (F = 24.941, p = 0.001, small effect: 0.016) in the 2015-16 and 2016-17 seasons than in 2017-18 and 2018-19.

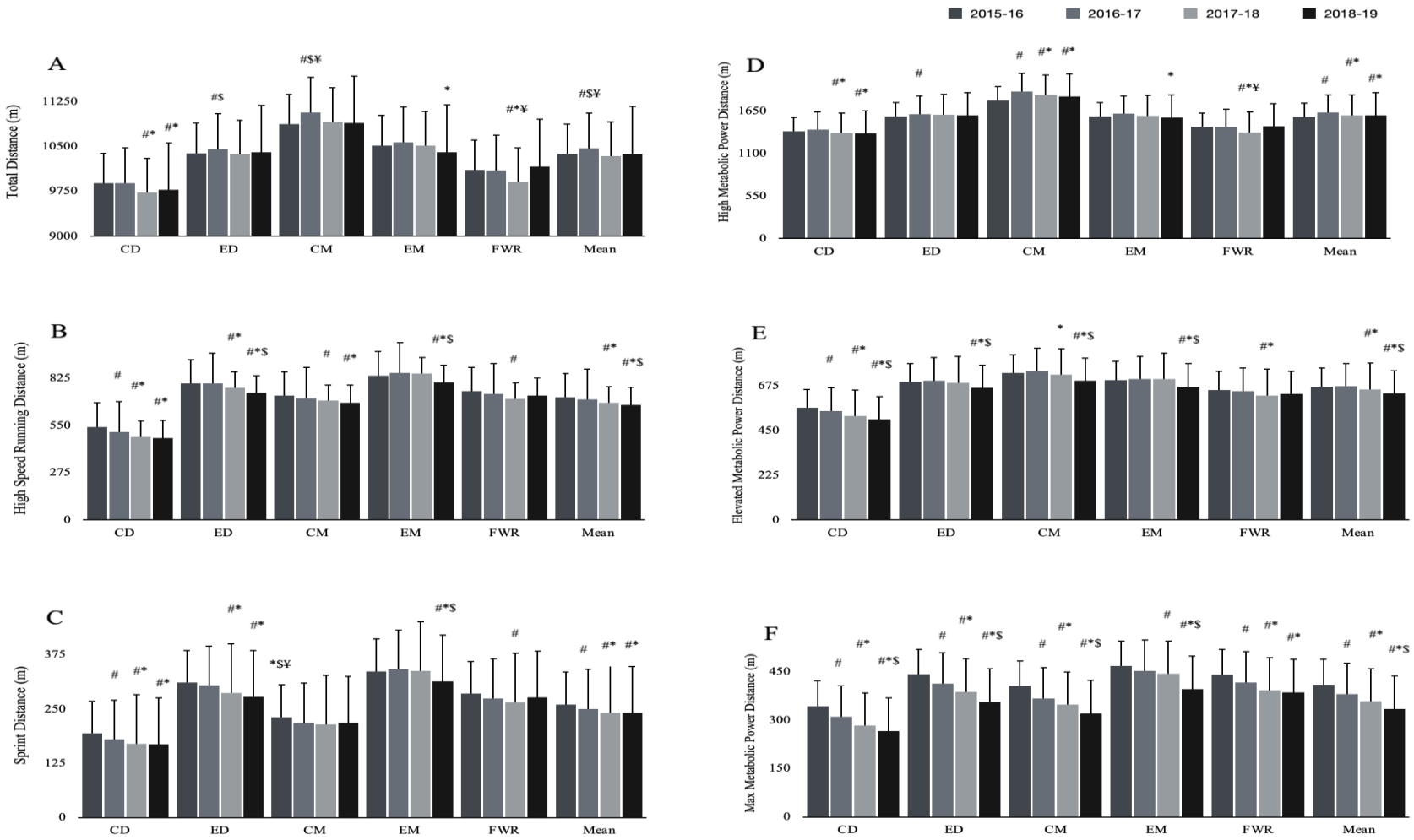
In terms of midfielders, CM covered significantly higher total distances (F = 24.158, p = 0.001, small effect: 0.014) in the 2016-17 season than the other three seasons. They also covered significantly higher HSR distance (F = 11.398, p = 0.001, trivial effect: 0.006) and sprint distance (F = 8.511, p = 0.001, trivial effect: 0.004) in 2015-16 than in both 2017-18 and 2018-19. As for EM, they covered significantly higher total distance (F = 4.914, p = 0.002, trivial effect: 0.006) in 2016-17 compared to 2018-19 as well as significantly higher HSR distances (F = 10.992, p = 0.001, small effect: 0.014), and sprint distance (F = 7.359, p = 0.001, trivial effect: 0.009) in 2015-16, 2016-17, and 2017-18 than in the 2018-19 season. Finally, FWR covered significantly higher total distances (F = 7.639, p = 0.001, small effect: 0.012), HSR distances (F = 4.470, p = 0.004, trivial effect: 0.007), and sprint distance (F = 3.245, p = 0.021, trivial effect: 0.005) in 2015-16 than in 2017-18.

Seasonal Variations in Match Metabolic Power Distances

Figure 1 also shows seasonal variations for the different positions in terms of HMP, EMP, and MMP distances across the four seasons considered here. The results for defenders show that CD covered significantly higher HMP distances (F = 14.146, p = 0.001, trivial effect: 0.009), EMP distances (F = 85.763, p = 0.001, moderate effect: 0.055), and MMP distances (F = 220.973, p = 0.001, moderate effect: 0.131) in 2015-16 and 2016-17 than in 2017-18 and 2018-19. Meanwhile, ED covered significantly higher HMP distances (F = 3.237, p = 0.021, trivial effect: 0.002) in 2016-17 than in 2015-16 and significantly higher EMP distance (F = 16.408, p = 0.001, small effect: 0.011), and MMP distance (F = 190.478, p = 0.001, moderate effect: 0.115) in 2015-16, 2016-17, and 2017-18 seasons covered than in 2018-19.

Figure 1

Variations by Season for Various Playing Positions in Terms of Distances Covered at Different Speeds and in Different Metabolic Power Zones



Note. Central Defenders: CD; External Defenders: ED; Central Midfielders: CM; External Midfielders: EM; Forwards: FWR; # Significant difference from 2015-2016 season; * Significant difference from 2016-2017 season; $: Significant difference from 2017-2018 season; ¥: Significant difference from 2018-2019 season

As for midfielders, CM covered significantly higher HMP distance (F = 33.391, p = 0.001, small effect: 0.019), and MMP distance (F = 1193.561, p = 0.001, moderate effect: 0.102) in 2015-16 and 2016-17 compared to 2017-18 and 2018-19 and significantly higher EMP distance (F = 31.689, p = 0.001, small effect: 0.018) in 2015-16, 2016-17 and 2017-18 than in 2018-19 season. Focusing on the EM position, they covered significantly higher HMP distance (F = 3.919, p = 0.008, trivial effect: 0.005) in 2016-17 than in 2018-19 while covering significantly higher EMP distance (F = 12.914, p = 0.001, small effect: 0.016), and MMP distance (F = 59.213, p = 0.001, moderate effect: 0.071) in 2015-16, 2016-17, and 2017-18 than in 2018-19. Finally, the results for FWR show that they covered significantly higher HMP (F = 7.503, p = 0.001, small effect: 0.012), EMP (F = 4.690, p = 0.003, trivial effect: 0.007), and MMP distances (F = 31.971, p = 0.001, moderate effect: 0.050) in 2015-16 and 2016-17 than in 2017-18.

DISCUSSION

This study investigated the seasonal variation in match physical performances of soccer players in different positions in the Turkish Super League from 2015-16 to 2018-19. The study's main findings are statistically significant differences in the distances covered by different playing positions at different running speeds and metabolic power zones both overall and, in some cases, between different seasons.

Our findings show that, as expected, there are differences between playing positions in terms of distances covered at different running speeds and overall distance covered. Unsurprisingly, players in the CM position were found to cover a statistically significantly greater total distance than all other positions. In contrast, those playing as CD covered the lowest total distance of all the positions. Interestingly, EM and ED covered statistically significantly greater high-intensity running and sprint distances than other positions. In contrast, CD covered the lowest distances in these speed zones. These results are in line with those of previous studies (Di Salvo et al., 2007; E. Rampinini et al., 2007; Rivilla-García et al., 2019). The differences between positions can be associated with each position's tactical role. CM players, for example, need to cover a more extensive area than other positions since their role is to contribute to defense and offense. EMs and EDs, meanwhile, need to perform more high-speed runs than other positions to get to the correct position in the match, both offensively and defensively.

However, the distances covered by players in various speed zones during a soccer match are insufficient to fully explain the metabolic demands imposed (Manzi et al., 2014). Therefore, this study is also important in that it provides findings regarding the metabolic

power distances for players during matches. These findings show that CMs cover the greatest distance at HMP and EMP, while CDs cover the lowest distance. In a similar study with a small sample size, Akyildiz et al. (2022) reported that the CD had the lowest values for the overall metabolic power distances, while the CM had the greatest distances in the Turkish Super League. Venzke et al. (2023) found results in line with current study findings in the German Bundesliga league. In addition, our study findings are consistent with those of Gaudino et al. (2013), who found in a 10-week observation of elite soccer players that CM covered higher HMP, EMP, and MMP distances in training than other positions. These findings demonstrate that the CM position requires more HMP activities than all other positions during the match.

The present study results showed a significant decrease in HSR distance (%6.4) and sprint distance (%8.4). In contrast, total distance did not change between seasons in the 2015-16 and 2018-19 seasons in the Turkish Super League. Partially parallel to the present study findings, Morgans et al. (2022) stated that although total distance (%6.1), HIR (%20.2) and sprint distance (%25.5) showed an increase from 2016–17 to the 2018–2019 season, total distance (%3.0), HIR (%9.8) and sprint distance (%9.3) showed a clear decrease between 2018–2019 and 2020-2021 seasons in the Russian Premier League. On the other hand, some of these findings are somewhat surprising when compared to the findings of Bush et al. (2015), which revealed significant increases in HSR distance (24–36%) and sprint distance (~ 50%), and only minor changes in total distance for all positions between 2006–07 and 2012–13 in the English Premier League. In another study, Lago-Peñas et al. (2023) showed that the number of HSR (%11.5) and HSR distance (%5.7) significantly increased between the 2012-2013 and 2019-2020 seasons in the Spanish La Liga. These results demonstrate that although the ball possession time has increased (from 51:22 to 53:31 min), the physical demands of the Turkish Super League decreased from 2015–16 to 2018–19 seasons, in contrast to the English Premier League and the Spanish La Liga. One of the reasons for these results may be that the average age in the Turkish Super League increased from 2015–2016 (27.3 years) to 2018–2019 (28.1 years). Sal de Rellán-Guerra et al. (2019) revealed that older professional soccer players showed significantly lower physical performance in total distance, number of HSR, and number of sprints than younger players. In addition, some technical parameters, such as the rhythm of the game and the speed of the ball during the ball possessions, may be one of the reasons for these results. Another reason for this result could be that the physical capacity of Turkish Super League players did not change from the 2015-16 to the 2018-19 season. Because previous studies have indicated that total, HSR and sprint distances covered in matches are strongly

related to the physical capacity of professional soccer players (Modric et al., 2021; Radziminski et al., 2020; Redkva et al., 2018).

This is the first study to examine the variation in the performance of soccer players in different positions over several seasons using the metabolic power approach. The present study shows significant decreases in EMP (excluding FWR) and MMP for all positions during four seasons, from 2015-16 to 2018-19 in the Turkish Super League. On the other hand, there are significant decreases for CD, EM, and CM in HMP, while the change in HMP is not significant for ED and FWR. These results may be that the coaches did not create training programs that considered the metabolic demands of the match. Therefore, coaches should remember that players should add drills in their training programs to increase their metabolic power distance and their traditional running-based distances.

The limitation of this study is that variables such as team formations, match outcome (win, draw, or loss), match location (home or away), and interactions between players were not examined. It should be noted that each of these variables can cause players to cover different distances in their positions.

CONCLUSION

The current study shows positional differences in the distance covered at different running speeds and metabolic power zones during matches. Our findings show in more detail than previously provided the extent to which the positional roles of the players entail different physical demands. Therefore, it is recommended that coaches consider the physical demands of different positions to recreate appropriate training loads.

Monitoring the variation in physical match data of a player, a position, or a team over a number of seasons can also provide information that can guide coaches to update their training programs. Our study shows that there was no consistent increase in the distances covered in the different running speed zones or in metabolic power zones of all positions across the 2015-16 and 2018-19 seasons in the Turkish Super League. Thus, it should be remembered that while creating their training programs, coaches should choose their training drills based on the tactical strategies, the playing positions, and the demand of players.

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Authors' contribution

The first and second authors have given the design of the manuscript, first and third authors to acquire, analyzed and interpret the data. All authors participated to drafting the manuscript, first and second authors revised it critically. All authors read and approved the final version of the manuscript.

Declaration of conflict interest

The authors have no conflicts of interest to report.

Ethics Statement

The study was approved by the Pamukkale University ethics committee (Number: 217385 and year: 2022).

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