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Examining the Relationship Between Sprint and Endurance Performances, Distances Covered During the Season, Positional Roles, and Success in Women's Football Players

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ABSTRACT

This study aimed to investigate the relationship between the distances covered by female football players during the season and their sprint and endurance performances, as well as to compare the findings based on match success outcomes and player positions.

The study included 10 female football players aged 18–36 (24.5±6.47) competing in the 2021-2022 Women's Football Super League. The performances of the same 10 players, who participated in five matches during the first half of the season, were evaluated. The study measured players' height, weight, IFT (30-15) test results, 0-10 m and 0-40 m sprint tests, and GPS match data. The collected data were analyzed using the statistical software package JAMOVI (The Jamovi Project, 2022; R Core Team, 2021), and mean, percentage, minimum, maximum, and standard deviation values were determined. Kolmogorov-Smirnov and Shapiro-Wilk normality tests were applied, and Independent Sample t-tests were used for comparisons of normally distributed data at a significance level of $p<0.05$. The Pearson correlation test was used to check the relationships between variables.

A significant difference was found in the total distance covered between winning matches (8808.25 ± 834.64 m) and drawn matches (7923.25 ± 883.57 m) at $p<0.05$. No significant relationship was observed between players' match performances (high-intensity running, sprinting, total distance covered, and acceleration) and performance test results.

When the in-season performances of female football players were examined, it was observed that sprint distance, acceleration count, and total distance covered in winning matches were lower on average compared to drawn matches. It was concluded that increasing sprint distances during matches enhances the likelihood of winning. However, no relationship was found between players' performance test results and the distances covered during matches.

Keywords: Football, GPS, High Intensity Running, Sprint

INTRODUCTION

The demands of football matches have evolved, requiring players to be adequately prepared to meet the physical challenges of the game (Carling C, et al., 2012). Evidence indicates a significant positive relationship between the sprint distances covered by players in specific positions (e.g., wide midfielders and forwards) and the number of matches won by their teams. HSR and sprint activities are considered key determinants of successful performance (Chmura P, et al., 2018).

Therefore, the ability to sustain HSR and perform sprints is a crucial factor for football players to compete at a professional level. Consequently, enhancing players' HSR and sprinting capacities is of paramount importance in terms of team staffing and sports science in professional football (Chmura P, et al., 2017; Gualtieri A, et al., 2023).

The training performance of athletes can be affected by the tactical features applied by the team. For example, teams with more ball control have been observed to cover higher levels of high intensity running distances in games that require more ball control compared to teams with less ball control (Bradley et al., 2013). In this case, when match activities are analyzed according to various playing positions, the success of the team may seem to depend on more physical actions in some positions and more technical activities in others (Di Salvo et al., 2013). For example, while Midfielders distribute most passes, Forwards usually take the most shots during a match (Bradley et al., 2013). The playing effectiveness of Wide Midfielders is usually associated with high-intensity distance (Konefał et al.,

2019), while capable Fullback playing in the area away from the center can achieve greater total sprint distances (Andrzejewski et al., 2018).

Football professionals and sports scientists are looking for key factors that contribute to improved performance of elite female players in both training and competition (Manson S, A et.al., 2014; Ramos G, P et.al., 2019). For this reason, academic interest in women's soccer has increased in recent years (Harkness-Armstrong et al., 2023). One of the topics that has attracted more attention in the literature is the analysis of the adaptability of locomotor activity performed at different speeds. However, despite the increasing interest in sports science and performance, a comprehensive understanding of the physical demands of women's soccer athletes has not yet been widely investigated (Castellano et al., 2011; Loturco et al., 2015; Ramirez-Campillo et al., 2016).

Although female football players have less muscular mass biologically than male football players, when women's football matches are examined, the performance rate of activities such as standing, walking, running, high intensity running and sprinting is similar to that of male football players (Stolen T, et.al., 2005; Mohr et al., 2008; Fessi et al., 2016;). High-level female football players cover a total of 9.5-11 km during a match (Datson et al., 2017). It has been revealed that elite female athletes who cover these distances perform approximately 1379-1459 different activities in every 4 seconds, and 125-154 of these activities are high-intensity runs that last an average of 2-3 seconds (Martinez-Lagunas V, et.al, 2014; Nikolaidis PT., 2014; Stepinski M. et.al. 2020).

It was also stated that female football players performed the majority of high-speed running (12.24–19.0 km·h-1) and sprinting (>19.0 km·h-1) over distances shorter than 10 meters (81–84% and 71–78%), and had an average recovery time of 14 seconds between these high-speed runs and 87 seconds between sprints, meaning a work-to-rest ratio of 1:7 and 1:43, respectively (Mara JK, et.al.2017).

A range of field and laboratory-based tests are used to assess the training status of athletes, predict potential match performance and determine the impact of training (Krustrup P, et.al.,2005). Perhaps the most widely used of these and studied under the name of wearable technology, global positioning system (GPS) and heart rate (HR) are used to evaluate the physiological and movement demands of athletes and to monitor their internal and external loads (Barbero Álvarez et al., 2008; Cunniffe et al., 2009; Konefał M. et.al., 2019).

Although research in the field of women's football has increased significantly in recent years, studies that consider gender differences are still not common and women's football needs to be analyzed specifically due to its structure (Milanovic et al., 2017; Pardos-Mainer et al., 2018). Based on this, the literature was evaluated and, in addition to the relationship between pre-season performance tests and running distances, no other study was found that analyzed the situation between position and match result (win and draw). For this purpose, in order to contribute to the literature, both the relationship between performance tests and covering distances and the relationships between success and positional differences were examined in our study.

METHODS

Participants

Ten female football players, aged between 18-36 (24.5±6.47) voluntarily participated in the study during the 2022-2023 season of the Turkish Women's Super League.

Study Design

Ten athletes who played at least 70 minutes in matches were selected for the study. Among these matches, five games with the same lineup (including the same goalkeeper) were referenced. The outcomes of these five matches (2 wins, 3 draws) were considered as success criteria (win, draw). Based on tactical formations, the players were divided into attackers and defenders, and positional differences were evaluated accordingly.

All these matches were played during the first half of the league, and performance tests were conducted before the season began.

Performance Assessment

30-15 IFT

All participants were informed about the test protocol in advance. In the 30-15 IFT test, which is widely used in the literature, a starting speed of 10 km/h was set.

Participants attempted to complete 30-second running phases followed by 15 seconds of rest within their designated 3-meter zones. If athletes failed to reach the 3-meter zones consecutively three

times within the specified times, their tests were terminated. Similarly, the tests were ended for those who voluntarily stopped running, VIFT values were recorded (Buchheit, 2008)

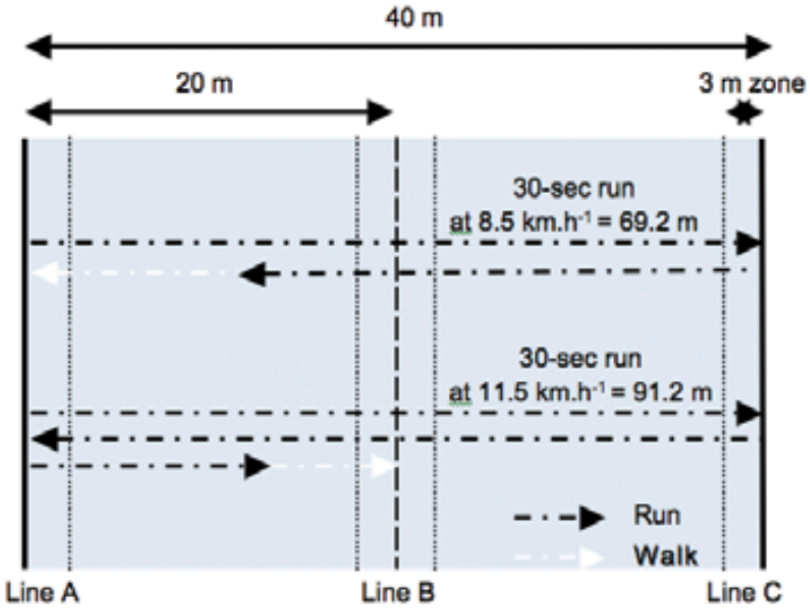

Fig.1 30-15 IFT (2008, Buchheit)

Maximum Sprint Speed (MSS) and Acceleration (ACC)

Determining for MSS, Fusion Sport SmartSpeedTM PRO photocells (Fusion Sport, Queensland, Australia) were used. The setup consisted of 40-meter lanes with gates every 10 meters. MSS values were measured based on the 10-meter section where the highest speed was achieved.

Before the test, all athletes performed a 5-minute warm-up followed by low-intensity 5-meter runs. Each athlete had two trials, and the highest value was recorded as the reference (Kayhan et al., 2021). For acceleration, the 10-meter sprint values from the same tests were used.

GPS Measurements

To analyze performance variables during matches, GPS devices with a data transmission capability of 10 Hz (Fitogether, Korea), considered the gold standard in team sports, were utilized.

Speed analysis included total running distance, high-intensity running distance (HSR: 18-23.9 km/h) and count, sprint distance (>24 km/h) and count, maximum sprint speed, average speed, accelerations (≥3 m/s²), and decelerations (≤3 m/s²). These metrics are frequently used by coaches and sports scientists for load and real-time performance monitoring (Andersson et al., 2010; Bradley et al., 2014; Mara et al., 2017; Meylan et al., 2017; Ramos et al., 2017; Ramos et al., 2019; Başkaya & Akkoyunlu 2023).

Statistical Methods

The research data were analyzed using the JAMOVI statistical analysis package (The Jamovi Project, 2022; R Core Team, 2021). Mean, percentage, minimum, maximum, and standard deviation values were calculated. Kolmogorov-Smirnov and Shapiro-Wilk normality tests were applied, and data that followed a normal distribution were compared using the Independent Sample t-test at a significance level of $p<0.05$. Pearson correlation was used to analyze relationships between variables.

FINDINGS

Table 1. Analyzing the performances of female footballers according to the match score

Variables	Group	N	Mean	SD	t	df	p
HSR	Draw	10	326,64	114,49	-0,68	18,00	0,50
	Win	10	367,77	151,80			
Sprint	Draw	10	18,53	16,35	-0,58	18,00	0,57
	Win	10	24,26	26,44			
TDC	Draw	10	8026,21	883,57	-2,04	18,00	**0,06**
	Win	10	8809,21	834,64			
ACC	Draw	10	9,23	6,29	-1,08	18,00	0,30
	Win	10	12,25	6,21			

The findings of the study revealed no statistically significant differences in the performance variables based on match outcomes (draw vs. win). High-speed running, sprint performance, and acceleration showed no meaningful variation between the groups, with p-values of 0.50, 0.57, and 0.30, respectively. Although the total distance covered approached significance (p = 0.06), it did not meet the threshold for statistical significance. These results suggest that match outcomes do not significantly impact the physical performance metrics analyzed.

Table 2. Analyzing the performances of female footballers according to the match score

Variables	Group	N	Mean	SD	t	df	p
HSR	Attack	5	287,06	139,22	-1,11	8,00	0,30
	Defence	5	366,22	78,71			
Sprint	Attack	5	20,48	21,34	0,36	8,00	0,73
	Defence	5	16,57	11,67			
TDC	Attack	5	7466,87	713,04	-2,53	8,00	**0,04**
	Defence	5	8585,54	682,66			
ACC	Attack	5	9,93	8,19	0,33	8,00	0,75
	Defence	5	8,53	4,56			

HSR ‘‘High Speed Run’’ TDC ‘‘Total Distance Cover’’ ACC ‘‘Acceleration’’

The analysis of female footballers' performances based on their positions during draw matches revealed no statistically significant differences in high-speed running (p = 0.30), sprint performance (p = 0.73), or acceleration (p = 0.75) between attackers and defenders. However, a significant difference was observed in total distance covered, with defenders covering more distance than attackers (p = 0.04). This suggests that positional roles may influence certain performance metrics, particularly total distance covered, during draw matches.

Table 3. Analysing the performances of female footballers according to positions according to wins

Variables	Group	N	Mean	SD	t	df	p
HSR	Attack	5	354,622	196,18	-0,26	8,00	0,80
	Defence	5	380,92	113,71			
Sprint	Attack	5	31,15	36,229	0,81	8,00	0,44
	Defence	5	17,37	11,909			
TDC	Attack	5	8420,03	978,06	-1,60	8,00	0,15
	Defence	5	9198,38	481,84			
ACC	Attack	5	12,8	8,578	0,27	8,00	0,80
	Defence	5	11,7	3,528			

The analysis of female footballers' performances based on their positions during wins showed no statistically significant differences in high-speed running (p = 0.80), sprint performance (p = 0.44), total distance covered (p = 0.15), or acceleration (p = 0.80) between attackers and defenders. These results indicate that positional roles do not significantly influence the physical performance metrics analyzed in winning matches.

Table 4. Analyzing the performance of attacking players according to the match score

Variables	Group	N	Mean	SD	t	df	p
HSR	Draw	5	287,06	139,22	-0,63	8,00	0,55
	Win	5	354,622	196,18			
Sprint	Draw	5	20,482	21,342	-0,57	8,00	0,59
	Win	5	31,15	36,229			
TDC	Draw	5	7466,874	713,04	-1,76	8,00	0,12
	Win	5	8420,03	978,06			
ACC	Draw	5	9,934	8,192	-0,54	8,00	0,60
	Win	5	12,8	8,578			

The analysis of attacking players' performances based on match outcomes (draw vs. win) showed no statistically significant differences in high-speed running (p = 0.55), sprint performance (p = 0.59), total distance covered (p = 0.12), or acceleration (p = 0.60). These findings suggest that match outcomes do not significantly affect the physical performance metrics of attacking players.

Table 5. Analysing the performance of defence players according to the match score

Variables	Group	N	Mean	SD	t	df	p
HSR	Draw	5	366,22	78,71	-0,24	8,00	0,82
	Win	5	380,92	113,71			
Sprint	Draw	5	16,57	11,67	-0,11	8,00	0,92
	Win	5	17,37	11,91			
TDC	Draw	5	8585,54	682,66	-1,64	8,00	0,14
	Win	5	9198,38	481,84			
ACC	Draw	5	8,53	4,56	-1,23	8,00	0,25
	Win	5	11,70	3,53			

Table 5 analyzes the performance of defensive players based on match outcomes (draw vs. win) across four variables: High-Speed Running (HSR), Sprint, Total Distance Covered (TDC), and Accelerations (ACC). While the means for all variables were slightly higher in wins compared to draws,

the differences were not statistically significant ($p > 0.05$). This suggests that defensive players' performances in these metrics were consistent regardless of the match result.

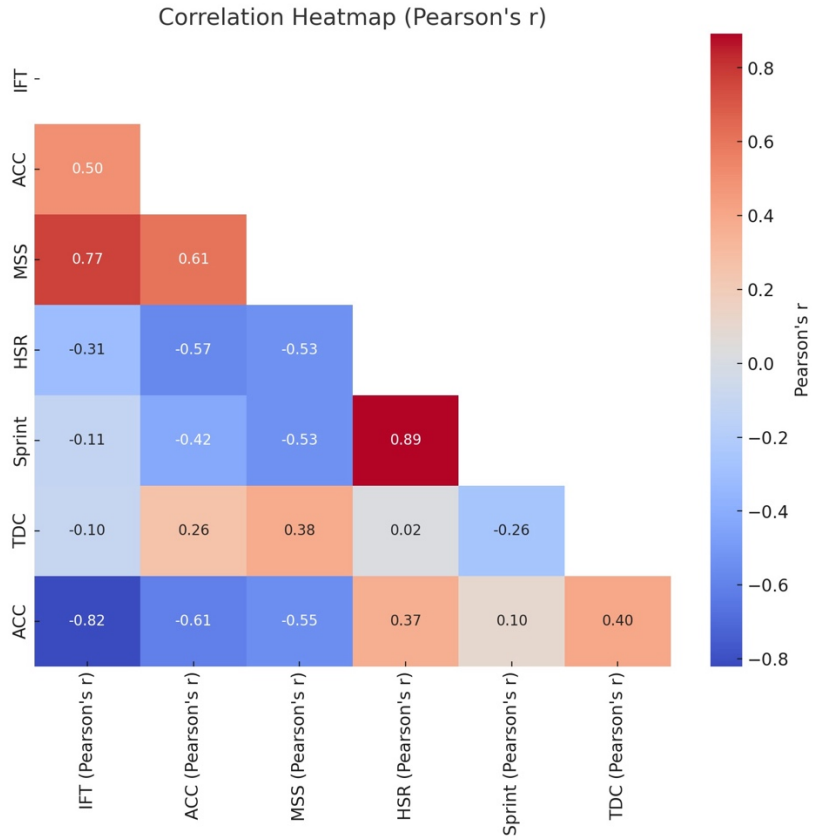

Fig 2. Examination of the relationship between performance test results and match performance

Figure 2 examines the relationships between performance test results and match performance metrics using Pearson's correlation (r). Significant positive correlations were observed between IFT and MSS ($r = 0.767$, $p = 0.010$), as well as between Sprint and HSR average ($r = 0.893$, $p < 0.001$). Additionally, a strong negative correlation was found between IFT and ACC ($r = -0.820$, $p = 0.004$). Other correlations, while present, were not statistically significant ($p > 0.05$), indicating limited relationships between the remaining variables.

DISCUSSION

In our study, the relationship between the results of pre-season performance tests and high-intensity running during matches, along with variables such as positive acceleration, sprint, and total distance covered, which are determinant factors of football performance, was examined. These variables were also analyzed in terms of positional differences (attack and defense). Additionally, the relationship between match outcomes (win and draw) and these performance components was investigated. When the design of our study is considered, the same starting eleven (the goalkeeper was included, but the same goalkeeper played in all five matches) and formation were evaluated over five matches. As a result of these matches, the team won twice and drew three times. Upon reviewing the literature, no studies were found that include all of these variables throughout a season, similar to our study.

When our study is analyzed based on match score variables, a significant difference ($p < 0.05$) was found in total distance covered between the wins (8808.25 ± 834.64) and draws (7923.25 ± 883.57).

However, in the other matches won and drawn, no significant relationship was found between players' match performances and variables such as high-intensity running, sprint, total distance covered, and acceleration values. Furthermore, no statistically significant relationship was observed between performance tests and match performance in our study.

A positive relationship between total distance covered and match winning in women's football has been observed in the literature (Bradley et al., 2014; Trevin et al., 2018). However, when examining the relationship between match success and performance, many variables need to be considered (Harkness-Armstrong A. et al., 2023). For example, in the 2023 Women's World Cup, it was stated that increasing the capacity for high-speed running could be beneficial for achieving elite-level success (Branquinho L. et al., 2023).

There are also contradictory studies in the literature (Oliva-Lozano JM et al., 2024). In another study, after analyzing the results of matches over a season (home and away games of the regular season), it was concluded that physical outputs were not influenced by factors like match outcome (win vs loss) (Vescovi JD et al., 2019). Additionally, Trewin, J et al. (2018) demonstrated that there is an effect between match outcome and opponent rankings. Similar to our study, a moderate increase in total distance and low-speed running was observed in wins against higher-ranked opponents compared to draws. However, in our study, the rankings of opponents were not considered. In the same study, a slight decrease in total distance and low-speed running was observed in losses against lower-ranked opponents compared to draws. Therefore, the rankings of the opposing team should be taken into account when evaluating total distance covered and success.

Another interesting point is the level of the matches played. Bradley et al. (2014) compared the Women's Champions League with national preparation matches. According to this study, total distances covered in Champions League matches were higher compared to international preparation matches. In a similar study, Hewitt A. et al. (2014) analyzed the relationship between sprint and HSR distances in league and international preparation matches and found higher performance values in league matches.

Similar to our study, Başkaya & Akkoyunlu (2023) found a moderate significant relationship between YoYo-1 and 30-15 IFT running distances and total distance covered in matches. In addition, unlike our study, a positive relationship between 30 sprint performances and match average speeds was found. The difference between these two studies may be explained by the level of the matches. The matches in our study were during the season, while the matches in this study were from pre-season preparation games.

Moreover, Trewin, J et al. (2018) found a relationship between match result and opponent rankings. As in our study, a moderate increase in total distance and low-speed running was observed in wins against higher-ranked opponents compared to draws. However, in our current study, opponent rankings were not considered. In the same study, a small decrease in total distance and high speed running was observed in losses against lower-ranked opponents compared to draws. Based on this, the rankings of the opposing team should also be considered when evaluating total distance and success.

Additionally, it is hypothesized that the reason for conflicting results like this could be that athletes' physical responses are selective and influenced by situational variables, such as the content of the match and instantaneous results (Errekagori I. et al.,2023).

It has been determined that female football players perform high-intensity running (greater than 19.8 km/h) over distances ranging from 250 to 520 meters during a match (Niessen et al., 2014; Hewitt et al., 2014; Datson et al., 2017). These high-intensity runs are also composed of short sprints (less than 10 meters), which is inherent to the structure of football. For this reason, direct comparisons between maximum speeds measured during a match and sprint test speeds are not sufficient to reach a definitive conclusion, as most of the sprints during the match (<10 m) are not long enough to reach maximum capacity (Vigne et al., 2010; Barnes et al., 2014; Mara JK et al., 2017). The absence of a significant relationship between variables in our study may stem from this reason.

Another important aspect is that the variability between matches in high-speed running (HSR; 19.8–25.2 km/h) and sprint (>25.2 km/h) distances is quite high, and this variability is influenced by positional roles (Bradley et al., 2009).

On the other hand, studies on female football players have revealed that forwards display superior sprint mechanical properties compared to defenders, midfielders, and goalkeepers (Boone et al., 2012; Thomas A. et al., 2020). The lack of statistically significant positional differences in our study may be due to the classification of positions not being made into wings and central roles. A study by

Alice Harkness-Armstrong et al. (2021) supports this, where wide players covered more distance than central players, which could be due to the different technical-tactical aspects required by their positions.

Additionally, considering that high-intensity running distances are associated with sports success and play an important role in competition and physical levels, it has been stated that forwards, wide midfielders, and other offensive roles in the team achieve higher values in these metrics (V. DiSalvo et al., 2009; Dellal et al., 2010, 2011; M.A. Campos Vazquez et al., 2021).

RECOMMENDATIONS

The similarity between distances measured in performance tests and distances covered at high speeds during matches is important for evaluation. However, due to the numerous variables that instantaneously affect match performance compared to out-of-match tests (e.g., match timing, score, tactical alignment, opponent, etc.), many possibilities should be considered when making comparisons at high-speed runs and total distances.

The technical and physical quality of the league and team can generally affect all running distances.

When making position-based evaluations, assessments should be based on the physical demands of the players (e.g., wing-backs and central players, etc.).

The values of performance tests should be periodically updated, and a relationship can be established based on the results of more games.

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