





# Characteristics of physical performance in professional female soccer athletes during a national competition

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## ABSTRACT

**Objectives:** Identify the descriptive characteristics of physical performance in different positions, compare physical performance between the first and second half of the match, and determine the association between physical performance variables in professional female soccer athletes during a national competition. **Method:** Fourteen professional women's soccer players participated in the study. Data from fifteen matches of the A1 division of the 2023 Brazilian Championship were collected using GPS devices. Athletes who participated in at least one complete match during the championship's classificatory phase were included. **Results:** The forwards and midfielders have covered greater distances at high and low intensity and maintained a higher average speed than the other positions. However, all positions have reached similar maximum speed values ( $25.9 \pm 1.9$  km/h). Significant differences were found between the first and second halves favourable to the first half for total distance ( $\Delta = -9.7\%$ ;  $p = .002$ ), distance per minute ( $\Delta = -7.8\%$ ;  $p = .010$ ), and sprint distance ( $\Delta = -11.4\%$ ;  $p = .000$ ), but not for maximum speed ( $\Delta = -0.4\%$ ;  $p = .728$ ). Pearson's correlation coefficient indicated associations between physical performance variables ranging from 0.567 to 0.850. **Conclusions:** Based on a descriptive analysis, it is suggested that different positions of professional female soccer athletes presented different physical demands during the competition. Lower performance was observed in the second half compared to the first for total distance, distance per minute, and sprint distance, but not for maximum speed. Moderate to high associations were also observed between physical performance variables.

**Keywords:** Performance analysis, Exercise, Sports medicine, Workload.

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## INTRODUCTION

Soccer is a sports modality with intermittent physiological demands, requiring physical efforts performed repeatedly in various technical and tactical movements (Dolci et al., 2020). In this dynamic and unpredictable environment, players run at different intensities with and without the ball, generating a physiological demand requiring a complex energy system interaction throughout the match (Turner & Stewart, 2014).

Studies use displacement variables to compare professional athletes' physical performance levels between matches (Andersson et al., 2010) or between playing positions (Mohr et al., 2008). Through global positioning system (GPS) devices, it is possible to monitor the total distance (Oliva-Lozano et al., 2023), distance per minute (Casamichana et al., 2019), sprint distance (Oliveira Junior et al., 2021), maximum speed (Nobari et al., 2021), among other variables with low levels of coefficient of variation (Scott et al., 2016) to make comparisons in order to understand better the physical performance of athletes during matches.

Some studies present divergent results when comparing soccer matches' first and second halves, showing reduced physical performance (Panduro et al., 2022) or maintaining across different variables (Hewitt et al., 2014; Strauss et al., 2019). This behaviour appears similar when comparing physical performance between positions, in which advantages were found for a given position in a specific variable (e.g., midfielders covering greater total distances than defenders) (Andersson et al., 2010), but no significant differences were found in other variables (e.g., maximum speed was similar between all positions) (Panduro et al., 2022). Furthermore, little is known about the association between physical performance variables in a group of athletes.

Considering that most studies with elite athletes had their samples composed of professional male soccer players (Baptista et al., 2020; Bradley et al., 2010; Carling & Dupont, 2011), the current study presents the possibility of understanding better the behaviour of physical performance variables in a sample of female athletes. The comparison of volume and intensity variables by each playing position and between different halves of the match can provide data to the physical performance analysis to develop substitution strategies during a match, rest of an athlete during the season, regulation of physical performance between the first and second half of the match, determine physiological demands, and structure training programs to increase physical performance (Lopes et al., 2023). Another difference concerns the physical performance variables during a national women's soccer competition to facilitate interpretations of different matches and championships based on this knowledge. Likewise, determining the characteristics of match activity by playing positions in a women's soccer team can help select new talents or indicate potential position changes.

Therefore, the present study aimed to identify the descriptive characteristics of the variables total distance, distance per minute, sprint distance, and maximum speed between the playing positions of the athletes of a professional women's soccer team in the A1 division of the 2023 Brazilian Championship. The study also aimed to compare the physical performance between the first and second halves and determine the association between the physical performance variables in the group of athletes from this same competition. It was hypothesized that there would be significant differences between the two halves of the match for physical performance, with higher values in the first half compared to the second; associations between all physical performance variables would be direct, strong, and significant.

## MATERIALS AND METHOD

### **Sample**

Fourteen professional women's soccer players aged  $26 \pm 5$  years, height  $1.67 \pm 0.06$  m, and body mass  $61.2 \pm 6.3$  kg participated in the study. Athletes from an elite team that participated in at least one full match in the A1 division of the 2023 Brazilian Championship were eligible for the study. Athletes absent due to injury throughout

the season were excluded. The procedures recorded here were routine used by the technical staff in charge of the performance analysis and were part of the program established by the head coach throughout the competition. All athletes were informed about the procedures and gave their informed consent.

### **Study design**

This retrospective study used physical performance data collected via GPS devices from a professional women's athletes soccer team participating in the national competition's first stage (round-robin tournament). This competition featured sixteen teams of the elite of Brazilian women's soccer. The teams faced each other in singles matches without return, accumulating fifteen matches in four months.

### **Procedures**

Playertek GPS (Catapult Sports, Melbourne, VIC, Australia) at 10 Hz was used for data collection. The GPS devices were positioned on the athletes' vests, activated ten minutes before the start of the matches, and deactivated immediately after the matches. The devices were positioned in the athletes' interscapular region. All devices were named, and all athletes used the same unit in all matches. The outcome variables were operationally defined according to the manufacturer:

- Total distance (km): sum of all distances the athletes cover during a match at any speed.
- Distance per minute (m/min): distance each athlete covers within sixty seconds.
- Sprint distance (m): sum of distances covered at a high intensity (18 km/h or above for women's soccer).
- Maximum speed (km/h): the highest speed the athlete reaches during the match, regardless of the distance covered in this effort.

Game variables were monitored in real-time using the PlayertekPlus application (Catapult Sports, ver. 1.3.9, Melbourne, VIC, Australia), and the data was exported to the Playertek platform using Sync tool software (Catapult Sports, ver. 5.69, Melbourne, VIC, Australia) on a computer. On the platform, making cuts with each athlete's minutes during the matches was necessary. Subsequently, the changes were saved and exported to a calculation spreadsheet (Microsoft Excel, Office 365, Microsoft Corporation, Redmond, WA, USA), where the study data were stored.

Physical performance variables were collected from fourteen athletes: two forwards, two midfielders, three defensive midfielders, three full-backs, and four central backs. After the fifteen matches, statistical analyses were carried out considering the average of the variables based on the number of complete matches for each athlete and their divisions between the first and second half. The average and standard deviation of the athletes' matches in the competition was  $6.1 \pm 3.2$ . The number of completed matches for each athlete was:

- Central back: athlete 1 (12 matches), athlete 2 (2 matches), athlete 3 (5 matches) and athlete 4 (5 matches).
- Full-back: athlete 5 (10 matches), athlete 6 (6 matches) and athlete 7 (2 matches).
- Defensive midfielder: athlete 8 (6 matches), athlete 9 (2 matches) and athlete 10 (7 matches).
- Midfielder: athlete 11 (6 matches) and athlete 12 (8 matches).
- Forward: athlete 13 (11 matches) and athlete 14 (4 matches).

### **Statistical analysis**

Due to the number of athletes selected for the study ( $n = 14$ ), performing inferential statistics to determine the difference between the playing positions became unfeasible. For this reason, descriptive statistics were carried out to characterize the athletes through the mean, standard deviation, and minimum and maximum values.

Considering all athletes, the Shapiro-Wilk test was used to verify the normality of data distribution for all physical performance variables. A dependent t-test was used to determine whether there was a significant difference for all variables between the first and second halves of the matches during the competition. The delta ( $2^{\text{nd}} \text{ half} \times 100 / 1^{\text{st}} \text{ half} - 100$ ) was used to identify the relative variation between the first and second half. Pearson's correlation coefficient ( $r$ ), followed by the significance level ( $P$ ), was used to determine the degree of association between the physical performance variables. Associations with  $r$  values below 0.29 were considered very weak, between 0.3 to 0.49 weak, 0.5 to 0.69 moderate, 0.7 to 0.89 strong, and above 0.9 very strong (Mukaka, 2012). All analyses were performed using GraphPad Prism (GraphPad Software Inc., ver. 10, San Diego, CA, USA), and the significance level adopted was  $p < .05$ .

## RESULTS

Table 1 shows the descriptive analysis by positions for the study's four physical performance variables. The physical performance variables did not deviate from normality ( $p > .05$ ). Figure 1 shows the average and individual differences in the physical performance between the first and second half of the athletes in the competition. Table 2 presents the association values between the physical performance variables of the entire team.

Table 1. Descriptive analysis of mean  $\pm$  standard deviation (minimum - maximum) by the position of physical performance.

Variables	CB (n = 4)	FB (n = 3)	DM (n = 3)	MF (n = 2)	FW (n = 2)	General (n = 14)
Total distance (km)	9.0 $\pm$ 0.3 (8.8 - 9.5)	8.4 $\pm$ 1.2 (7.1 - 9.4)	8.9 $\pm$ 0.6 (8.5 - 9.6)	9.6 $\pm$ 0.1 (9.5 - 9.7)	9.7 $\pm$ 0.1 (9.7 - 9.7)	9.0 $\pm$ 0.7 (7.1 - 9.7)
Distance per minute (m/min)	91.6 $\pm$ 3.2 (87.9 - 95.5)	85.4 $\pm$ 13.0 (70.4 - 93.2)	97.4 $\pm$ 6.4 (90.0 - 101.5)	97.5 $\pm$ 0.4 (97.2 - 97.8)	98.9 $\pm$ 0.6 (98.4 - 99.3)	93.4 $\pm$ 7.8 (70.9 - 101.5)
Sprint distance (m)	546.7 $\pm$ 182.9 (346.5 - 781.3)	727.6 $\pm$ 323.5 (371.5 - 1003.5)	578.1 $\pm$ 95.2 (479.9 - 670.0)	916.3 $\pm$ 146.4 (812.7 - 1019.8)	789.2 $\pm$ 9.5 (782.5 - 795.9)	679.6 $\pm$ 182.9 (346.5 - 1019.8)
Maximum speed (km/h)	26.6 $\pm$ 1.1 (25.7 - 28.2)	25.3 $\pm$ 3.3 (21.6 - 28.1)	24.5 $\pm$ 2.2 (22.3 - 26.7)	26.8 $\pm$ 1.3 (25.9 - 27.8)	26.8 $\pm$ 0.5 (26.4 - 27.1)	25.9 $\pm$ 1.9 (21.6 - 28.2)

Note. Note: CB: central back; DM: defensive midfielder; FB: full-back; FW: forward; MF: midfielder.

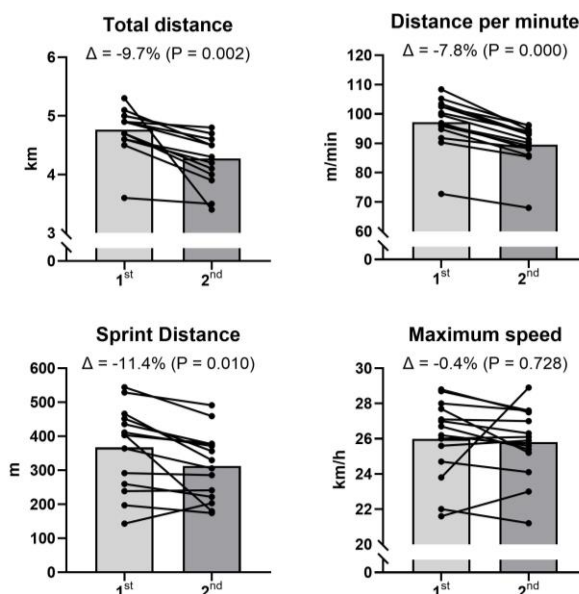


Figure 1. Comparison between the first and second half of physical performance for all athletes and matches.

Table 2. Pearson's correlation coefficient and significance level (P) of physical performance variables for all athletes and matches.

Variables	DM (m/min)	SD (m)	MS (km/h)
TD (km)	0.632 (0.015)	0.850 (0.001)	0.644 (0.013)
DM (m/min)		0.567 (0.034)	0.668 (0.009)
SD (m)			0.621 (0.018)

Note: DM: distance per minute; MS: maximum speed, SD: sprint distance; TD: total distance.

## DISCUSSION

The present study had three distinct objectives. Therefore, the discussion was segmented into three subgroups to address the objectives and hypotheses presented, interpret the results, compare with studies in the literature, and inform the limitations and applicability.

### **Descriptive analysis**

Andersson et al. (2010) observed the displacement actions using monitoring cameras in seventeen Swedish and Danish professional female soccer athletes, divided into three groups by position: nine defenders, five midfielders, and three forwards. The results suggest a similarity with those found in the present study, in which midfielders ( $10.6 \pm 0.3$  km) had an advantage compared to defenders ( $9.5 \pm 0.9$  km) for total distance in international games. It was also possible to observe that the distance of the sprints did not present a significant difference for midfielders ( $316 \pm 51$  m) and defenders ( $221 \pm 32$  m). A possible explanation for this disagreement may have been the non-subdivision of the group of defenders between central backs and full-backs. The forwards were excluded from the statistical analysis by the authors, who considered the low sample size for this position.

Datson et al. (2017) classified groups by positions closest to those in the current study, comparing the physical performance of professional female soccer athletes in international matches. For this purpose, five different positions were presented, with twenty-five central defenders, twenty-eight wide defenders, thirty-one central midfielders, seventeen wide midfielders, and sixteen forwards. As in the present study, the central midfielders were the athletes with the greatest total distance covered ( $10.9 \pm 0.7$  km), and for the distance covered at high-speed running, a variable similar to the sprint distance, lower average values were recorded for the central defenders ( $423 \pm 79$  m).

Maximum speed appears to be similar between positions in the present study ( $25.9 \pm 1.9$  km/h). However, there are divergent results in the literature, with a study indicating that there was no significant difference in maximum speed between positions (Panduro et al., 2022) while another indicating that defenders ( $21.9 \pm 2.3$  km/h) and forwards ( $22.1 \pm 2.4$  km/h) presented higher maximum speed values compared to midfielders ( $21.4 \pm 2.1$  km/h) (Vescovi, 2012). The tactical aspect may be a factor that influences this variable, indicating that depending on the team's playing style, the maximum speed an athlete can reach may be one of the criteria for selection.

Carrying out a one-way analysis of variance could indicate a false negative result. A significant difference between positions in specific physical performances could be observed with a larger sample of athletes. In this case, we would commit a type 2 error by not rejecting the null hypothesis when it could show a significant difference. With a higher sample, the studies by Panduro et al. (2022) and Vescovi (2012), for example, used a sample size of ninety-four and seventy-one women, respectively, and observed a significant difference between different positions for the sprint distance variable. It is therefore suggested that new studies be carried out with a greater number of athletes from different clubs to test the alternative hypothesis and

possibly show that there would be a significant difference in performance variables between positions. These comparisons could also be made throughout a given competition and observe evolution over time. However, it must be considered that different teams have different playing philosophies and, therefore, different physical qualities compared to other teams.

### Inferential analysis

One of the present study's hypotheses was that there would be a significant difference in the athletes' physical performance between the first and second half of the matches during the competition. The hypothesis was confirmed for the variables total distance, distance per minute, and sprint distance; however, it was rejected for maximum speed. Table 3 summarizes some studies that discussed the difference between halves for these physical performance variables collected by GPS devices in female soccer athletes.

Table 3. Studies that compared physical performance between the first and second halves using GPS devices.

Studies	Sample	Comparisons	Summary of results
Present study	14 W Professionals 26 ± 5 years	TD, DM, SD, and MS between the first and second half in 15 matches	TD: 1st ≠ 2nd half ( $4.8 \pm 0.4 \neq 4.3 \pm 0.4$ km). DM: 1st ≠ 2nd half ( $97.2 \pm 8.7 \neq 89.6 \pm 7.1$ m/min). SD: 1st ≠ 2nd half ( $367.2 \pm 112.9 \neq 312.4 \pm 100.1$ m). MS: 1st = 2nd half ( $26.0 \pm 2.3 = 25.8 \pm 2.0$ km/h).
Hewitt et al. (2014)	15 W Professionals 24 ± 1 years	TD and SD between the first and second half in 13 matches	TD: 1st = 2nd half ( $4.9 \pm 0.1 = 4.7 \pm 0.1$ km). SD: 1st = 2nd half ( $173.0 \pm 15.0 = 165.0 \pm 18.0$ m).
Panduro et al. (2022)	94 W Professionals 23 ± 4 years	TD, SD, and MS between the first and second half of 8 teams in a season	TD: 1st ≠ 2nd half (central midfielders: $5.3 \pm 0.5 \neq 5.2 \pm 0.5$ km). SD: 1st ≠ 2nd half (central and external midfielders: $328 \pm 129 \neq 295 \pm 134$ and $459 \pm 158 \neq 404 \pm 169$ m). MS: 1st = 2nd half.
Strauss et al. (2019)	30 W Semi-elite 23 ± 2 years	DM between the first and second half in 10 matches	DM: 1st = 2nd half ( $82.8 \pm 11.7 \neq 76.4 \pm 15.6$ m/min).

Note: DM: distance per minute; MS: maximum speed, SD: sprint distance; TD: total distance; W: women; =:  $p > .05$ ; ≠:  $p < .05$ .

Hewitt et al. (2014) observed a significant reduction in the total distance covered between the first fifteen minutes and the final thirty minutes of the match (-11.4%;  $p < .05$ ) but not between the first and second half (-4.9%;  $p > .05$ ) in a group of fifteen professional female soccer athletes. Panduro et al. (2022) reported that greater distances were covered in the first half only for central midfielders when observing eight Danish Women's League teams. A review study suggests this was probably due to fatigue accumulated during the match, leading to a drop in physical performance in the second half (Mohr et al., 2005). The present study found a significant decrease of 9.7% in the total distance covered between the first and second half of the match. However, this result must be interpreted with caution due to the contextual variables of the matches and competition (Lago-Peñas, 2012).

Strauss et al. (2019) found no significant difference between the first and second half for the distance per minute. This result differs from the present study (1<sup>st</sup> vs. 2<sup>nd</sup> half = -7.8%) and can be explained by the high minutes of the same athletes (starters) in the different competition matches analysed in this work. Even so, the average values of distance per minute of the second half of the game of the professional athletes monitored by the present study ( $89.6 \pm 7.1$  m/min) seem to be greater than the average values of the first half of the game of the semi-elite athletes analysed by Strauss et al. (2019) ( $82.8 \pm 11.7$  m/min) due to category difference.

The sprint distance presented divergent results between studies. While the present study observed a significant decrease of 11.4% in sprint distance between the first and second half of the match, Hewitt et al. (2014) found no difference. However, Panduro et al. (2022) observed a significant difference for very-high-speed running (sprint distance here) between the first and second half only for central midfielders, with higher values found in the first half. A possible reason for this discrepancy in the literature was the lack of a standard for what should be understood as sprint distances and high-intensity distances (Mäkiniemi et al., 2023). The definition of sprint distance varies for distances covered at speeds above 18, 21, 23, and 25 km/h, among other cutoff points (Vescovi, 2012). Variable definitions may also vary depending on the operational settings of the GPS devices.

Panduro et al. (2022) analysed the maximum speed difference between the match's first and second half. In the same way, as in this study, no significant difference was observed for this variable between the halves of the match. Despite the drop in game volume (shorter total distance and sprint distance), the peak speed probably did not change because some decisive plays were carried out at high speeds (Schulze et al., 2022).

One of the study's limitations is that contextual variables such as changes in tactical scheme, climate variations, easier and more difficult matches, and expulsions, among other possibilities, cause behavioural variations during matches and competitions and influence the responses observed in physical performance (Augusto et al., 2021). This can cause changes in behaviour between the halves of the match and generate incongruity in the results found in the literature for the physical performance variables discussed here.

### **Correlational analysis**

Through the association test between physical performance variables, it was possible to identify moderate and significant correlations between total distance and distance per minute ( $r = 0.632$ ,  $p = .015$ ) and between total distance and maximum speed ( $r = 0.644$ ,  $p = .013$ ). This may be an indication that the athletes who have covered the greatest distances are not always the ones who cover the most space on the playing field or who reach the highest peak speed. However, there was a strong association between total distance and sprint distance ( $r = 0.850$ ,  $p = .001$ ). This may indicate that the athletes who covered greater distances also achieved greater distance values at high intensity in the analysed competition.

Distance per minute showed moderate associations compared to sprint distance ( $r = 0.567$ ,  $p = .034$ ) and maximum speed ( $r = 0.668$ ,  $p = .009$ ). Considering these results, it seems that the athletes with higher average speed values were not necessarily those who maintained a higher running intensity or reached higher maximum speeds, highlighting the interrelationship between the volume and intensity of the game.

The moderate correlation found between sprint distance and maximum speed ( $r = 0.621$ ,  $p = .018$ ) did not present the expected result. The initial hypothesis was that athletes who covered greater sprint distances would also have the greatest maximum speed potential. However, the athletes with the highest peak speed were not essentially those who reached the highest sprint distances. It seems that top speed is linked to the ability to accelerate and decelerate (Kobal et al., 2022).

### **CONCLUSIONS**

Based on a descriptive analysis, it was concluded that different positions of professional female soccer athletes present different physical demands during a national competition. The forwards and midfielders seem to have covered greater distances at high and low intensity and maintained a higher average speed

than the midfielders, full-backs, and central backs. However, all positions appear to have reached similar maximum speed values.

According to an inferential analysis, lower physical performance was observed in the second half of the match compared to the first for total distance, distance per minute, and sprint distance, but not for maximum speed. This is probably due to the fatigue accumulated during the match, which led to a drop in physical performance in the second half. However, this result must be interpreted with caution due to the contextual variables of the matches and competition.

The total distance, distance per minute, sprint distance, and maximum speed obtained moderate to strong correlations, all of which were direct and significant. These associations indicated an interrelationship between the volume and intensity of physical performance variables during a competition.

## **AUTHOR CONTRIBUTIONS**

Domingues HC carried out the conceptualization of the study, design of methodology, data curation, and original draft preparation; Soares ALC carried out the conceptualization of the study, design of methodology, data curation, data analysis, and original draft preparation; Gonet DT carried out the conceptualization of the study and draft review; Gomes PSC carried out the conceptualization of the study, design of methodology, data analysis, draft review, and research supervision.

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## **DISCLOSURE STATEMENT**

No potential conflict of interest was reported by the authors.

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