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Player position relationships with centrality in the passing network of world cup soccer teams: Win/loss match comparisons

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ABSTRACT

Among elite national soccer team play of the 2018 FIFA World Cub, we analyzed (a) network centrality variations between playing positions during passing sequences, and (b) their relationship to match outcomes. We observed and coded the 64 matches played by 32 teams and collected passing distribution data between teammates. We then converted it into adjacency matrices to calculate passing network data. We found large decreases in degree prestige (inbound pass links) among players in winger positions compared to external defenders (−41.8%; ES (effect size): −1.79). Large decreases in degree prestige were also found in central forwards in comparison to external defenders (−38.7%; ES: −1.62), central defenders (−42.3%; ES: −1.60), defensive midfielders (−47.1%; ES: −1.87) and midfielders (−40.8%; ES: −1.59). Comparisons of passing network centrality levels between won and lost matches revealed small increases in degree prestige among midfielders (17.4%; ES: 0.31) and small increases among forwards (33.9%,; ES: 0.53) among matches won. Thus, match outcome (and possibly scoring status during the match) was somewhat related to the passing network centrality of various playing positions during passing sequences.

1. Introduction

A successful passing process is one of the main determinants of a soccer team's attack performance, as the passing process can positively correlate with higher chances of winning matches [1,2]. The passing process emerges from specific dynamics established between teammates and depends on many conditions, including a player's scoring status, the opponent's defensive pressure, and a team's specific style of play [3]. Therefore, passing strategies vary from team to team and within each team [4]. To understand a team's passing process, an observer must identify the connections between teammates. During passing sequences, how passes are made relates to both these connections between players and the collective behavior of the team [5,6]. A principal constraint regulating the distribution of passes and connections between teammates is a player's playing position [7,8]. In fact, some studies have suggested that playing position influences player prominence such some positions are more likely to be involved in passing than others [5,7].

One means of analyzing prominence levels of players zed is to think of players as nodes and passes between them as links in a network [9]. Past researchers have used such a social network analysis to identify collective and individual team characteristics [5,7,10]. In soccer, network centralities can inform us as to which players are most prominent during attacking actions or which players that intermediate between their teammates [11]. In this way, these centrality measures may provide evidence of the importance of each player or playing position during in attacking actions, helping to identify possible imbalances in team structure [12]. Past researchers have found that, on elite soccer teams, midfielders have hightest player prominence levels during the passing process in that midfielders are most often recruited by their colleagues and, thus, most influence social network connections among team members [5,7,8].

During the 2014 FIFA World Cup, meaningful variations between playing positions were found for degree prestige (passes received), prestige (passes made) and betweenness centrality (intermediation) [7]. Midfielders and external defenders had greater values for all measures, and forwards had the lowest values among various player positions. Using this approach in the 2010 FIFA

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World Cup, researchers found that, among the top four teams, there was a tendency toward greater centrality among external and central defenders and midfielders [8]. These two examples of research using the social network approach to analyze the passing process suggest that external defenders and midfielders act as links, enabling the team to move the ball from the defenders to the attackers.

Of note, however, the passing patterns differ during certain moments of a match such as transitions/counter attacks or attacks that lead to goals. A team's style of play may influence the pattern, and, importantly a team's momentary scoring status (e.g., winning or losing the match) may influence a player's style of play or the players' decisions during the passing process. Despite the importance of scoring status to these passing dynamics, in the best of our knowledge no studies have tested the influence of scoring status on player position centrality. Thus, this study undertook two analyses of the passing process during elite game play: (a) variations in network centrality between different playing positions, and (b) the influence of a team's scoring status (i.e. won/lost match outcome) on such playing position variations. We hypothesize that midfielders will present the greatest centralities considering previous findings [7] and that scoring status will promote variations in the network measures between playing positions.

2. Method

2.1. Sample

We observed and coded the 64 matches played by 32 teams during FIFA World Cup 2018 that occurred in Russia, converting passing distributions among teammates converted into adjacency matrices for further network calculations. Match play was coded by expert observers who were tested for intra- and inter-reliability (see more detail below). Observation was performed using television recordings made available by channels with official broadcasting rights. The study was approved by the local university committee.

2.2. Study design

This study followed a cross-sectional design in which the passing distribution of each team was collected for each match and then treated to identify network centrality levels. Players' playing positions and the final score of each match were also collected and considered in the statistical analysis. Variations in network centrality levels were compared between playing positions. Moreover, such variations were considered separately for won matches and lost matches. The following playing positions were classified: external defender (ED), central defender (CD), defensive midfielder (DMF), midfielder (MF), winger (W), and central forward (FW). The overall analysis included lost, drawn, and won matches; however, the comparisons between scores were only conducted between won and lost matches.

2.3. Data collection

A weighted adjacency matrix was constructed based on the teammates' passing distribution. Successful passes were coded in all passing sequences with more than two consecutive passes. The direction of passes was considered; a pass from player A to player B it was considered different than a pass from player B to player A. The weight of adjacency matrices was considered based on the number of passes made between each pair of players in the same direction (e.g., how many passes were made from player A to player B). The procedures followed those of previous studies that used this type of approach (Clemente et al., 2015; Clemente, Martins, Kalamaras, Wong, & Mendes, 2015). The weighted adjacency matrices were standardized considering the player's time of play.

The codification of passing distribution was conducted by two soccer analysts with more than three years of experience in match analysis. A 20-day test-retest pilot study was conducted to assess the reliability levels of the analysts using 11% of the full data. The intra-class correlation tests revealed an intra-observer value of 0.97 (excellent reliability) and an inter-observer level of 0.91 (excellent reliability) [14].

2.4. Network measures

The conversion of weighted adjacency matrices to network-weighted digraphs was executed in the Social Network Visualizer (SocNetV, version 2.4.) software, which allows for the visualization and analysis of centralities. Degree prestige, degree centrality, and reciprocity levels were calculated as absolute (A.U.) and standardized (%) values.

2.4.1. Degree of centrality

Degree of centrality measures the overall level of connection a player has with his teammates. Higher degree centrality levels suggest a higher connection, signifying that the player is a significant contributor to the team's passing distribution. The standardized degree can be represented as $C'^{w}_{(D-out)} = \frac{k_i^{w-out}}{\sum_{i=1}^{n}\sum_{\substack{j=1 \\ j\neq i}}^{n} a_{ij}}$, where k_i^{w-out} represents the centrality index of the vertex and n_i and a_{ij} are elements of the weighted adjacency matrix of G (Clemente et al., 2015).

2.4.2. Degree prestige

Degree prestige represents the inbound links that a player receives from his teammates. A higher centrality level suggests that the player is more often recruited by his colleagues during the passing distribution process. The standardized degree prestige can be calculated as $P'^{w}_{D-in}(n_i) = \frac{k_i^{w-in}}{\sum_{i=1}^{n}\sum_{\substack{j=1 \\ j\neq i}}^{n} a_{ij}}$, where k_i^{w-in} is the index of the vertex and n_i and a_{ij} are elements of the weighted adjacency matrix of G (Clemente et al., 2015).

2.4.3. Reciprocity

This measure represents the likelihood that vertices in a directed network are mutually linked, making it possible to be classified as arc reciprocity. Reciprocity measures quantify the proportion of directed edges that are bidirectional and for which a value of 1 means the matrix is symmetric.

2.5. Statistical procedures

Text, tables, and figures, either as means with standard deviation (SD) or means with a 90% confidence interval (90% CI) where specified in the form of text, tables and figures. Between-playing positions centralities variations were analyzed using standardized differences of effect size (ES) with a 90% CI [15]. The following interpretation of ES was used [16]: <0.2 = trivial; 0.2–0.6 = small; 0.6–1.2 = moderate; >1.2 = large. Probabilities were calculated by considering the smallest worthwhile changes (SWC, 0.2 $\times$ between-subjects SD) [17]. Qualitative probabilistic mechanistic inferences about the true effects were made using these probabilities (17]. The scale for qualitative probabilities was as follows: 25–75% = possible; 75–95% = likely; 95–99% = very likely; $>99\%$ = almost certain (17).

Table 1
Descriptive statistics (mean ± SD) of network centralities between playing positions.

	ED	CD	DMF	MF	W	FW
DPres (%)	9.78(2.86)	10.49(3.23)	11.38(3.13)	10.19(2.96)	8.27(2.39)	6.44(2.85)
DCen (%)	9.02(2.83)	11.71(3.25)	12.53(3.44)	10.26(3.28)	6.69(2.45)	4.89(2.64)
Rec. (A.U.)	0.18(0.11)	0.15(0.11)	0.16(0.11)	0.17(0.12)	0.19(0.13)	0.21(0.12)

DPres.: degree prestige (%); DCen: degree centrality (%); Rec.: reciprocity (A.U.); ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

Table 2
Percentage changes of network centralities between playing positions.

Variable	Comparison	% difference (A-B)		% greater/similar/lower values (A-B)
		Value	[90%CI]	
Degree Prestige (%)	CD (A) vs. ED (B)	6.2	[−1.2;14.2]	50/50/0 *Possibly*
	DMF(A) vs. ED (B)	15.9	[7.3;25.3]	97/3/0 *Very likely*
	MF(A) vs. ED (B)	3.7	[−3.7;11.5]	29/69/2 *Possibly*
	W(A) vs. ED (B)	−41.8	[−53.7;−26.9]	0/0/100 *Almost certain*
	FW(A) vs. ED (B)	−38.7	[−44.9;−31.7]	0/0/100 *Almost certain*
	DMF(A) vs. CD (B)	9.1	[0.6;18.4]	65/35/0 *Possibly*
	MF(A) vs. CD (B)	−2.4	[−9.7;5.4]	2/80/18 *Likely*
	W(A) vs. CD (B)	−20.6	[−0.88;−0.46]	0/0/100 *Almost certain*
	FW(A) vs. CD (B)	−42.3	[−48.3;−35.5]	0/0/100 *Almost certain*
	MF(A) vs. DMF (B)	−10.6	[−17.6;−2.9]	0/19/81 *Likely*
	W(A) vs. DMF (B)	−27.2	[−32.7;−21.3]	0/0/100 *Almost certain*
	FW(A) vs. DMF (B)	−47.1	[−52.8;−40.7]	0/0/100 *Almost certain*
	W(A) vs. MF (B)	−18.6	[−24.4;−12.4]	0/0/100 *Almost certain*
	FW(A) vs. MF (B)	−40.8	[−47.1;−33.9]	0/0/100 *Almost certain*
	FW(A) vs. W (B)	−27.3	[−34.8;−19.0]	0/0/100 *Almost certain*
Degree Centrality (%)	CD (A) vs. ED (B)	30.7	[21.4;40.7]	100/0/0 *Almost certain*
	DMF(A) vs. ED (B)	39.2	[27.9;51.3]	100/0/0 *Almost certain*
	MF(A) vs. ED (B)	12.4	[3.2;22.4]	83/17/0 *Likely*
	W(A) vs. ED (B)	−27.3	[−33.0;−21.1]	0/0/100 *Almost certain*
	FW(A) vs. ED (B)	−50.7	[−56.4;−44.3]	0/0/100 *Almost certain*
	DMF(A) vs. CD (B)	6.9	[−0.9;15.3]	52/48/0 *Possibly*
	MF(A) vs. CD (B)	−14.9	[−20.8;−6.6]	0/4/96 *Very likely*
	W(A) vs. CD (B)	−44.4	[−48.7;−39.8]	0/0/100 *Almost certain*
	FW(A) vs. CD (B)	−62.3	[−66.6;−57.5]	0/0/100 *Almost certain*
	MF(A) vs. DMF (B)	−19.2	[−26.3;−11.4]	0/1/99 *Very likely*
	W(A) vs. DMF (B)	−47.8	[−52.2;−42.9]	0/0/100 *Almost certain*
	FW(A) vs. DMF (B)	−64.6	[−68.8;−59.8]	0/0/100 *Almost certain*
	W(A) vs. MF (B)	−35.3	[−40.9;−29.2]	0/0/100 *Almost certain*
	FW(A) vs. MF (B)	−56.2	[−61.4;−50.2]	0/0/100 *Almost certain*
	FW(A) vs. W (B)	−32.2	[−40.2;−23.1]	0/0/100 *Almost certain*
Reciprocity (A.U.)	CD (A) vs. ED (B)	−17.2	[−27.0;−6.0]	0/14/86 *Likely*
	DMF(A) vs. ED (B)	−9.3	[−21.2;4.6]	1/53/46 *Possibly*
	MF(A) vs. ED (B)	−2.1	[−13.6;10.9]	5/82/13 *Likely*
	W(A) vs. ED (B)	9.6	[−0.06;0.40]	42/57/0 *Possibly*
	FW(A) vs. ED (B)	16.5	[2.0;33.1]	72/28/0 *Possibly*
	DMF(A) vs. CD (B)	9.6	[−4.9;26.3]	43/56/1 *Possibly*
	MF(A) vs. CD (B)	18.2	[4.3;33.9]	79/21/0 *Likely*
	W(A) vs. CD (B)	32.4	[17.1;49.7]	99/1/0 *Very likely*
	FW(A) vs. CD (B)	40.7	[23.1;60.8]	100/0/0 *Almost certain*
	MF(A) vs. DMF (B)	7.8	[−6.3;24.1]	33/65/1 *Possibly*
	W(A) vs. DMF (B)	20.8	[5.2;38.8]	82/18/0 *Likely*
	FW(A) vs. DMF (B)	28.4	[10.7;48.9]	94/6/0 *Likely*
	W(A) vs. MF (B)	12.0	[−0.7;26.4]	59/41/0 *Possibly*
	FW(A) vs. MF (B)	19.0	[4.3;35.8]	84/16/0 *Likely*
	FW(A) vs. W (B)	6.3	[−6.7;21.0]	30/67/2 *Possibly*

DPres.: degree prestige (%); DCen: degree centrality (%); Rec.: reciprocity (A.U.); ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

3. Results

Degree prestige was higher in defensive midfielders (11.38%) and lower in forwards (6.44%). Similarly, degree centrality was lower in forwards (4.89%) and higher in defensive midfielders (12.53%). Reciprocity levels were higher in forwards (0.21 A.U.) and lower in central defenders (0.15 A.U.). The descriptive statistics can be found in Table 1.

Percentage differences of network centralities between playing positions can be found in Table 2 and the standardized differences can be found in Figs. 1 and 2. Almost certain large decreases of degree prestige were found in wingers comparing to external defenders (−41.8%, [−53.7;26.9]); ES: −1.79, [−2.55;−1.04]). Almost certain large decreases of degree prestige were found in central forwards in comparison to external defenders (−38.7%, [−44.9;−31.7]; ES: −1.62, [−1.97;−1.26]), central defenders (−42.3%, [−48.3;−35.5]; ES: −1.60, [−1.92;−1.27]), defensive midfielders (−47.1%, [−52.8;−40.7]; ES: −1.87, [−2.22;−1.55]) and midfielders (−40.8%, [−47.1;−33.9]; ES: −1.59, [−1.92;−1.25]).

Almost certain large decreases of degree centrality were found in wingers in comparison to central defenders (−44.4%,

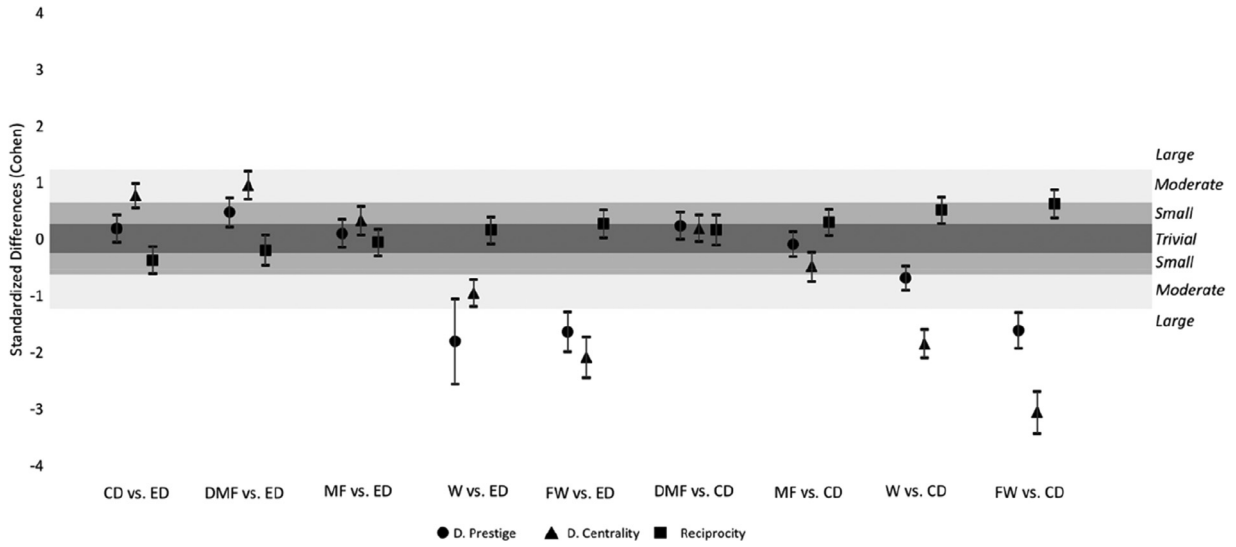


Fig. 1. Standardized changes of network centralities between playing positions. ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

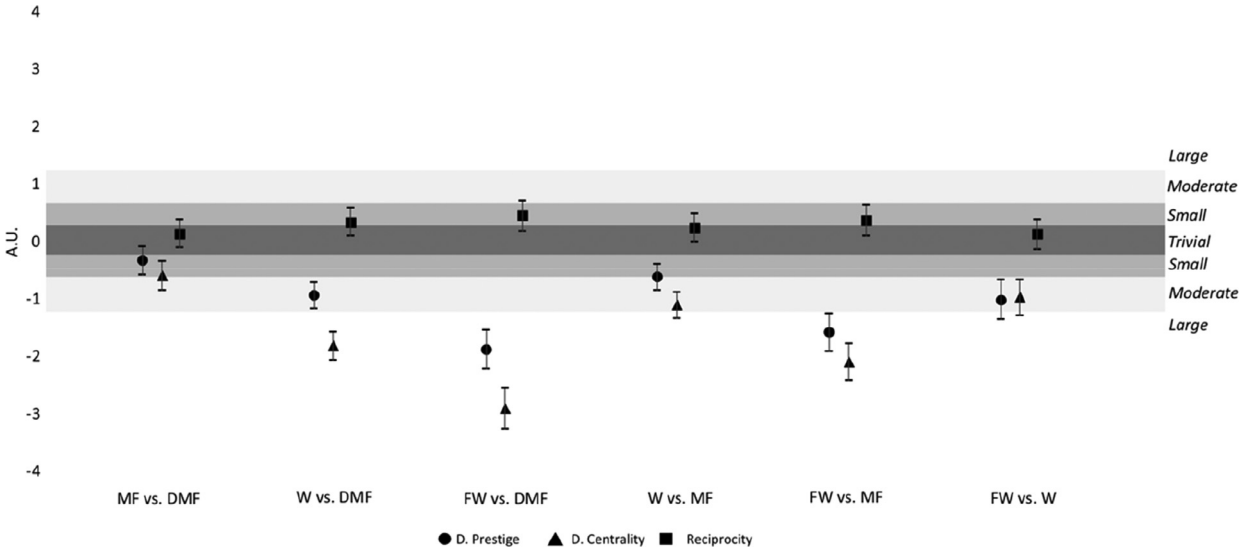


Fig. 2. Standardized changes of network centralities between playing positions (continuation). ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

[−48.7;−39.8], ES: −3.05, [−3.42;−2.67]) and defensive midfielders (−47.8%, [−52.2;−42.9], ES: −2.91, [−3.26;−2.56]).

Almost certain large decreases of degree centrality were found in forwards in comparison to external defenders (−50.7%, [−56.4;−44.3], ES: −2.07, [−2.43;−1.71]), central defenders (−62.3%, [−66.6;−57.5]), ES: −3.05, [−3.42;−2.67]), defensive midfielders (−64.6%, [−68.8;−59.8]; ES: −2.91, [−3.26;−2.56]) and midfielders (−56.2%, [−61.4;−50.2]; ES: −2.10, [−2.42;−1.77]).

The absolute values of degree prestige and centrality compared by playing positions were split in losing and winning. The descriptive statistics can be found in Table 3.

Variations of degree prestige and centrality between playing positions in losing matches can be found in Table 4.

Differences of centralities between playing positions in won matches can be found in Table 5.

Comparisons of centrality levels between winning and losing matches by playing positions can be found in Fig. 3. Possibly small increases of degree prestige were found in midfielders during winning matches (17.4%, [0.2;37.5]; ES: 0.31, [0.00;0.62]) and very likely small increases (33.9%, [12.7;59.0]; ES: 0.53, [0.22;0.85]) in forwards were also found in won matches.

Possibly small increases of degree centrality were found in midfielders (15.2%, (−2.2;35.7); ES: 0.26, [−0.04;0.56]) and wingers (11.3%, [−3.5;28.2]; ES: 0.20, [−0.07;0.48]) in won matches and likely small increases in forwards (31.7%, [8.2;60.2]; ES: 0.43, [0.12;0.74]) were also found in won matches.

4. Discussion

Degree prestige can be considered an indicator of the overall prestige or prominence of a player to receive the ball from his teammates [18]. In our study, defensive midfielders had larger levels than external defenders (+15.9%), central defenders (+9.1%), midfielders (+10.6%), wingers (+27.2%), and central forwards (+47.1%).

Previous studies have been consistent in revealing that midfielders are, generally, the most prominent players in this measure [5,7,8]. However, in our approach, the general midfielder position

Table 3
Descriptive statistics (mean ± SD) of centrality measures of playing positions between winning and losing matches.

	ED	CD	DMF	MF	W	FW
Lost						
DPres (A.U.)	32.81(18.83)	36.25(20.96)	38.25(21.12)	33.47(20.79)	26.99(12.14)	17.56(9.61)
DCen (A.U.)	29.96(17.04)	40.24(21.73)	42.61(22.36)	33.20(19.00)	21.38(11.57)	13.16(8.19)
Win						
DPres (A.U.)	33.13(16.35)	38.74(19.97)	41.60(21.08)	38.86(19.87)	28.94(12.80)	22.40(8.65)
DCen (A.U.)	31.54(17.19)	43.48(20.64)	45.10(22.41)	37.90(19.42)	23.42(11.96)	16.39(8.12)

DPres.: degree prestige (absolute, A.U.); DCen: degree centrality (absolute, A.U.); Rec.: reciprocity (A.U.); ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

Table 4
Percentage and standardized changes of network centralities between playing positions in lost matches.

Variable	Comparison	% difference (A-B)		Standardized difference (A-B)		% greater/similar/lower values (A-B)
		Value	[90%CI]	Value (*Magnitude*)	[90%CI]	
Degree Prestige (A.U.)	CD (A) vs. ED (B)	7.7	[−6.7;24.4]	0.14 *trivial*	[−0.13;0.42]	36/61/2 *Possibly*
	DMF(A) vs. ED (B)	16.3	[−0.2;35.6]	0.29 *small*	[0.00;0.58]	69/30/0 *Possibly*
	MF(A) vs. ED (B)	1.7	[−12.0;17.5]	0.03 *trivial*	[−0.24;0.31]	16/76/8 *Unclear*
	W(A) vs. ED (B)	−14.3	[−24.8;−2.4]	−0.30 *small*	[−0.54;−0.05]	0/26/74 *Possibly*
	FW(A) vs. ED (B)	−46.7	[−54.5;−37.6]	**−1.20 *large***	[−1.50;−0.90]	0/0/100 *Almost certain*
	DMF(A) vs. CD (B)	8.0	[−7.6;26.3]	0.13 *trivial*	[−0.14;0.40]	34/64/2 *Possibly*
	MF(A) vs. CD (B)	−5.6	[−18.5;9.4]	−0.10 *trivial*	[−0.35;0.16]	3/72/26 *Possibly*
	W(A) vs. CD (B)	−20.5	[−30.5;−9.1]	−0.40 *small*	[−0.63;−0.16]	0/8/92 *Likely*
	FW(A) vs. CD (B)	−50.5	[−57.9;−41.9]	**−1.21 *large***	[−1.49;−0.94]	0/0/100 *Almost certain*
	MF(A) vs. DMF (B)	−12.6	[−25.2;2.2]	−0.25 *small*	[−0.55;0.04]	1/38/62 *Possibly*
	W(A) vs. DMF (B)	−26.4	[−36.2;−15.0]	−0.57 *small*	[−0.84;−0.30]	0/1/99 *Very likely*
	FW(A) vs. DMF (B)	−54.2	[−61.3;−45.8]	**−1.46 *large***	[−1.78;−1.15]	0/0/100 *Almost certain*
	W(A) vs. MF (B)	−15.8	[−26.3;−3.7]	−0.34 *small*	[−0.60;−0.07]	0/19/81 *Likely*
	FW(A) vs. MF (B)	−47.6	[−55.4;−38.5]	**−1.27 *large***	[−1.58;−0.95]	0/0/100 *Almost certain*
	FW(A) vs. W (B)	−37.8	[−46.4;−27.9]	−1.09 *moderate*	[−1.43;−0.75]	0/0/100 *Almost certain*
Degree Centrality (A.U.)	CD (A) vs. ED (B)	33.2	[15.1;54.1]	0.52 *small*	[0.25;0.78]	98/2/0 *Very likely*
	DMF(A) vs. ED (B)	44.1	[23.5;68.1]	0.66 *moderate*	[0.38;0.94]	100/0/0 *Almost certain*
	MF(A) vs. ED (B)	10.6	[−5.1;28.8]	0.18 *trivial*	[−0.09;0.46]	46/53/1 *Possibly*
	W(A) vs. ED (B)	−28.2	[−38.0;−17.0]	−0.60 *moderate*	[−0.86;−0.34]	0/1/99 *Very likely*
	FW(A) vs. ED (B)	−57.8	[−64.6;−49.7]	**−1.56 *large***	[−1.88;−1.24]	0/0/100 *Almost certain*
	DMF(A) vs. CD (B)	8.2	[−7.0;25.8]	0.14 *trivial*	[−0.13;0.41]	36/63/2 *Possibly*
	MF(A) vs. CD (B)	−17.0	[−28.5;−3.5]	−0.33 *small*	[−0.60;−0.06]	0/21/79 *Likely*
	W(A) vs. CD (B)	−46.1	[−53.3;−37.8]	−1.10 *moderate*	[−1.35;−0.84]	0/0/100 *Almost certain*
	FW(A) vs. CD (B)	−68.3	[−73.4;−62.3]	**−2.04 *large***	[−2.35;−1.74]	0/0/100 *Almost certain*
	MF(A) vs. DMF (B)	−23.2	[−34.4;−10.1]	−0.51 *small*	[−0.82;−0.21]	0/5/95 *Very likely*
	W(A) vs. DMF (B)	−50.2	[−57.2;−42.1]	**−1.36 *large***	[−1.65;−1.06]	0/0/100 *Almost certain*
	FW(A) vs. DMF (B)	−70.7	[−75.6;−65.0]	**−2.39 *large***	[−2.74;−2.04]	0/0/100 *Almost certain*
	W(A) vs. MF (B)	−35.1	[−44.1;−24.6]	−0.80 *moderate*	[−1.08;−0.52]	0/0/100 *Almost certain*
	FW(A) vs. MF (B)	−61.9	[−68.1;−54.4]	**−1.78 *large***	[−2.12;−1.45]	0/0/100 *Almost certain*
	FW(A) vs. W (B)	−41.3	[−50.6;−30.1]	−1.02 *moderate*	[−1.35;−0.69]	0/0/100 *Almost certain*

DPres.: degree prestige (absolute, A.U.); DCen: degree centrality (absolute, A.U.); Rec.: reciprocity (A.U.); ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

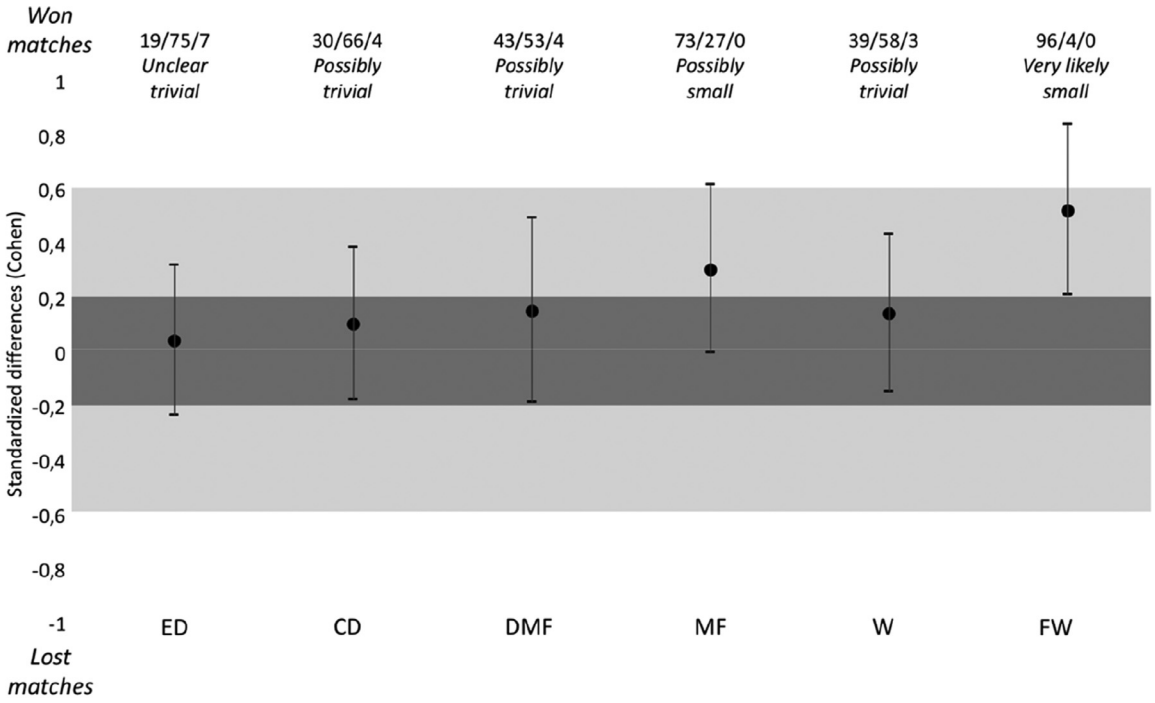
was split into the defensive midfielder and midfielder (box-to-box) positions, making it possible to identify small variations between these sub-positions; it was found that the defensive midfielder is the most recruited position. This was relatively different from the literature. In a study that presented values from La Liga and the FA Premier League [19] it was found that central attacking midfielders were the players with greater duration of ball possession, although similar results in the number of passes towards the opponent's goal were observed between defensive and attacking central midfielders.

Oppositely, central forwards had the lowest degree centrality, suggesting that this position is the least recruited by teammates during ball possession. Such results are in line with those of previous studies that compared playing positions when building an attack [7,8,18]. Generally, there is an unfavorable numeral relationship in the central forward's zone (caused by a constant numerical superiority by the opponent's defenders) [20], and this might explain the low values of degree prestige.

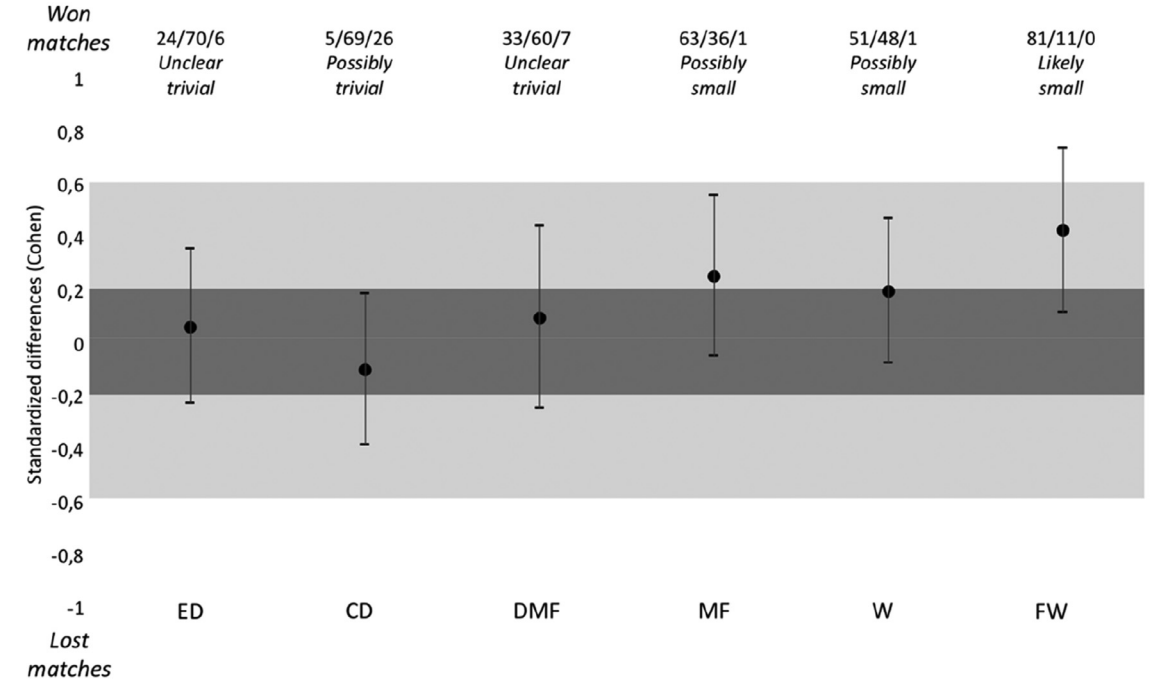
Considering that degree centrality provides information about the overall contribution of a player to ball possession, it was found that defensive midfielders and central defenders were the greatest contributors. Particularly, defensive midfielders and central defenders had greater values than external defenders (+39.2 and +30.7%, respectively), midfielders (+19.2 and +14.9%, respectively), wingers (+47.8 and +44.4%, respectively), and central forwards (+64.6 and +62.3%, respectively).

These values are different from those found in a similar study conducted using data from FIFA World Cup 2014; in that study, external defenders and midfielders had the greatest values for this parameter [7]. This suggests that teams now tend to use the central region more often to establish ball possession and to initiate the transition into an attack, while the players in positions furthest back on the field are prominent due to their superiority advantage and the fact that they play in a zone that puts less pressure on them [20]. The opposite occurs with central forwards who are less prominent in the passing network.

Reciprocity levels were also analyzed during the between-playing position comparisons. Variations were trivial to small. However, central forwards and wingers had the greatest mean values, suggesting that these positions are the most balanced in terms of bidirectional relationships despite being less recruited and less prominent in the passing network. This could be because of the



(a)



(b)

Fig. 3. Comparison of (a) degree prestige and (b) degree centrality between winning and losing per playing position.

lower values of weighted matrices, which makes them more homogeneous. This, in turn, reduces the reciprocity of playing positions with greater interventions and non-balanced weights as central defenders or defensive midfielders.

The second main purpose of this study was to analyze the between- and within-playing position variations in terms of centralities between won and lost matches. It was found that the large meaningful changes between playing positions decrease in won matches when compared to lost matches. In lost matches, almost certain large decreases were found in degree prestige in forwards versus external defenders, central defenders, defensive midfielders, and midfielders. Moreover, almost certain large decreases of degree centrality were found in wingers when compared to defensive midfielders, and almost certain large decreases were found in forwards when compared to external defenders, central defenders, defensive midfielders, and midfielders.

Table 5
Percentage and standardized changes of network centralities between playing positions in won matches.

Variable	Comparison	% difference (A-B)		Standardized difference (A-B)		% greater/similar/lower values (A-B)
		Value	[90%CI]	Value (*Magnitude*)	[90%CI]	
Degree Prestige (A.U.)	CD (A) vs. ED (B)	11.8	[−5.0;31.5]	0.22 *small*	[−0.10;0.55]	55/44/2 *Possibly*
	DMF(A) vs. ED (B)	23.4	[3.7;46.8]	0.42 *small*	[0.07;0.77]	85/15/0 *Likely*
	MF(A) vs. ED (B)	16.1	[−0.9;36.0]	0.30 *small*	[−0.02;0.61]	69/30/1 *Possibly*
	W(A) vs. ED (B)	−11.0	[−22.6;2.4]	−0.23 *small*	[−0.51;0.05]	1/42/57 *Possibly*
	FW(A) vs. ED (B)	−30.6	[−40.9;−18.6]	−0.73 *moderate*	[−1.05;−0.41]	0/0/100 *Almost certain*
	DMF(A) vs. CD (B)	10.4	[−8.4;33.0]	0.16 *trivial*	[−0.14;0.46]	41/57/2 *Possibly*
	MF(A) vs. CD (B)	3.8	[−12.6;23.3]	0.06 *trivial*	[−0.22;0.34]	20/74/6 *Unclear*
	W(A) vs. CD (B)	−20.4	[−31.9;−6.9]	−0.37 *small*	[−0.62;−0.12]	0/14/86 *Likely*
	FW(A) vs. CD (B)	−38.0	[−47.9;−26.2]	−0.77 *moderate*	[−1.05;−0.49]	0/0/100 *Almost certain*
	MF(A) vs. DMF (B)	−5.9	[−21.6;12.9]	−0.11 *trivial*	[−0.44;0.22]	6/61/33 *Unclear*
	W(A) vs. DMF (B)	−27.9	[−39.0;−14.7]	−0.59 *small*	[−0.90;−0.29]	0/2/98 *Very likely*
	FW(A) vs. DMF (B)	−43.8	[−53.2;−32.4]	−1.05 *moderate*	[−1.38;−0.71]	0/0/100 *Almost certain*
	W(A) vs. MF (B)	−23.3	[−34.1;−10.8]	−0.51 *small*	[−0.80;−0.22]	0/4/96 *Very likely*
	FW(A) vs. MF (B)	−40.2	[−49.6;−29.2]	−0.98 *moderate*	[−1.31;−0.66]	0/0/100 *Almost certain*
	FW(A) vs. W (B)	−22.1	[−33.2;−9.1]	−0.54 *small*	[−0.88;−0.21]	0/5/95 *Very likely*
Degree Centrality (A.U.)	CD (A) vs. ED (B)	38.7	[16.9;64.6]	0.55 *small*	[0.26;0.84]	98/2/0 *Very likely*
	DMF(A) vs. ED (B)	46.3	[21.7;75.8]	0.64 *moderate*	[0.33;0.95]	99/1/0 *Very likely*
	MF(A) vs. ED (B)	22.5	[3.1;45.5]	0.34 *small*	[0.05;0.63]	79/21/0 *Likely*
	W(A) vs. ED (B)	−23.2	[−34.5;−10.0]	−0.45 *small*	[−0.71;−0.18]	0/7/93 *Likely*
	FW(A) vs. ED (B)	−46.6	[−55.6;−35.8]	−1.06 *moderate*	[−1.37;−0.75]	0/0/100 *Almost certain*
	DMF(A) vs. CD (B)	5.4	[−12.0;26.4]	0.09 *trivial*	[−0.22;0.39]	27/67/6 *Unclear*
	MF(A) vs. CD (B)	−11.7	[−25.4;4.6]	−0.21 *small*	[−0.49;0.08]	1/47/52 *Possibly*
	W(A) vs. CD (B)	−44.7	[−52.6;−35.4]	−1.00 *moderate*	[−1.26;−0.73]	0/0/100 *Almost certain*
	FW(A) vs. CD (B)	−61.5	[−67.9;−53.9]	**−1.61 *large***	[−1.91;−1.30]	0/0/100 *Almost certain*
	MF(A) vs. DMF (B)	−16.3	[−30.2;0.50]	−0.33 *small*	[−0.66;0.01]	1/26/74 *Possibly*
	W(A) vs. DMF (B)	−47.5	[−55.7;−37.8]	−1.19 moderate	[−1.50;−0.88]	0/0/100 *Almost certain*
	FW(A) vs. DMF (B)	−63.5	[−69.9;−55.7]	**−1.86 *large***	[−2.22;−1.51]	0/0/100 *Almost certain*
	W(A) vs. MF (B)	−37.3	[−46.4;−26.7]	−0.88 *moderate*	[−1.18;−0.59]	0/0/100 *Almost certain*
	FW(A) vs. MF (B)	−56.4	[−63.7;−47.7]	**−1.57 *large***	[−1.91;−1.22]	0/0/100 *Almost certain*
	FW(A) vs. W (B)	−30.5	[−41.3;−17.7]	−0.75 *moderate*	[−1.09;−0.40]	0/1/99 *Very likely*

DPres.: degree prestige (absolute, A.U.); DCen: degree centrality (absolute, A.U.); Rec.: reciprocity (A.U.); ED: external defender; CD: central defender; DMF: defensive midfielder; MF: midfielder; W: winger; FW: central forward.

However, in won matches, there were no large between-playing position variations; any changes were trivial-to-moderate. In the case of degree centrality, almost certain large decreases were found in central forwards in comparison to central defenders, defensive midfielders, and central forwards. Such findings suggest that the overall participation and prominence of playing position is more homogeneous during won matches than during lost matches. This may occur because less centralized and denser networks are associated with better performance outcomes (measured as goals scored, shot attempts, and final score success) [10,13].

The within-playing positions changes between won and lost matches revealed possibly small increases in degree centrality in midfielders and wingers and likely small increases of this measure in forwards during won matches. Such results confirm that players with lower values of degree centrality (i.e., wingers and central forwards) increase their overall participation in passing the ball in won matches. This can be related with the fact that winning teams presents more short and long passes performed comparing to losing and drawing [21], thus increasing the players involved in the passing sequences.

This study had some limitations. Ball possession networks were built based on overall adjacency matrices; thus, specific moments of the game or attacking process (indirect or direct attacking; transitions; or specific codes as scored goals, shots, or non-succeeded attacking units) were not considered. Moreover, emergent playing formations during the match were not considered based on the complexity of actually classifying such information.

Based on these reasons, future studies should consider splitting the adjacency matrices into different types of events and attacking processes. Moreover, the team's formation and the opponent's defensive style should be considered. Finally, qualitative information based on the tactical behavior of players and the dynamic collective organization of the team should be considered and cross-referenced with the social network analysis outcomes in an attempt to obtain a bigger picture of the results.

5. Conclusions

The overall comparisons executed between playing positions for degree prestige, degree centrality, and reciprocity revealed that only the first two measures were largely sensitive to changes between playing positions. For both degree prestige and centrality, the central forwards showed almost certain large decreases in balls received and passed. Variations in reciprocity levels were trivial to small. This study also revealed possibly-to-likely smaller increases in degree centrality levels in midfielders, wingers, and central forwards during won matches in comparison to lost matches.

Declaration of Competing Interest

The author declares no conflict of interest.

CRediT authorship contribution statement

Filipe Manuel Clemente: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Hugo Sarmento:** Investigation, Writing - original draft, Writing - review & editing. **Rodrigo Aquino:** Investigation, Writing - original draft, Writing - review & editing.

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