Original Article

Network structure and centralization tendencies in professional football teams from Spanish La Liga and English Premier Leagues

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ABSTRACT

The aim of this study was to analyse the variance of different competitive leagues, score status, and tactical position in the centrality levels of degree prestige, degree centrality and page rank in football players. A total of 20 matches from the Spanish La Liga League (10 matches) and English Premier League (10 matches) were analysed and codified in this study. In this study only the top four teams and their opponents per each competitive league were analysed. A total of 14,738 passes between teammates were recorded and

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processed. The multivariate MANOVA revealed statistical differences in centrality among tactical positions (λ = 0.958; $F_{(15,1212)}$ = 37.898; p-value = 0.001; η^2 = 0.319; Moderate Effect Size). Midfielders had the greatest centrality values, followed by the external and central defenders. The lowest values of centrality were found in goalkeepers and forwards. No statistical differences were found in centrality between different competitive leagues (λ = 0.001; $F_{(3,402)}$ = 0.050; p-value = 0.985; η^2 = 0.001; Very Small Effect Size) and score status (λ = 0.003; $F_{(6,806)}$ = 0.175; p-value = 0.983; η^2 = 0.001; Very Small Effect Size). **Key words:** PERFORMANCE, MATCH ANALYSIS, COLLECTIVE BEHAVIOUR, NETWORK.

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INTRODUCTION

The teammates' cooperation within a team is a determinant to improve the opportunity of success (Grund, 2012). Designated as network competency, such cooperation is determined by cooperation rules and specific dynamics that come from multiple constraints (Gréhaigne, Bouthier, & David, 1997). Besides the regular football training and coach's strategy, the network competency of a team may depend on contextual variables such as score status, period of the match or even the different social approach to the game (Travassos, Davids, Araújo, & Esteves, 2013).

The systematic analysis to a team is usually designated as match analysis (Carling, Williams, & Reilly, 2005). In such process the ultimate aim is to extract the variables and the outcomes that can provide a better understanding about the coordination dynamics of a team and the main tendencies of play (Filipe Manuel Clemente, Couceiro, Martins, Mendes, & Figueiredo, 2014). To do that there are several techniques and approaches that could be used (Sarmento et al., 2014). In an analytic fashion there is a traditional notational analysis based on manual observation and codification of individual variables (M. D. Hughes & Bartlett, 2002; M. Hughes & Franks, 2005). Lately, a growing tactical concern increased the observational techniques to extract collective variables (Duarte, Araújo, Correia, & Davids, 2012). From semi-computational solutions as graph theory (Passos et al., 2011) or temporal-patterns (Jonsson et al., 2006) until computational algorithms such as spatio-temporal metrics (Bourbousson, Sève, & McGarry, 2010; Frencken, Lemmink, Delleman, & Visscher, 2011) or tactical metrics (Filipe M Clemente, Couceiro, Martins, Mendes, & Figueiredo, 2013).

For the specific case of teammates cooperation the network approach may be one of the best solutions considering the opportunities of graph theory (Wasserman & Faust, 1994). The social network approach provide a set of metrics that determine the cooperation level of a team and the centrality levels of each player within the network (Cotta, Mora, Merelo, & Merelo-Molina, 2013). Thus, in the past few years some studies have analysed the application of network for team sports (Bourbousson, Poizat, Saury, & Seve, 2010; Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014; Duch, Waitzman, & Amaral, 2010; Passos et al., 2011; Peña & Touchette, 2012). Particularly, the centrality levels studied based on network approach can be very important to determine the cooperation tendencies inside the football team (Duch et al., 2010).

One of the first studies that used centrality metrics based on social network analysis in football revealed that during UEFA 2014 Tournament the Spanish midfielder Xavi had the greatest centrality score in the competition (Duch et al., 2010). The network analysis of such study also had a great association with the ranking of best players defined by the external observers (Duch et al., 2010). In other study, the prominence of each player and tactical position in the Final and third place qualifiers matches in FIFA World Cup 2010 was analysed (Peña & Touchette, 2012). In the Spanish team it was found that Xavi and Busquets (both midfielders) had the greatest values of centrality levels. On the other hand, in the Germany team the greatest values were found in Lahm (external defender). In a recent study, a top-team in a national premier league of Portugal was analysed (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014). In this study it was found that the highest centrality values were in the external defenders, central defender and midfielders. The lowest values were generally found in goalkeeper and forwards (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014).

Although there is increasing number of studies using network approach, the knowledge about the cooperation organization of football teams is still limited. Moreover, the influence of situational variables such as the type of competitive league, score status or match period in the centrality levels of network have been not studied so far. Thus, it seems extremely important to consider such kind of variables in the analysis in order to understand the contribution and to explain the centrality levels of cooperation among players.

Therefore, the aim of this study was to analyse the variance of different competitive leagues, score status, and tactical position in the centrality levels of degree prestige, degree centrality and page rank in football players. Based on previous studies it is hypothesized that there are statistical differences in centrality parameters between different tactical positions.

METHOD

Sample

A total of 20 matches from the Spanish La Liga League (10 matches) and English Premier League (10 matches) were analysed and codified in this study. The matches involved one team from the first four places of both leagues. In this study only the top four teams and their opponents per each competitive league were analysed. A total of 14,738 passes between teammates were recorded and processed. In each match participated one of the top four in each competition at least.

Data Collecting and Processing

The general tactical positions were classified based on the tactical assignment to positional roles (Di Salvo et al., 2007). It is possible to observe such general classification in the Figure 1. In the present study, the tactical positions of players were codified according to the tactical line-up. The tactical line-up of each team was classified and validated by two football coaches in two occasions with 20-day interval. The two football coaches had more than five years of experience. A Kappa value of 0.94 was obtained after testing the full data using the Cohen's Kappa test (Robinson & O'Donoghue, 2007).

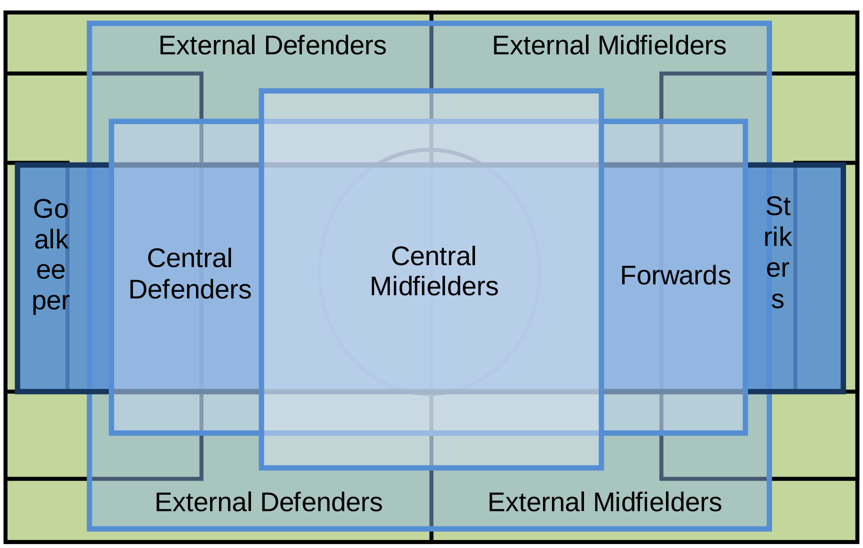

Figure 1. Tactical positions codified based on match analysis.

The interactions between teammates were analysed based on the passes. Thus, the passes from player A to player B were considered as the linkage factor to run the network computation. As in previous studies (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014; Passos et al., 2011), an adjacency matrix was generated per each unit of attack. A unit of attack is considered from the point that one player recover the possession of the ball until the last moment that the team lose the ball after passing sequence without

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interception. The adjacency matrix represents the direction of interaction (arrows) between players (nodes). For each pass it was codified 1 (one) and non-pass 0 (zero). The observation and codification were made by the same researcher with more than five years of experience in match analysis. A retest was performed for the observer using 20% of the data in a 20-day interval (Robinson & O'Donoghue, 2007). A Kappa value of 0.81 was observed, thus ensuring a recommended margin for this type of procedure (Robinson & O'Donoghue, 2007).

Network Assessment

For each period of 15 minutes of a match, the adjacency matrices that resulted from attacking units were added. Such adjacency matrices were then imported by the software Social Network Visualizer (version 1.5). This software is an application to visualize the graphs and analyse a set of metrics based on the social networks (Kalamaras, 2014).

Degree Centrality

Degree centrality is a simple metric for computation that only considers the number of outbound edges. Degree centrality is usually interpreted as a measure of the activity of each node (Nieminen, 1974). Nodes with higher degree centrality are connected to more nodes than those with lower degree centrality. Thus, such nodes are believed to be more important for the overall network structure. In the case of this study, the players with larger degree centrality are those who contributed with more passes to the other players of their team.

Degree Prestige

The degree prestige considers only inbound links, it is often used as indication of the "prestige" of each node among its peers. Nodes with high degree prestige are those that receive many inbound links from other nodes. In the case of football the players with higher degree prestige are those to whom their teammates preferred to pass the ball more often.

Page Rank

The page rank it is a recursive notion of popularity (Peña & Touchette, 2012) that are associated with a notion that a given player is popular if he gets passes from other popular players (Brin & Page, 1998). Page Rank centrality attributes a probability that each player will have the ball after a reasonable number of passes have been made (Peña & Touchette, 2012).

Statistical Procedures

The influences of competitive league, score status and tactical position factors on the %Degree Centrality (%DC), %Degree Prestige (%DP), and %Page Rank (%PR) were analyzed using two-way MANOVA after validating the normality and homogeneity assumptions. MANOVA was specifically selected because it reduces Type I Error Inflation compared with ANOVA (O'Donoghue, 2012). In many cases, MANOVA can detects statistical differences that many one-way ANOVAs cannot (Pallant, 2011). The assumption of normality for each univariate-dependent variable was examined using Kolmogorov–Smirnov tests (p-value > 0.05). The assumption of the homogeneity of the variance/covariance matrix of each group was examined using the Box's M Test (Pallant, 2011). When the MANOVA detected significant statistical differences between the two factors, the two-way ANOVA was used for each dependent variable, followed by Tukey's HSD post-hoc test (O'Donoghue, 2012). When the two-way ANOVA showed an interaction between factors, it also generated a new variable that crossed the factors (e.g., Spanish Li Liga*Win*Goalkeeper) for each dependent variable to identify statistical significance. Ultimately, the statistical procedures used were one-way ANOVA and Tukey's HSD post-hoc test. If no interactions were detected in the two-away ANOVA, one-way ANOVA was used for each independent variable. The following scale was used to classify the effect size (partial eta square) of the test (Pierce, Block, & Aguinis, 2004): small, 0.14–0.36; moderate, 0.37–0.50; large, 0.51–1. All statistical analyses were performed using IBM SPSS Statistics (version 21) at a significance level of $p < 0.05$.

RESULTS

The multivariate MANOVA revealed statistical differences in the independent variable of tactical position ($\lambda = 0.958$; $F_{(15,1212)} = 37.898$; *p-value* = 0.001; $\eta^2 = 0.319$; *Moderate Effect Size*). No statistical differences were found in the independent variables of competitive league ($\lambda = 0.001$; $F_{(3,402)} = 0.050$; *p-value* = 0.985; $\eta^2 = 0.001$; *Very Small Effect Size*) and score status ($\lambda = 0.003$; $F_{(6,806)} = 0.175$; *p-value* = 0.983; $\eta^2 = 0.001$; *Very Small Effect Size*). Statistical differences were found in the interactions of league*tactical position ($\lambda = 0.085$; $F_{(15,1212)} = 2.363$; *p-value* = 0.002; $\eta^2 = 0.028$; *Very Small Effect Size*) and score*tactical position ($\lambda = 0.116$; $F_{(30,1212)} = 1.618$; *p-value* = 0.019; $\eta^2 = 0.039$; *Very Small Effect Size*). No interactions between factors were found in league*score ($\lambda = 0.004$; $F_{(6,806)} = 0.870$; *p-value* = 0.951; $\eta^2 = 0.028$; *Very Small Effect Size*). Finally, statistical differences were found in the interaction league*score*tactical position ($\lambda = 0.161$; $F_{(30,1212)} = 2.297$; *p-value* = 0.001; $\eta^2 = 0.054$; *Very Small Effect Size*).

As described in statistical procedures, where MANOVA showed statistical differences in the interactions between factors a new variable was generated crossing the factors. After that, a one-way ANOVA was tested for each new cross variable.

The one-way ANOVA for the cross factor between league and tactical position found statistical differences in the dependent variables of %DC ($F_{(11,428)} = 32.859$; *p-value* = 0.001; $\eta^2 = 0.458$; *Moderate Effect Size*), %DP ($F_{(11,428)} = 32.770$; *p-value* = 0.001; $\eta^2 = 0.457$; *Moderate Effect Size*) and %PR ($F_{(11,428)} = 37.430$; *p-value* = 0.001; $\eta^2 = 0.490$; *Moderate Effect Size*). The post-hoc results can be found in the following table 1.

The one-way ANOVA for the cross factor between score status and tactical position found statistical differences in the dependent variables of %DC ($F_{(17,422)} = 21.950$; *p-value* = 0.001; $\eta^2 = 0.469$; *Moderate Effect Size*), %DP ($F_{(17,422)} = 21.975$; *p-value* = 0.001; $\eta^2 = 0.470$; *Moderate Effect Size*) and %PR ($F_{(17,422)} = 24.722$; *p-value* = 0.001; $\eta^2 = 0.499$; *Moderate Effect Size*). The post-hoc results can be found in the following table 2.

Finally, the one-way ANOVA for the cross factor League*Score*Tactical Position revealed statistical differences for the variables of %DC ($F_{(35,404)} = 12.431$; *p-value* = 0.001; $\eta^2 = 0.519$; *Large Effect Size*), %DP ($F_{(35,404)} = 11.979$; *p-value* = 0.001; $\eta^2 = 0.509$; *Large Effect Size*) and %PR ($F_{(35,404)} = 13.075$; *p-value* = 0.001; $\eta^2 = 0.531$; *Large Effect Size*). The post-hoc results can be found in the following table 3.

DISCUSSION

The aim of this study was to investigate the influence of situational variables such as competitive league, score status and tactical position on the centrality levels of cooperation. A network approach was used to identify the patterns of cooperation between teammates and from such analysis it was possible to extract three levels of centrality. The fundamental results showed no statistical differences in the level of centrality between competitive leagues and score status. Only statistical differences in the level of centrality were found between different tactical positions.

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In this study only the top four teams and their opponents per each competitive league were analysed. No significant differences of centrality levels were found between the two leagues. Despite of no studies compared such item in the network approach, it is possible to discuss that in the top teams the style of play ensures a similar values of centrality, simply based on the proximity between teammates participation. Even in the case of cross factor with tactical position no differences in centrality levels between tactical positions in Spanish La Liga and English Premier Leagues were identified. Therefore, the present study supports the concept that despite the different styles of play of each team, the general principles that rule the dynamic of high competitive teams ensure a similar level of participation in the match (Gréhaigne, Richard, & Griffin, 2005).

In the present study, generally there was no differences in centrality levels between different score status. Nevertheless, in the case of cross factor with tactical position it was observed that a statistical difference in page rank between lose*midfielder and win*midfielder. In this case the greatest value of page rank was found in lose situation, thus the midfielders tend to have a greater centralization in games that teams need to attack to revert the disadvantage (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014). On the other hand, when teams are in advantage they tend to reduce the circulation in the middle and try to explore the counter-attack, thus centralizing the passes directly in the external midfielders and forwards (Malta & Travassos, 2014).

In the specific case of tactical positions comparison, statistical differences between the tactical positions were observed. In all cross factors the goalkeepers had the lowest values of degree centrality, degree prestige and page rank. This could attribute to the specific positioning and tactical roles of goalkeeper. The goalkeeper tends to not participate in the attacking building, and only in punctual cases of ball circulation in retreated spaces. Despite of that it was found that greater values of degree centrality than degree prestige, thus goalkeeper contributed more in generating passing sequences than as the target to pass the ball. In the opposite way, the forwards tend to have greater values of degree prestige than degree centrality. This can be explained by their main function that is received the ball and to score. Therefore, the participation of forwards to generate passing sequences is lower than their participation to receive and try to shot (Peña & Touchette, 2012). Thus, the forwards are one of the targets of team to put the ball in the end of ball circulation (Malta & Travassos, 2014). Despite of these differences between goalkeepers and forwards, both had the lowest values of centrality levels as similar with previous studies (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014; Peña & Touchette, 2012).

The highest centrality levels were found in external defenders and midfielders. Their tactical positions have specific roles associated with linkage missions (Reilly & Thomas, 1976). Thus, the degree prestige of both tactical positions is the greatest. Nevertheless, the external defenders had generally the lowest values of degree centrality in comparison with central defenders. This could attribute to the regular passing sequence in the attacking building. Typically, the central defenders tend to pass the ball to the external defenders and midfielders to initiate the progression of the ball. Thus, central defenders made more passes than receive from teammates. On the other hand, external defenders receive more passes from central defenders because when the external defender have the ball the regular trajectory is moving forward and not to maintain the position.

Finally, in the majority of situations midfielders had the greatest values of degree centrality, degree prestige and page rank. As observed in previous studies, this tactical position is fundamental to ensure the passing sequence and team's dynamic (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014; Duch et al., 2010; Malta & Travassos, 2014; Peña & Touchette, 2012). As the intermediate sector, these players link the first phase of attacking building with the forwards. Thus, midfielders are the prominent players in any situation and, as observed in this study, in any score status.

This study had some limitations that must be considered in future studies. It could be meaningful to extract the data per match period of 15 minutes in order to consider different score status and the relative effect of fatigue. Moreover, the efficiency of technical actions may be interesting to identify if the players that stops the passing sequences tend to be associated with a given tactical position. With this kind of information it could better identify the patterns of interaction and approximate the scientific knowledge from the practical applications for the match analysis in professional football teams. Additionally, with a temporal analysis it would be also possible to predict some interactional patterns between teammates.

CONCLUSION

In this study it was found that different competitive leagues and scores had no statistical influence on the centrality levels of cooperation in football. The fundamental statistical differences of centrality levels were found between different tactical positions. Midfielders had the greatest levels of centrality in-degree and out-degree, thus being the link between team sectors. The central defenders had greatest values of degree centrality than external defenders. On the other hand, external defenders had the greatest values of degree prestige than central defenders, by the specific dynamic of attacking building. Finally, goalkeeper and forwards had the lowest values of centrality levels.

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REFERENCES

1. Bourbousson, J., Poizat, G., Saury, J., & Seve, C. (2010). Team Coordination in Basketball: Description of the Cognitive Connections Among Teammates. *Journal of Applied Sport Psychology*, *22*(2), 150–166.
2. Bourbousson, J., Sève, C., & McGarry, T. (2010). Space-time coordination dynamics in basketball: Part 2 The interaction between the two teams. *Journal of Sports Sciences*, *28*(3), 349–358.
3. Brin, S., & Page, L. (1998). The anatomy of a large-scale hypertextual Web search engine. *Computer Networks and ISDN Systems*, *30*(1-7), 107–117. doi:10.1016/S0169-7552(98)00110-X
4. Carling, C., Williams, A. M., & Reilly, T. (2005). *Handbook of Soccer Match Analysis: A Systematic Approach to Improving Performance*. London & New York: Taylor & Francis Group.
5. Clemente, F. M., Couceiro, M. S., Martins, F. M. L., Mendes, R., & Figueiredo, A. J. (2013). Measuring Collective Behaviour in Football Teams: Inspecting the impact of each half of the match on ball possession. *International Journal of Performance Analysis in Sport*, *13*(3), 678–689.
6. Clemente, F. M., Couceiro, M. S., Martins, F. M. L., & Mendes, R. S. (2014). Using network metrics to investigate football team players ' connections: A pilot study. *Motriz*, *20*(3), 262–271. doi:dx.doi.org/10.1590/S1980-65742014000300004
7. Clemente, F. M., Couceiro, M. S., Martins, F. M. L., Mendes, R. S., & Figueiredo, A. J. (2014). Practical Implementation of Computational Tactical Metrics for the Football Game: Towards an Augmenting Perception of Coaches and Sport Analysts. In Murgante, Misra, Rocha, Torre, Falcão, Taniar, … Gervasi (Eds.), *Computational Science and Its Applications* (pp. 712–727). Springer.

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8. Cotta, C., Mora, A. M., Merelo, J. J., & Merelo-Molina, C. (2013). A network analysis of the 2010 FIFA world cup champion team play. *Journal of Systems Science and Complexity*, *26*(1), 21–42.
9. Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *Int J Sports Med*, *28*, 222–227.
10. Duarte, R., Araújo, D., Correia, V., & Davids, K. (2012). Sports Teams as Superorganisms: Implications of Sociobiological Models of Behaviour for Research and Practice in Team Sports Performance Analysis. *Sports Medicine*, *42*(8), 633–642.
11. Duch, J., Waitzman, J. S., & Amaral, L. A. (2010). Quantifying the performance of individual players in a team activity. *PloS One*, *5*(6), e10937.
12. Frencken, W., Lemmink, K., Delleman, N., & Visscher, C. (2011). Oscillations of centroid position and surface area of football teams in small-sided games. *European Journal of Sport Science*, *11*(4), 215–223.
13. Gréhaigne, J. F., Bouthier, D., & David, B. (1997). Dynamic-system analysis of opponent relationship in collective actions in football. *Journal of Sports Sciences*, *15*(2), 137–149.
14. Gréhaigne, J. F., Richard, J. F., & Griffin, L. (2005). *Teaching and learning team sports and games*. New York, USA: Routledge Falmar.
15. Grund, T. U. (2012). Network structure and team performance: The case of English Premier League soccer teams. *Social Networks*, *34*(4), 682–690.
16. Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739–754.
17. Hughes, M., & Franks, I. (2005). Analysis of passing sequences, shots and goals in soccer. *Journal of Sports Sciences*, *23*(5), 509–514.
18. Jonsson, G. K., Anguera, M. T., Blanco-Villaseñor, Á., Losada, J. L., Hernández-Mendo, A., Ardá, T., … Castellano, J. (2006). Hidden patterns of play interaction in soccer using SOF-CODER. *Behavior Research Methods*, *38*(3), 372–381.
19. Kalamaras, D. (2014). Social Networks Visualizer (SocNetV): Social network analysis and visualization software. *Social Networks Visualizer*. Homepage: http://socnetv.sourceforge.net .
20. Malta, P., & Travassos, B. (2014). Characterization of the defense-attack transition of a soccer team. *Motricidade*, *10*(1), 27–37.
21. Nieminen, J. (1974). On the centrality in a graph. *Scandinavian Journal of Psychology*, *15*(1), 332–336.
22. O'Donoghue, P. (2012). *Statistics for sport and exercise studies: An introduction*. London and New York, UK and USA: Routledge Taylor & Francis Group.
23. Pallant, J. (2011). *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using the SPSS Program*. Australia: Allen & Unwin.
24. Passos, P., Davids, K., Araújo, D., Paz, N., Minguéns, J., & Mendes, J. (2011). Networks as a novel tool for studying team ball sports as complex social systems. *Journal of Science and Medicine in Sport*, *14*(2), 170–176.
25. Peña, J. L., & Touchette, H. (2012). A network theory analysis of football strategies. In *arXiv preprint arXiv* (p. 1206.6904).
26. Pierce, C. A., Block, R. A., & Aguinis, H. (2004). Cautionary Note on Reporting Eta-Squared Values from Multifactor ANOVA Designs. *Educational and Psychological Measurement*, *64*(6), 916–924. doi:10.1177/0013164404264848
27. Reilly, T., & Thomas, V. (1976). A motion analysis of work-rate in different positional roles in professional football match-play. *Journal of Human Movement Studies*, *2*, 87–97.

28. Robinson, G., & O'Donoghue, P. (2007). A weighted kappa statistic for reliability testing in performance analysis of sport. *International Journal of Performance Analysis in Sport*, *7*(1), 12–19.
29. Sarmento, H., Marcelino, R., Anguera, M. T., CampaniÇo, J., Matos, N., & LeitÃo, J. C. (2014). Match analysis in football: a systematic review. *Journal of Sports Sciences*, *32*(20), 1831–1843. doi:10.1080/02640414.2014.898852
30. Travassos, B., Davids, K., Araújo, D., & Esteves, P. T. (2013). Performance analysis in team sports : Advances from an Ecological Dynamics approach. *International Journal of Performance Analysis in Sport*, *13*(1), 83–95.
31. Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. New York, USA: Cambridge University Press.

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Table 1. Mean and standard deviation for the cross factor league*tactical position.

	BBVA*GK	BBVA *ED	BBVA *CD	BBVA *MF	BBVA *EM	BBVA *F	PL*GK	PL*ED	PL*CD	PL*MF	PL*EM	PL*F
DCentrality	4,83±2,74[b,c,d,h,j,k]	9,15±2,45[d,f,g,j,l]	9,80±2,99[d,e,f,g,j,l]	12,95±2,74[e,f,g,h,i,k,l]	7,32±2,35[g,i,j]	5,66±2,22[h,i,j,k]	4,53±1,93[h,i,j,k]	9,03±2,32[j,l]	9,46±3,12[j,k]	12,28±3,48[k,l]	8,23±2,73	6,40±3,25
DPrestige	2,77±1,83[b,c,d,e,f,h,i,j,k,l]	9,49±2,34[c,d,g,j]	7,11±2,29[d,e,g,h,j,k]	11,96±2,30[e,f,g,h,i,k,l]	10,03±2,58[g,i]	8,75±2,97[g,j]	3,30±1,98[h,i,j,k,l]	9,49±2,79[j]	7,97±3,11[j,k]	11,59±3,29[l]	10,02±2,96	8,03±2,43
PageRank	5,45±0,80[b,c,d,e,f,h,i,j,k,l]	8,97±1,16[d,g,j]	7,87±1,32[d,e,f,g,h,j,k,l]	10,98±1,46[e,f,g,h,i,k,l]	9,55±1,31[g,i]	9,54±1,98[g]	5,72±0,74[h,i,j,k,l]	9,02±1,67[j]	8,30±1,65[j,k,l]	10,53±1,63	9,64±1,41	9,60±1,98

Statistically different of [a]BBVA*GK; [b]BBVA*ED; [c]BBVA*CD; [d]BBVA*MF; [e]BBVA*EM; [f]BBVA*F; [g]PL*GK; [h]PL*ED; [i]PL*CD; [j]PL*MF; [k]PL*EM; [l]PL*F for a *p-value* < 0,05

Table 2. Mean and standard deviation for the cross factor score*tactical position.

	L*GK	L*ED	L*CD	L*MF	L*EM	L*F	D*GK	D*ED	D*CD	D*MF	D*EM	D*F	W*GK	W*ED	W*CD	W*MF	W*EM	W*F
DCentrality	5,03±1,43[b,c,d,i,n,o,p]	9,35±2,34[d,f,j,m,p]	10,20±3,40[e,f,g,j,l,m,p,r]	12,19±3,44[e,f,g,h,k,l,m,n,o,q,r]	7,75±2,65[j,m,p]	5,08±2,40[i,j,n,o,p,q,r]	5,56±4,32[j,p]	7,85±2,43[j,m,p]	9,10±3,31[j,m,p]	13,17±3,33[k,l,m,n,o,q,r]	7,53±1,88[p]	5,68±2,11[p]	4,02±2,14[n,o,p,q]	9,27±2,31[p]	9,27±2,56[p]	12,84±2,71[q,r]	7,88±2,77	6,91±3,02
DPrestige	3,48±2,25[b,c,d,e,f,h,j,k,l,n,o,p,q,r]	9,68±2,53[g,i,j,m]	7,98±3,20[d,g,j,m,p]	11,52±2,88[f,g,h,i,m,o,r]	9,70±2,84[g,i,j,m]	7,79±2,85[j,m,p]	3,75±2,09[j,k,n,p,q,r]	8,23±2,82[j,m,p]	6,23±1,90[j,k,m,n,p,q]	12,57±3,62[m,n,o,r]	10,47±2,91[m]	8,75±2,95[m]	2,34±1,20[n,o,p,q,r]	9,75±2,44	7,58±2,44	11,73±2,43[r]	10,20±2,65	8,80±2,55
PageRank	2,67±0,91[a,b,c,d,e,f,h,j,k,l,n,o,p,q,r]	9,04±1,38[d,g,j,m,p]	8,09±1,60[d,e,g,j,k,l,m,p,q,r]	10,87±1,70[g,i,m,p]	9,44±1,17[g,m]	9,22±2,16[h,j,k,l,n,o,p,q,r]	5,59±0,71[j,m,p]	8,42±1,57[j,k,l,n,p,q,r]	7,37±1,26[m,n,o]	10,82±1,73[m]	9,95±1,78[m]	10,60±2,45[n,o,p,q,r]	5,51±0,68[p]	9,16±1,42[p]	8,34±1,43	10,61±1,33	9,62±1,37	9,60±1,61

Statistically different of [a]L*GK; [b]L*ED; [c]L*CD; [d]L*MF; [e]L*EM; [f]L*F; [g]D*GK; [h]D*ED; [i]D*CD; [j]D*MF; [k]D*EM; [l]D*F; [m]W*GK; [n]W*ED; [o]W*CD; [p]W*MF; [q]W*EM; [r]W*F for a *p-value* < 0,05

Table 3. Mean and standard deviation for the cross factor league*score*tactical position.

	LE*L*GK	LE*L*ED	LE*L*CD	LE*L*MF	LE*L*EM	LE*L*F
	4,81±1,60 [b,c,d,i,j,n,o,p,t,u,v,ab,ah]	9,22±2,55 [d,f,m,p,ab,ae,aj]	9,13±3,17 [d,f,m,p,ab,ae,ah]	13,31±3,24 [e,f,k,l,m,n,o,q,r,s,t,w,x,y,z,aa,ac,ad,ae,af,ag,ai,aj]	7,72±2,83 [p,u,ab,ah]	4,23±2,31 [i,j,n,o,p,t,u,v,ab,af,ag,ah,ai]
	LE*D*GK	LE*D*ED	LE*D*CD	LE*D*MF	LE*D*EM	LE*D*F
	8,79±7,16	7,86±2,18 [ab]	12,18±2,63 [m,s,x,y,ae]	11,29±1,98 [m,s,y,ae]	6,37±1,15 [p,ab,ah]	4,49±0,10 [p,ab,ah]
	LE*W*GK	LE*W*ED	LE*W*CD	LE*W*MF	LE*W*M	LE*W*F
	3,97±2,02 [n,o,p,t,u,v,af,,ag,,ah,ai]	9,36±2,44 [p,ab,ae]	9,95±2,73 [s,y,ab,ae]	12,98±2,16 [q,r,s,t,w,x,y,z,aa,ac,ad,ae,af,ag,ai,aj]	7,14±2,01 [u,v,ab,ah]	6,93±1,46 [u,v,ab,ag]
DCentrality	PL*L*GK	PL*L*ED	PL*L*CD	PL*L*MF	PL*L*EM	PL*L*F
	5,28±1,26 [u,v,ab,ah]	9,50±2,15 [ab,ae]	11,40±3,33 [x,y,ae,aj]	10,88±3,26 [x,y,ae,aj]	7,77±2,51 [ab,ah]	4,93±2,29 [ab,ah]
	PL*D*GK	PL*D*ED	PL*D*CD	PL*D*MF	PL*D*EM	PL*D*F
	3,95±1,93 [ab,ah]	7,85±2,69 [ab,ah]	7,56±2,47 [ab,ah]	14,11±3,54 [ac,ad,ae,af,ag,ai,aj]	8,11±1,95 [ah]	6,28±2,44 [ah]
	PL*W*GK	PL*W*ED	PL*W*CD	PL*W*MF	PL*W*EM	PL*W*F
	4,07±2,41 [ac,ad,ae,af,ag,ai,aj]	9,15±2,22 [ah]	8,54±2,22 [ah]	12,68±3,24 [ai,aj]	8.83±3,36	6,88±4,29

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	LE*L*GK	LE*L*ED	LE*L*CD	LE*L*MF	LE*L*EM	LE*L*F
	3,13±1,84^{b,d,e,h,j,k,n,o,p,q,r,t,,u,v,w,x,ab,ac,af,ag,ah,ai,aj}	9,43±2,36^{m,s,y,ab,ae}	6,71±2,16^{d,e,m,p,v,ab,ah,ai}	12,44±2,56^{f,m,o,s,w,x,y,z,aa,ae,ag,aj}	10,24±3,24^{m,s,y,aa,ae}	7,24±3,18^{m,p,ab,ah}
	LE*D*GK	LE*D*ED	LE*D*CD	LE*D*MF	LE*D*EM	LE*D*F
	5,30±3,06^{ab}	9,45±1,66^{m,ae}	7,02±2,06^{ab}	10,68±3,22^{m,s,y,ae}	9,73±1,31$^{m.ae}$	10,23±4,91^{m}
	LE*W*GK	LE*W*ED	LE*W*CD	LE*W*MF	LE*W*S	LE*W*F
DPrestige	1,84±0,83^{n,o,p,q,rt,u,v,w,x,z,ab,ac,ad,af,ag,ah,ai,aj}	9,56±2,56^{s,y,ab,ae}	7,54±2,50^{p,ab,ae,ah}	11,75±1,57^{s,y,aa,ae,ag,aj}	9,88±2,10^{m,y,ae}	9,68±2,21^{m,y,ae}
	PL*L*GK	PL*L*ED	PL*L*CD	PL*L*MF	PL*L*EM	PL*L*F
	3,87±2,72^{t,u,v,w,ab,ac,af,ah,ai}	9,96±2,77^{y,ae}	9,41±3,62^{y,ab,ae}	10,44±2,93^{y,aa,ae}	9,08±2,26^{y,ab,ae}	8,34±2,54^{ab,ae}
	PL*D*GK	PL*D*ED	PL*D*CD	PL*D*MF	PL*D*EM	PL*D*F
	2,97±1,33^{ab,ac,af,ah,ai}	7,62±3,18^{ab}	5,84±1,83^{ab,ai}	13,52±3,55^{ae,ag,,aj}	10,84±3,48^{ae}	8,00±2,07
	PL*W*GK	PL*W*ED	PL*W*CD	PL*W*MF	PL*W*EM	PL*W*F
	2,89±1,37^{af,ah,ai,aj}	9,96±2,35	7,62±2,45^{ah}	11,70±2,45^{aj}	10,62±3,26	7,76±2,63

PageRank	LE*L*GK	LE*L*ED	LE*L*CD	LE*L*MF	LE*L*EM	LE*L*F
	5,75±0.98 [b,d,e,f,j,k,l,n,o,p,q,r,t,u,v,w,x,ab,ac,ad,af,ag,ah,ai,aj]	8,99±1,09 [d,m,s,y,ab,ae]	7,63±1,38 [d,m,p,q,v,x,ab,ah,ai]	11,48±1,40 [e,f,g,h,i,m,n,o,q,s,t,u,w,y,z,aa,ae,af,ag,aj]	9,34±1,26 [m,s,y,ae]	8,49±1,70 [m,s,ab]
	LE*D*GK	LE*D*ED	LE*D*CD	LE*D*MF	LE*D*EM	LE*D*F
	5,61±0,76[l,p,v,ab,ah]	8,39±0,97	7,48±1,58 [p,ab]	10,09±2,36 [m,s,y,ae]	10,48±1,81 [m,s,y,ae]	11,87±3,67 [m,s,y,ae]
	LE*W*GK	LE*W*ED	LE*W*CD	LE*W*MF	LE*W*S	LE*W*F
	5,13±0.52 [n,o,p,q,r,t,u,v,w,x,z,ab,ac,ad,af,ag]	9,07±1,28 [s,y,ae]	8,20±1,20 [p,s,v,ab,ah]	10,64±1,05 [s,u,y,aa,ae,ag]	9,54±1,24 [m,y,ae]	9,98±1,58 [s,y,aa,ae]
	PL*L*GK	PL*L*ED	PL*L*CD	PL*L*MF	PL*L*EM	PL*L*F
	5,58±0.88 [t,u,v,w,x,z,ab,ac,ad,af,ag,ah,ai,aj]	9,08±1,69 [y,ae]	8,60±1,71 [ab,ae,ah]	10,14±1,77 [y,aa,ae]	9,55±1,10 [y,ae]	9.95±2,41 [y,ae]
	PL*D*GK	PL*D*ED	PL*D*CD	PL*D*MF	PL*D*EM	PL*D*F
	5,57±0,81 [ab,ac,ad,af,ah,ai,aj]	8,44±1,87 [ab]	7,31±1,19 [ab,ah]	11,19±1,29 [ae,ag]	9,68±1,83[ae]	9,96±1,99[ae]
	PL*W*GK	PL*W*ED	PL*W*CD	PL*W*MF	PL*W*EM	PL*W*F
	5,94±0,58 [af,ag,ah,ai,aj]	9,25±1,59	8,48±1,67 [ah]	10,57±1,60	9,72±1,56	9,15±1,61

Statistically different of [a]LE*L*GK; [b]LE*L*ED; [c]LE*L*CD; [d]LE*L*MF; [e]LE*L*EM; [f]LE*L*F; [g]LE*D*GK; [h]LE*D*ED; [i]LE*D*CD; [j]LE*D*MF; [k]LE*D*EM; [l]LE*D*F; [m]LE*W*GK; [n]LE*W*ED; [o]LE*W*CD; [p]LE*W*MF; [q]LE*W*EM; [r]LE*W*F; [s]LI*L*GK; [t]LI*L*ED; [u]LI*L*CD; [v]LI*L*MF; [w]LI*L*EM; [x]LI*L*F; [y]LI*D*GK; [z]LI*D*ED; [aa]LI*D*CD; [ab]LI*D*MF; [ac]LI*D*EM; [ad]LI*D*F; [ae]LI*W*GK; [af]LI*W*ED; [ag]LI*W*CD; [ah]LI*W*MF; [ai]LI*W*EM; [aj]LI*W*F for a *p-value* < 0,05

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