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An Exploratory Study of Spatial Division of Football Pitch Passing Networks

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INTRODUCTION:
The integration of network science into the analysis of football passing performance has recently attracted extensive research interest. Compared to player passing networks, pitch passing networks, which describe zonal information and general attacking profile of a team, have received comparatively less attention. Therefore, this exploratory study focused on determining the optimal spatial divisions of the football pitch passing networks and on examining the most prominent network metrics within such networks regarding zone importance.
METHODS:
A dataset consisting of spatiotemporal records of 1,665,510 passes of 1,941 matches from the 2017/2018 season of the top five European Leagues, 2018 World Cup and UEFA Euro 2016 was used. The pitch passing networks were constructed by dividing the field into K equal areas (nodes), with K scales ranging from coarsest (1×2) to finest (20×20). Edges were respectively weighted by the numbers of passes between two nodes. Subsequently, two criteria were applied for determining the division scale: i. the extent of how much passing information was retained (L/N, the ratio of the total links (L) to the total successful passes (N) and ii. the heterogeneity of nodes degree (representing whether passes are evenly distributed under a certain network scale). Kendalls Rank Correlation Coefficient (τ) was used to analyze the association between the ranking of zone importance (based on four key passing events: smart pass, forward pass, assist, key pass) and the following network metrics: degree centrality, clustering coefficient, neighbor degree, closeness centrality, betweenness centrality and eigenvector centrality.
RESULTS:
It was shown that the division scales of 24, 50, 100 and 400 contained 81.3%, 90.9%, 95.3%, and 98.9% of all pass information. In addition, no obvious difference in the heterogeneity of node degree was shown between different scales. Regarding the relationship of the ranking of the zone importance at four scales with network metrics, degree centrality, betweenness centrality, eigenvector centrality and closeness centrality showed strong correlations (τ_ave(SD)) of 0.77 (0.121), 0.77 (0.108), 0.75 (0.117) and 0.71 (0.116) respectively, while neighbor degree and clustering coefficient showed trivial correlations of 0.36 (0.234) and 0.18 (0.456).
CONCLUSION:
The study indicated that scale divisions from K=24 retains largely the passing information, and the heterogeneity may not be a criterion in deciding optimal scales. Also, areas with higher centrality values contained a greater number of key passing events, which proves the prominence of these areas and potentially aids in future assessments of team passing styles. Nonetheless, it should also be acknowledged that the suitable scale for pitch passing networks may differ depending on analysis purposes. While this study focuses on the micro-level of networks, future research could explore improvements at the meso and marco levels with subgroups or entire networks.

Topic: Statistics and Analyses

Presentation Oral