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Original Article

An examination of offensive transition at World Cup matches using social network analysis

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Abstract:
This study applied Social Network Analysis (SNA) to the passing networks during the offensive transitions of Men, Women, and Men u20 at the World Cup matches of 2018 and 2019. For each offensive transition, the progression of the sequence was categorized as 1) a goal-scoring attempt (GSAtt), 2) a set play (SP), or 3) possession lost (PosL). For SNA, two different networks were constructed: 1) Possession Network (PoN) and 2) Goal Scoring Attempt Network (GSAN). The SNA tool SocNetV was used to conduct the metrics: 1) Out-Degree centrality (%OdC), 2) In-Degree centrality (%IdC) and 3) Closeness centrality (%CC). For progression, results revealed that age had a significant effect on PoL, where Men demonstrated significantly higher PoL than Men u20. Concerning the type of SP, there were significant effects of age and sex on corner kicks awarded, where Women and Men u20 awarded significantly more corner kicks than Men. The centrality metrics for PoN revealed that teams from the three World Cup tournaments used the defensive and pre-defensive sectors to recover ball possession and often lost possession at the attacking and pre-attacking sectors. The centrality metrics for GSAN proposed that the final pass was executed mainly outside the box (Zone 7) in all three tournaments but differences were found concerning the execution zone of the final attempt. This study adds to the previous research on network analysis in football and demonstrates an effective method of determining the efficacy of offensive transition during World Cup matches and the existing differences between Men, Women, and Men u20.
Key Words*:* **performance analysis, goal-scoring, effectiveness, counterattack**

Introduction

Transition periods in field sports reveal both opportunities and vulnerabilities (Turner & Sayers, 2010). From the offensive point of view, the transition phase in soccer includes ball recovery and a high degree of offensive directness for a team to exploit their opponent's imbalance. Compared to organized attacks, offensive transitions occur less frequently during soccer matches; nonetheless, they are the most effective style of play for scoring goals, especially against an imbalanced defense (Tenga et al., 2010). Similar results were found by Schulze and his colleagues (2022), reporting that offensive transitions were characterized by fewer defenders behind the ball and were also more physically demanding than organized and direct attacks.

Concerning ball recovery, older studies highlighted the significance of recovering the ball as close as possible to the opponent's goal to improve goal-scoring odds (Hughes & Churchill, 2005). On the contrary, recent studies suggest that limited ball possession recoveries (0–2%) occur in a team's offensive areas, while the primary zones of recoveries are mainly the defensive and pre-defensive zones of the pitch (Barreira, et al., 2013; Tenga et al., 2010). In this vein, Gonzalez-Rodenas and his colleagues (2016) studied offensive transitions during MLS matches and reported that although they started more frequently in the pre-defensive sector, logistic regression revealed that ball recovery in the pre-offensive sector was more effective in creating scoring opportunities compared to ball recovery at the defensive sector. Moreover, Armatas and his colleagues (2005) argued that 54.6% and 36.4% of counterattacks in which goals were scored during Champions League matches started from the middle and attacking thirds of the field, respectively. For women's soccer, Wang and Qin (2020) presented that during World Cup 2019 the 34.9% of shoot attempts and 46.2% of the goals scored was initiated in the defensive half, 65.1% of shots and 53.8% of the goals scored started from the offensive half, while 49.9% of shots and 69.2% of the goals scored started from the central zone.

Within the study of the finishing actions, the assist seems to be a crucial indicator in defining the offensive effectiveness during the attacking phase. The spatial analysis of final attempts, in general, has revealed that both assisting and shooting involve central areas, outside and inside the box, respectively for both men (Gonzalez-Rodenas et al., 2020; Smith & Bedwell, 2021) and women (Wang & Qin, 2020). Along this line, Horn, Williams, and Ensum (2002) presented that passes from Zone 14 (the zone just in front of the opponent's penalty box) to the penalty box produced a high proportion of goals during the English Premier League season of 2001-02. In the four World Cup football tournaments between 2002 and 2014, Zone 14+ was the most successful area to make assists, as proposed by Smith and Lyons (2017). Concerning shooting, Pollard and his colleagues

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(2004) analyzed 1096 shots and concluded that for each additional yard farther from the goal, the chances of scoring are reduced by 15%. Rathke (2017) examined the factors that were associated with predicting expected goals in the English Premier League and the Bundesliga from the seasons of 2012 and 2013 and found that most shots were taken inside the box, especially inside the central corridor, in both leagues.

To investigate the characteristics of offensive transitions, various tools have been used to date, including observational analysis (Gonzalez-Rodenas et al., 2016), sequential analysis and expert interviews (Sarmento, et al., 2014), T-pattern analysis (Sarmento, et al., 2011), and social network analysis (Clemente et al., 2015; Malta & Travassos, 2014). Social network analysis (SNA) is a relatively new method of investigating soccer matches but can effectively describe the team's interactive behaviors via connectivity (how connected the team is by passes) and cohesive metrics (reciprocal passes within the team), as well as the influential entities (players) within the team (relative to the entire team) (McLean et al., 2018).

From a single team competing in the Portuguese League, Malta and Travassos (2014) analyzed four matches using SNA and concluded that, during an offensive transition, the team had two preferable patterns of play. These two patterns include the supported play, with the midfielder receiving the ball more often in the defensive central zone of the field; and the direct play, with the striker receiving long balls in the first offensive central zone or on the first right-wing zone of the offensive midfield. Clemente et al. (2015) analyzed four matches of Swiss National team during World Cup 2014 and found that the prominent players to receive the ball were the midfielders, suggesting a style of play based on attacking building and not in counter-attack or quickly attacking transition. A similar analysis was performed (Clemente et al., 2016), analyzing the goals scored and conceded by a single team using SNA for team members' connectivity and zones' connectivity. The results revealed that the 18 zones can be associated with three main phases of building up the attack. The first phase of ball recovery generally occurs in the central midfield, after which players opt to exploit the wings, and finally, the ball is returned to the central region (closest to the scoring zone) to increase the possibility of scoring. During the more recent Euro 2016 matches, it was found that, on average, the network created is reflective of efficient attacking sequences that employ short and direct networks rather than long passing networks, referring to the offensive transition phase (McLean, et al., 2018). Concerning zones, the authors found that approximately 50% of the goal-scoring network originated from the offensive sector of the pitch.

Offensive transition is the most effective phase during soccer matches for scoring goals when compared to organized attacks. There exists a lack of studies on the World Cup, especially on Women's and Youth's teams. This study aimed to use SNA to analyze offensive transitions at the World Cup of Men 2018, Women 2019, and Men u20 2019 to assess the effects of age and sex.

Material & methods

Sample

The sample consisted of 48 knock-out matches from the three recent World Cups of Men 2018 (n=16), Women 2019 (n=16), and u20 Men 2019 (n=16). Following the qualifying stage, only the top 16 teams took part in the final stage, reducing the impact of the competitive level (Praça et al., 2019). Extra time was also excluded from the sample to ensure homogeneity of the matches (Tuo et al., 2019).

Procedure

Before data collection, ethical approval was sought from the Bioethics Committee of the School of Physical Education and Sport Science at the National and Kapodistrian University of Athens. The selected matches were downloaded from the Wyscout platform (Wyscout Spa, Italy) and were coded using Sportscode software (Hudl, Lincoln, NE, USA). During the selected matches, 1,016 attacking sequences were classified as offensive transitions based on the following definition: the possession starts by winning the ball in play; the first or second player in action tries to penetrate using penetrative passes or dribbles; the progression towards the opponent's goal has a high percentage of penetrative passes and a short duration (evaluated qualitatively). This kind of possession tries to prevent the opponent from having the opportunity to minimize surprise, reorganize their system, and become prepared defensively (Lago-Ballesteros et al., 2012; Tenga et al., 2010).

The progression of these offensive transitions resulted in three situations: 1) *Goal scoring attempt (GSAtt)*, in which the attacking team completed the attacking sequence with a goal-scoring attempt; 2) *Set play (SP)*, during which the attacking team completed the attacking sequence by being awarded a set play (corner kick, free kick, or throw in). Although penalty kicks were registered, due to the insufficient number to conduct statistical analysis, were excluded from the final sample (Men = 1, Women = 2 and Men u20 = 1). Finally, 3) *Possession lost (PosL)*, in which the attacking team lost possession of the ball.

Social network analysis

The social network analysis (SNA) involved reviewing offensive transitions and constructing a social network matrix and diagram, comprising the nodes (pitch zones) in the network and the edges (passes) between them. Two different networks were developed: 1) *Possession network (PoN)*, including the 12 zones (Figure 1) of ball recovery and possession lost as proposed by Sarmento et al., (2020); and 2) *Goal Scoring Attempt Network (GSAN)*, including the 8 zones (Figure 1) of the final pass and final attempt based on Rathke (2017). The SNA tool SocNetV (Kalamaras, 2014) was used to conduct the metrics:

1) *Out-Degree centrality (%OdC)*: Out-degree centrality denotes the zone that originates more passes

compared to other zones. Therefore, the greater values suggest that the zone is the priority zone for outbound passes and the smallest values suggest that the zone is not one of the zones that originate passes (Clemente et al., 2016).

2) *In-Degree centrality (%IdC)*: In-degree centrality represents the prominence level of each zone as a target to which players pass the ball. Thus, the greater values suggest that the zone is the priority zone to pass the ball and the smallest values suggest that the zone is not one of the targets to which players pass the ball (Clemente et al., 2016).
3) *Closeness centrality (CC)*: Closeness centrality is a more complex index than both the above-mentioned degree centrality metrics. This index focuses on how close each node is to all other nodes in the network. It is calculated as the average of the shortest path length from the node to every other node in the network. The variance attains its minimum value of 0 in a network with equal zones' indices (equal distances between all zones). The highest values translate to a star graph situation, where one zone chooses all the other zones, and the other zones interact only with this singular star zone (Wasserman & Faust, 1994).

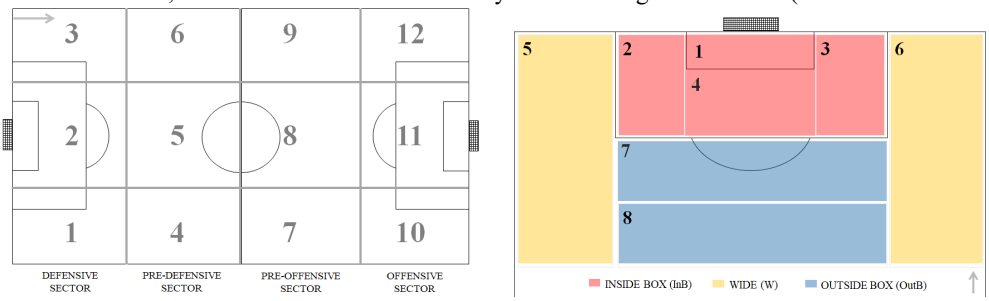

Figure 1. *Pitch zones and divisions: 12 zones and 4 sectors (left), 8 zones and 3 sectors (right).*

Statistical analysis

Data are reported as mean ± SD, and the level of significance was set at .05. Independent-sample t-tests were used to assess the effects of age (Men vs. Men u20) and sex (Men vs. Women) on the type of progression after offensive transition and the type of set plays awarded. Additionally, effect size (ES) was used to examine the magnitude of the mean differences between the two groups compared. ES values were classified as small (0.01), medium (0.06), and large (0.14) (Levine & Hullett, 2002). For the tournament pitch zone analysis, a one-way ANOVA was conducted to determine differences between the centrality metrics for the four pitch zones after the confirmation of normality and homogeneity assumptions. Post-hoc comparisons were performed when the probability between groups was $p < .05$, using the least significant difference (LSD) method, with no adjustments for multiple comparisons. Partial eta squared (η_P^2) was calculated as an indicator of effect size with categories as described above.

Results

Figure 2 presents the results for the types of progression at the three World Cups after an offensive transition. The descriptive statistics indicated that Men produced higher goal-scoring attempts (5.38 ± 2.45) when compared with Women (4.94 ± 2.59) and Men u20 (4.81 ± 2.64). Women won a higher proportion of set plays (4.75 ± 2.27) when compared with Men (4.13 ± 1.93), while Men u20 (3.94 ± 2.26) won a lower proportion when compared with Men. Concerning the loss of possession, Women reported a higher proportion of possession loss (13.50 ± 3.27) when compared with both Men (12.88 ± 3.10), and Men compared with Men u20 (9.25 ± 3.24). The statistical analysis found that there was a significant effect of age on possession loss, where Men demonstrated significantly higher possession loss than Men u20 ($t(30) = 3.23$, $p = .003$; ES = 1.14). On the contrary, there were no other significant effects for sex and age regarding goal-scoring attempts, set plays, or possession loss.

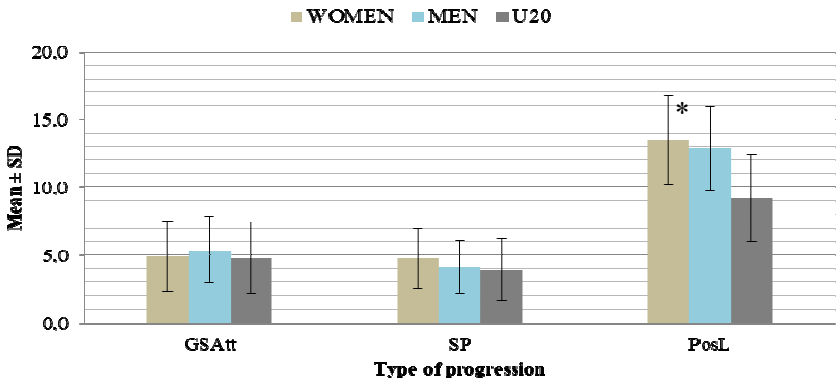

Figure 2. *Type of progression after offensive transition during World Cup matches.*

The results concerning the type of set play after offensive transition are presented in Figure 3. The descriptive statistics indicated that Women (1.58 ± 0.67) and Men u20 (1.83 ± 0.75) awarded a higher proportion of corner kicks when compared to Men (1.11 ± 0.33). In addition, Men were awarded a higher proportion of free kicks (2.00 ± 0.78) when compared to both Women (1.64 ± 0.67) and Men u20 (1.85 ± 1.07). In general, throw-ins were the most frequent set play during the examined World Cups. Moreover, Men were awarded a higher proportion of throw-ins (2.55 ± 1.13) when compared to both Women (2.53 ± 1.30) and Men u20 (1.86 ± 1.10).

The statistical analysis revealed that there were statistically significant effects of age and sex on the number of corner kicks awarded. More precisely, Women were awarded significantly more corner kicks than Men ($t(17) = 2.12$, $p = .049$; ES = 0.90) and Men u20 were awarded significantly more corner kicks than Men ($t(13) = 2.56$, $p = .024$; ES = 1.24).

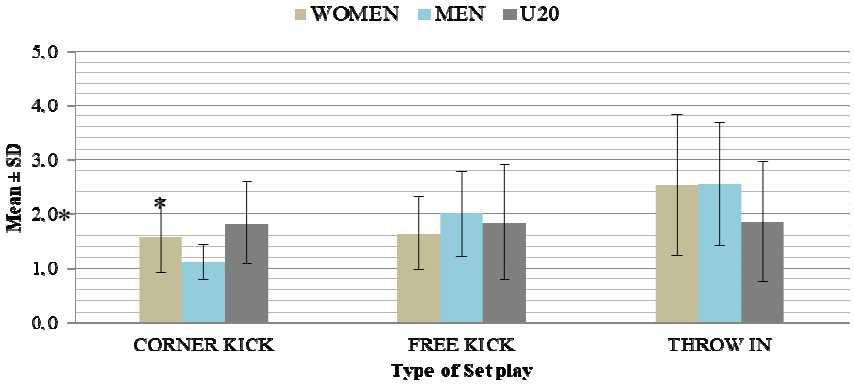

Figure 3. *Type of set play awarded after offensive transition during World Cup matches.*

Table 1 and Figure 4 present the degree centrality metrics of the "Possession Network" for the three World Cups studied. Regarding the pitch zones involved in the "Possession Network" for Men, there were significant ($p < .05$) main effects for pitch sectors for %OdC (F = 7.290; $p < .01$; η_P^2 0.732), and %IdC (F = 18.258; $p < .001$; η_P^2 0.873) with large effect size, but no significant effects for %CC (F = .374; $p = .774$). Follow-up posthoc comparisons revealed that the Defensive sector had significantly higher values compared to the Pre-attacking and Attacking sectors for %OdC (pAtt $p < .05$; Att $p < .001$). Moreover, Pre-defensive sector had significantly higher values compared to the Pre-attacking and Attacking sectors for %OdC (pAtt $p < .05$; Att $p < .001$). For the %IdC, the posthoc comparisons revealed that the Attacking sector had significantly higher values compared to the Defensive and Pre-defensive sectors (Def $p < .0001$; pDef $p < .001$). In addition, the Pre-attacking sector had significantly higher values when compared to the Pre-defensive and Defensive sectors for %IdC (pDef $p < .001$; Def $p < .001$).

Table 1. *Degree centrality metrics for possession network (mean ± SD).*

	%OdC			%IdC			%CC		
	MEN	**WOM**	**u20**	**MEN**	**WOM**	**u20**	**MEN**	**WOM**	**u20**
Def	14.96±7.23	15.04±8.51	16.75±8.51	0.00±0.00	0.00±0.00	0.00±0.00	5.73±4.71	5.21±3.40	7.01±3.54
pDef	13.39±5.33	13.40±1.41	11.76±1.55	3.28±1.20	2.47±1.61	3.14±1.03	11.89±9.17	7.34±2.99	9.87±2.64
pAtt	4.86±0.99	4.66±1.98	4.83±0.48	12.86±2.62	13.03±1.76	12.54±4.00	9.19±3.99	11.85±5.24	16.46±10.51
Att	0.13±0.23	0.23±0.40	0.00±0.00	17.19±5.84	17.84±5.83	17.66±4.27	6.53±11.32	8.93±15.46	0.00±0.00

MEN: Men's World Cup 2018, WOM: Women's World Cup 2019, u20: Men's u20 World Cup 2019
Def: Defensive sector, pDef: Pre-defensive sector, pAtt: Pre-attacking sector, Att: Attacking sector

For the pitch zones involved in the "Possession Network" for Women, there were significant ($p < .05$) effects for pitch sectors for %OdC (F = 7.629; $p < .01$; η_P^2 0.741), %IdC (F = 21.776; $p < .001$; η_P^2 0.891) with large effect size, but no significant effects for %CC (F = .327; $p = .806$). Follow-up posthoc comparisons revealed that the Defensive sector had significantly higher values compared to the Pre-attacking and Attacking sectors for %OdC (pAtt $p < .05$; Att $p < .001$). Moreover, the Pre-defensive sector had significantly higher values compared with the Pre-attacking and Attacking sectors for %OdC (pAtt $p < .05$; Att $p < .001$). For the %IdC, the posthoc comparisons revealed that Attacking sector had significantly higher values when compared with the Defensive and Pre-defensive sectors (Def $p < .0001$; pDef $p < .0001$). The Pre-attacking sector had significantly higher values when compared with the Pre-Defensive and Defensive sectors for %IdC (pDef $p < .01$; Def $p < .001$).

For the pitch zones involved in the "Possession Network" for u20 Men, there were significant ($p < .05$) main effects for pitch sectors for %OdC (F = 11.847; $p < .001$; η_P^2 0.816), %IdC (F = 22.779; $p < .001$; η_P^2 0.895) and %CC (F = 4.291; $p < .05$), with large effect sizes for all centrality metrics. Follow up post-hoc comparisons revealed that the Defensive sector had significantly higher values when compared with the Pre-

attacking and Attacking sectors for %OdC (pAtt $p < .001$; Att $p < .001$). Moreover, the Pre-defensive sector had significantly higher values when compared with the Attacking sector for %OdC (Att $p < .001$). For the %IdC, the posthoc comparisons revealed that the Attacking sector had significantly higher values when compared with the Defensive and Pre-defensive sectors (Def $p < .0001$; pDef $p < .0001$). The Pre-attacking sector had significantly higher values when compared with the Pre-defensive and Defensive sectors for %IdC (pDef $p < .001$; Def $p < .001$). For %CC, the posthoc comparisons revealed that the Pre-Attacking sector had significantly higher values when compared with the Attacking sector (Att $p < .001$).

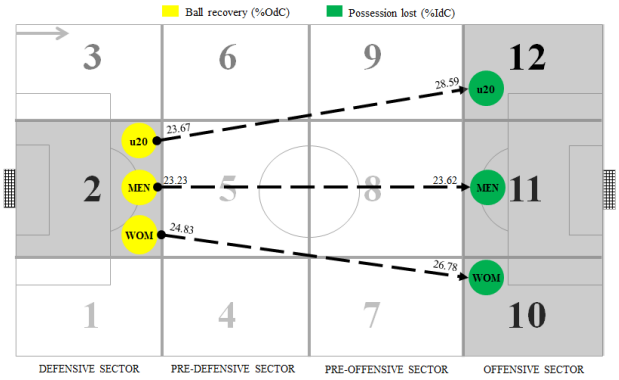

Figure 4. *Possession network display results during offensive transition.*

Table 2 and Figure 5 present the degree centrality metrics of the "Goal Scoring Attempt Network" for the three World Cups studied. For the pitch zones involved in the "Goal Scoring Attempt Network" for Men, there were significant ($p < .05$) main effects for pitch sectors for %OdC ($F = 10.724$; $p < .05$; η_P^2 0.811), %CC ($F = 8.390$; $p < .05$; η_P^2 0.770) with large effect size, but no significant effects for %IdC ($F = 1.488$; $p = .311$). Follow-up posthoc comparisons revealed that the Outside Box Zone had significantly higher values when compared with Inside Box and Wide Zones for %OdC (InB $p < .01$; W $p < .05$). For the %CC, the posthoc comparisons revealed that the Outside Box Zone had significantly higher values when compared with the Inside Box Zone (OutB $p < .01$).

Table 2. *Degree centrality metrics for goal scoring attempt network (mean ± SD).*

	%OdC			%IdC			%CC		
	MEN	**WOM**	**u20**	**MEN**	**WOM**	**u20**	**MEN**	**WOM**	**u20**
InB	4.76±2.57	2.96±2.92	2.09±0.80	16.37±10.44	18.42±14.41	11.46±7.38	7.28±2.58	12.69±19.70	18.60±14.23
W	8.93±2.52	4.61±2.79	8.33±1.97	0.00±0.00	0.66±0.93	0.70±0.98	11.96±2.67	13.70±10.39	6.22±3.03
OutB	31.55±14.31	39.47±13.02	37.50±1.97	17.26±19.36	12.50±15.81	26.39±23.57	23.49±8.80	10.93±2.03	6.58±0.30

MEN: Men's World Cup 2018, WOM: Women's World Cup 2019, u20: Men's u20 World Cup 2019
InB: Inside box, W: wide, OutB: Outside box

For the pitch zones involved in the "Goal Scoring Attempt Network" for Women, there were significant ($p < .05$) main effects for pitch zones for %OdC ($F = 23.934$; $p < .001$; η_P^2 0.905) with large effect size, but no significant effects for %IdC ($F = 1.203$; $p = .375$) and %CC ($F = .016$; $p = .985$). Follow-up posthoc comparisons revealed that the Outside Box Zone had significantly higher values when compared with the Inside Box and Wide Zones for %OdC (InB $p < .01$; W $p < .01$).

For the pitch zones involved in the "Goal Scoring Attempt Network" for u20 Men, there were significant ($p < .05$) main effects for pitch zones for %OdC ($F = 44.766$; $p < .001$; η_P^2 0.994) with large effect size, but no significant effects for %IdC ($F = 2.322$; $p = .194$) and %CC ($F = 1.207$; $p = .374$). Follow-up posthoc comparisons revealed that the Outside Box Zone had significantly higher values when compared with the Inside box and Wide zones for %OdC (InB $p < .001$; W $p < .001$). Moreover, the Wide Zones presented higher values when compared with the Inside Box Zone for %OdC (InB $p < .01$).

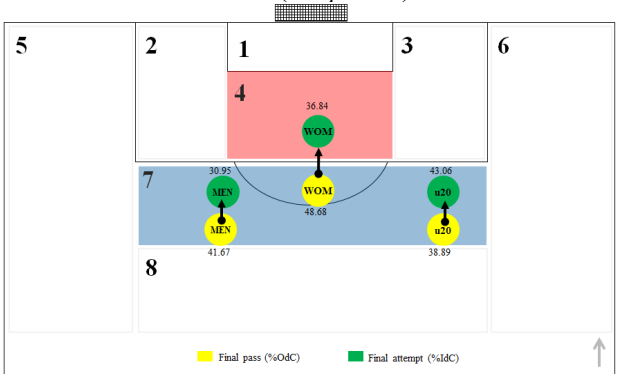

Figure 4. *Goal scoring attempt network display results during an offensive transition.*

Discussion

The study aimed to identify the main differences in the social interactions between Senior Men, Women, and Men u20 during World Cup matches using SNA. The presented data provide a better understanding of how national teams behave during offensive transitions and indicate the zones used by players to attack and finish attempts. In addition, the study investigated the type of progression in offensive transitions and the differences between sex and age. Whilst SNA has recently emerged as a useful tool for analyzing team passing across an entire match, it has received little attention as a tool for analyzing offensive transitions (McLean et al., 2017).

The results of the investigation on progression type during the transition phase indicated that Men demonstrated a significantly higher rate of possession loss than Men u20, yet no other effects were found between gender and age regarding goal-scoring attempts, set plays, or possession loss. Although not significant, descriptive statistics revealed that Women lost possession of the ball and won set plays more frequently when compared to Men, while Men achieved more frequent goal scoring attempts when compared to Women and Men u20. In this sense, Casal et al. (2020), who evaluated the gender differences in technical and tactical behavior in the Spanish 1st division, observed that Women had a greater number of "Set plays attacks" and a smaller number of "Lost balls" and "Lost balls in opposite half" when compared to Men.

Regarding ball possession, our results are in agreement with previous studies that concluded that women lost ball possession more frequently (Casal et al., 2020; Hjelm, 2011). Moreover, in previous studies it was found that women used a more vertical style of play which may encourage more risks and therefore, more unsuccessful actions, leading to a greater interchange of possession between teams (Mitrotasios et al., 2022). It is noteworthy to mention that the above tactical differences between genders could also be due to external and natural physical and physiological factors (Pedersen et al., 2019).

In the case of the type of set play after offensive transition, the throw-ins were the most frequent set play during the examined three World Cups. This agrees with a study from the previous men's World Cup in both 2006 and 2014. The authors investigated the possibility that interruptions were used as a tactical means and concluded that the most frequent reason for stoppages was throw-ins, which occurred almost every two minutes on average (Augste & Cordes, 2016). As in some previous studies, we have not detected differences in free kicks and throw-ins by gender or by age (Casal et al., 2020).

Concerning the corner kick, which is the most effective set play, it was found that Women and Men u20 were awarded significantly more corner kicks than Men after an offensive transition. However, due to the lack of similar studies, this couldn't be compared to other results. On the contrary, Sousa and Garganta (2001) investigated Men's World Cup matches and concluded that teams who used positional attack as a method of offensive game won more set plays when compared to the use of offensive transition. Overall, winning a set play during an attacking sequence has previously been used as a key performance indicator for offensive effectiveness such as final third entries, box entries, and more (Casal et al., 2020; Hjelm, 2011). Set plays that were awarded as a result of offensive transition could support previous studies suggesting that offensive transitions are the most effective style of play, especially against an imbalanced defense (Tenga et al., 2010).

During offensive transition, the "Possession Network" presented similar start and end zones for the three World Cups. More precisely, the most frequently used starting sectors of offensive transition was the defensive and pre-defensive sectors. Previous studies concluded that the primary zones of recovery are the defensive and pre-defensive zone of the pitch (Barreira et al., 2013; Tenga et al., 2010). In a more recent study, Gonzalez-Rodenas et al. (2016) studied offensive transitions during MLS matches and reported that although they started more frequently in the pre-defensive sector, logistic regression revealed that ball recovery in the pre-offensive sector was more effective in creating scoring opportunities when compared to ball recovery at the defensive sector. Concerning the transitions' end sector, the high use of the offensive sector could lead to the assumption that offensive transition is an effective style of play regardless of gender and age. Likewise, previous studies suggest that goals are mainly scored with shots made from the final third of the pitch (Wright et al., 2011), and increasing control of the final third is associated with a higher winning probability (Rein et al., 2017).

Although Men, Women, and Men u20 executed the final pass mainly outside the box and specifically inside Zone 7, differences were found in the "Goal Scoring Attempt Network" concerning the execution zone of the final attempt. Compared to Women, whose %IdC metric presented a higher proportion of the finishing action occurring inside the box, Men and u20 Men executed the finishing action outside the box. These results are unexpected, as both assisting and shooting involve central areas outside and inside the box, respectively (Gonzalez-Rodenas et al., 2020; Smith & Bedwell, 2021; Wang & Qin, 2020).

Previous studies have also highlighted the importance of Zone 14, in accordance with Zone 7 of the present study, during the English Premier (Horn, Williams & Ensum, 2002) and the World Cups (Smith & Lyons, 2017). However, no data were found from Youth's and Women's tournaments. The gender differences observed could be attributed to the still-evolving technical and tactical development of women's soccer (Mitrotasios et al., 2022) and due to external and natural physical and physiological factors (Pedersen et al., 2019).

Conclusions

Our study supports the standpoint that Social Network Analysis can effectively describe the team's interactive behaviors via connectivity and cohesive metrics. The findings indicate the effectiveness of offensive transition during World Cup matches and propose that age and gender influence transition. These results have important practical implications for soccer coaches, fitness coaches and analysts, due to the observed differences between men and women and between senior men and youth. Thus, the level of coaching (senior, youth etc) will provide to the coaches the basis in order to design game-based training and match preparation strategy from both offensive and defensive point of view. It is clear that soccer differs from level to level and coaches must adapt to the characteristics and demands of each one. Moreover, Social Network Analysis could be used as a match analysis tool in soccer where interactions between team members and zones are necessary and provide valuable information for own and opponent teams. Future studies could compare the spatial networks between organized attack and offensive transition and use match samples from domestic leagues.

Conflicts of interest

The authors declare that they have no conflict of interest.

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