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Trend Analysis of Substitution Characteristics in The Final Stage of European Cup under the Background of New Substitution Rules

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Abstract: World soccer experienced several weeks of disruption in 2020 due to the New Crown epidemic, in response to which FIFA revised the cap of three substitutions in regular time to five and announced its permanent retention in 2022. We watched all 51 matches of each European Cup and collected information on the number, time, position, and reason of substitutions used by each team. The purpose of this study is to derive the trend of coaches' use of substitutions and teams' tactical changes in the final stage of the European Cup in the context of the new substitution regulation. Results: 1. The percentage of games using three or more substitutions in Euro 2020 was 92.16%, which was significant ($p<0.05$) when comparing the number of substitutions at right back, right wingback, center back, in the first half of overtime and in leading situations in Euro 2016. 2. The coaches' tactical substitution time tended to be in the middle of the second half when leading. A tendency to keep the remaining substitutions when tied and use them over time was noted. When falling behind, the substitution time tends to be toward the end of the second half to reduce the number of defensive players of their own team through staggered substitution and change the status quo of the team. 3. Even if a player is injured or sent off, the ample number of substitutions allows the coaches to make opposite substitutions in a short period to prevent the opponent from catching obvious loopholes.

Keywords: Soccer; European Cup; Substitution; New Rules for Substitution; Substitution Characteristics.

1. Introduction

Football (referred to as Soccer in the United States) substitution refers to the act of a coach using a player from the bench to replace a player on the field. Substitutions can be divided into tactical substitutions (aimed at improving the team's performance) or non-tactical substitutions (forced adjustments caused by events such as injuries) (Lorenzo-Martínez et al, 2022). The successful use of substitutions reflects the coach's ability to read the game and outplay the opponent team (Geyer, 2009; De Backer et al, 2018). Previous research shows that giving clear instructions to the substitute players is related to better substitution outcomes (Gomez et al, 2016). Correct substitutions can have a positive impact on the outcome of a match, while wrong substitutions can set the stage for a team's defeat. Previous studies have concluded that coaches generally recognize the role of substitution (Del Corral et al, 2008) and that 60% of substitutions during a match have a positive impact on the overall performance of the team (Reilly et al, 2003). In addition, it has been suggested that substitutions in football not only help reduce the risk of injuries but can also increase fans' and sponsors' entertainment (Carling et al, 2010).

Risk management and early preemptive interventions should be considered in football (Fuller et al, 2012), and a rule for an additional substitution in the extra time phase was adopted by IFAB and FIFA in 2016. A concussion substitution rule was also introduced in the Premier League 2020-2021 season. Due to the impact of COVID-19, football matches around the world experienced several weeks of interruptions, resulting in a busier schedule.

Furthermore, studies have shown that teams in most top leagues experienced reduced fitness when facing league suspensions (Thron et al, 2022) and players were more prone to fatigue and injury after the accumulation of multiple match days. On May 8, 2020, FIFA announced that each team could allow a substitution quota of five temporarily (FIFA, 2020). In June 2022, FIFA announced that this rule was retained permanently, and the number of substitutions per team per match was increased from three to five.

The length of the recovery period is strongly linked to the player's muscle damage (Hägglund et al, 2013), and frequent substitutions can reduce fatigue during matches and help players stay healthy (Ribeiro et al, 2020; Carling & Christopher, 2012). The new rules of substitution aim to reduce the risk of players getting injured, as well as to expand coaches' options to interfere in the match. Since the promulgation of the new FIFA substitution regulation, trend studies of substitution characteristics in international football tournaments have been relatively scarce. Therefore, this study compares the use of substitutions by coaches of each national team in the European Championships of 2016 and 2020, in the context of the new substitution regulations.

2. Methods

The study comprised the analyses of all substitutions taking place in the 51 matches of each European Cup. The 2016 tournament took place in France, and it was under the old substitution rules of a maximum of three substitutions per

match per team. The 2020 tournament actually took place in 2021 because of the Covid-19 pandemic. It took place in multiple European countries, and it was under the new substitution rules of a maximum of five substitutions per match per team. In addition to the regular substitutions, the 2020 tournament also allowed for one extra substitution per team if the match would go to extra time. Although the tournament only happened in 2021, it is referred to as the 2020 Euro Cup throughout the manuscript.

The first author watched all matches and filled out a spreadsheet containing the following information about the substitutions: (a) number of substitutions per team; (b) time when the substitution happened (divided into 11 groups: 1-15 min, 16-30 min, 31-45 min including injury time, halftime, 46-60 min, 61-75 min, 75-90 min including injury time, break between regular time and extra time, first half of extra time, halftime of the extra time, latter half of extra time). Information was also obtained on the position of the players who were substituted and their replacement players, divided into 16 categories (center forward, left wing forward, right wing forward, attacking midfielder, left midfielder, right midfielder, center midfielder, left center midfielder, right center midfielder, left back, right back, left wing back, right wing back, center back, goalkeeper). We also divided the substitutions into tactical and non-tactical (caused by injuries or red cards). The definitions of all indicators were derived from the official UEFA webpage (www.uefa.com).

3. Data Analysis

Characteristic trend analysis of substitution time, position and situation

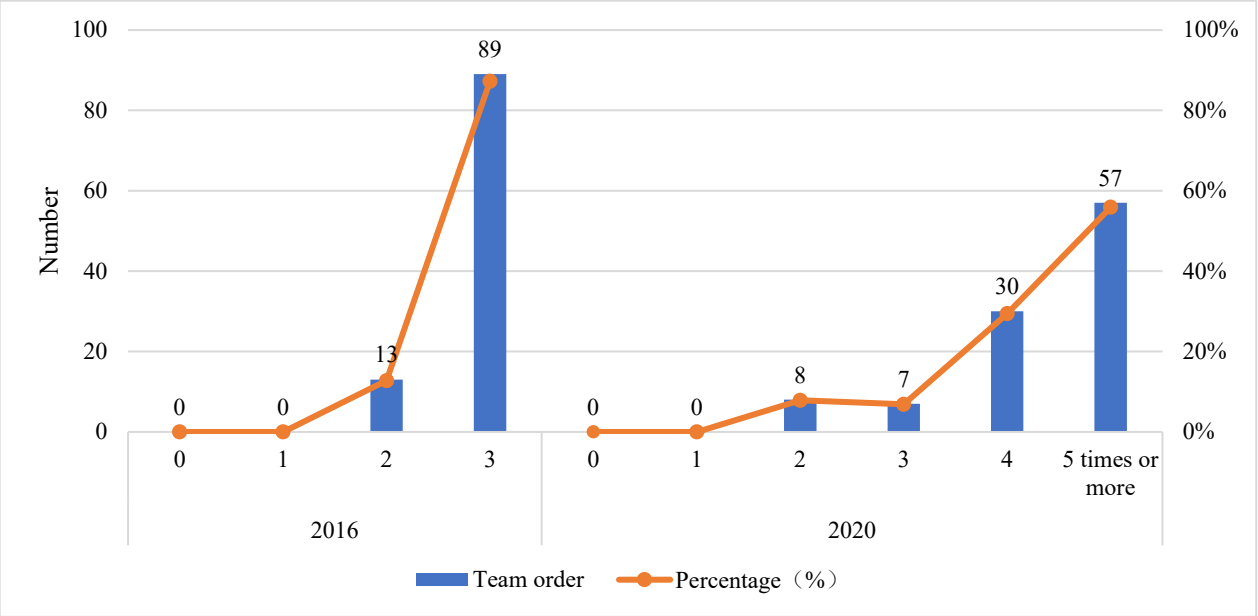

Figure 1. Use of substitution places in Euro 2016 and Euro 2020

Table 1. Cardinality analysis of the timing of Euro 2016 and Euro 2020 substitutions.

Substitution time		2016	2020	X^2	P
First half	Forepart	0	1	0.646	0.421
	Middle piece	2	6	0.686	0.407
	Terminal	1	6	1.843	0.175
Half time		23	30	0.417	0.519
Latter half	Forepart	27	41	0.007	0.932
	Middle piece	101	161	0.077	0.782
	Terminal	130	170	3.552	0.059
Final rest		0	4	2.595	0.107
Extra time	First half	3	17	5.058	0.025*
	Half time	0	5	3.249	0.071
	Latter half	6	13	0.478	0.489
	Total	293	454		

In the 2016 European Cup, a total of 293 substitutions were used in 51 matches. If all teams had used all substitutions possible, the maximum number of substitutions that could be observed would be 306. Therefore, the utilization rate was 95.8%. In the 2020 European Cup, 454 substitutions were used in 51 matches, with a utilization rate of 89.0%. The average number of substitutions per match increased from 5.74 in the 2016 Euro Cup to 8.90 in the 2020 Euro Cup. The average number of substitutions per team increased from 2.87 in 2016 to 4.45 in 2020. Figure 1 describes the substitutions used in each tournament. In 2016, almost 90% of the teams used the three substitutions possible, whereas in 2020, just

over half the teams used the maximum number of substitutions possible. In both Euro Cups, none of the teams used zero or one substitution per match.

Table 1 shows that the substitutions of coaches in both Euros were generally concentrated in the second half, especially in the middle and end of the second half (78.84% versus 72.9%), indicating that players maintain a high level of fitness in the first half and that the load of players gradually increases and high-intensity running significantly decreases in the final stages of high-level soccer matches. A significant difference ($p<0.05$) in the number of substitutions in the first half of overtime in Euro 2020 compared to Euro 2016 by chi-square test demonstrates that players' performance decreases in overtime and that coaches can direct their teams more comfortably with more substitutions, except for the high-frequency substitutions in the second half, where more places are widely distributed in other time nodes, and personnel adjustments can be made at any time even in overtime.

Table 2. Chi-square analysis of substitution positions in the European Cup in 2016 and 2020

Location	2016	2020	X^2	P
Center forward	70	93	1.211	0.271
Left wing forward	12	25	0.753	0.385
Right wing forward	12	20	0.042	0.838
Attacking middle fielder	27	28	2.425	0.119
Left midfield	47	56	2.058	0.151
Right midfield	43	56	0.849	0.357
Center midfield fielder	12	11	1.67	0.196
Left center midfield	6	9	0.004	0.950
Right center midfield	6	13	0.478	0.489
Center defense midfield	34	40	1.557	0.212
Left back	4	17	3.69	0.055
Right back	2	16	6.115	0.013*
Left wing back	2	12	3.722	0.054
Right wing back	4	20	5.293	0.021*
Centre back	12	37	4.775	0.029
Goalkeeper	0	1	0.646	0.421
Total	293	454		

The position with the most substitutions in both Euro 2016 and Euro 2020 was midfield (59.71% vs. 46.9%), and the percentage of substitutions for forwards remained higher than those for other specific positions (23.89% vs. 20.49%). After the chi-square test, a significant difference ($p<0.05$) was found in the number of substitutions at the right back, right wingback, and center back in Euro 2020 compared to 2016, while the proportion of opposite substitutions exceeded 60% in both tournaments, indicating that opposite substitutions remained the main method of coaches' substitutions in Euro 2020, and the defenders on the right side and in the middle of the field of each team received an overall increase in impact. The coaches adjust the personnel at the back to stabilize the team's formation and keep their own goals intact.

Table 3. Cardinal analysis of the tactical substitution use situation in Euro 2016 and Euro 2020.

Situation	2016	2020	X^2	P
Lead	81	151	4.981	0.026*
Tie	105	102	12.216	0.000*
Fall behind	92	151	1.317	0.251
Total	278	404		

Among tactical substitutions in leading situations, Euro 2016 has the highest number of tied situations, followed by falling behind and leading situations, indicating that in Euro 2016 coaches used substitutions more often in tied or trailing situations, trying to turn around trailing situations by changing tactical plays or enhancing team impact through new players on the field. Euro 2020 had the highest number of leading situations, followed by fall behind and tied situations. The cardinal analysis showed a significant difference in the number of substitutions between leading and tied situations in Euro 2020 compared to 2016 ($p<0.05$), indicating that coaches in Euro 2020 tended to make more personnel adjustments in leading situations to rest important players, and even when the team was tied or trailing, sufficient substitutions were still available to change the result of the match.

Characteristic trend analysis of tactical substitution in different situations

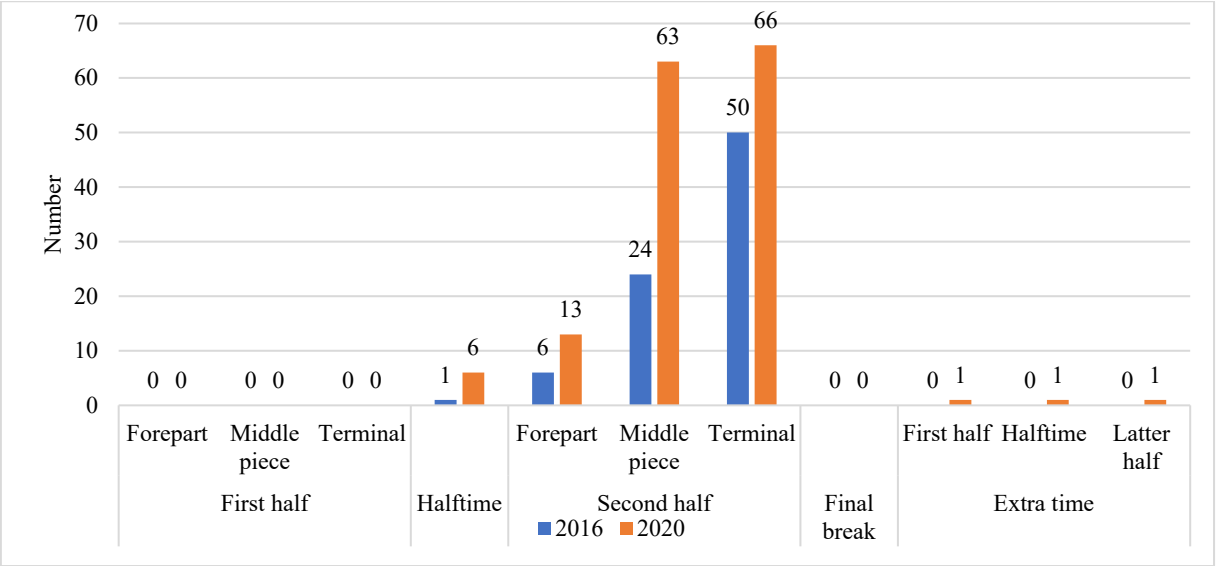

Figure 2. Time distribution of tactical substitutions in leading situations in Euro 2016 and Euro 2020

In the leading situation, Euro 2016 used 81 tactical substitutions and Euro 2020 used 151 tactical substitutions. In Euro 2016, coaches made the most tactical substitutions at the end of the second half (61.73%), while in Euro 2020, coaches tended to make more tactical substitutions in the middle of the second half (41.72%), reflecting the substitution of players with more running distance or midfield positions. This indicates that Euro 2020 coaches replaced players with more physical strength earlier when the team was ahead to cope with the opponent's counterattack in the final stage, which also saved the physical strength of the team's core positions or older players to ensure smooth advancement and avoided the possibility of prolonged confrontation with players, thus increasing the possibility of injury and illness. This strategy allows players to test new tactics of the team by replacing them and preparing for subsequent key games.

Table 4. Cardinal Analysis of Tactical Substitution Times in tie Situations at Euro 2016 and Euro 2020.

Time		2016	2020	X^2	P
First half	Forepart	0	0	--	--
	Middle piece	0	0	--	--
	Terminal	0	0	--	--
Half time		5	3	0.462	0.497
Latter half	Forepart	9	6	0.557	0.456
	Middle piece	36	45	2.1	0.147
	Terminal	49	25	11.058	0.001*
Final rest		0	4	4.199	0.040*
Extra time	First half	2	11	6.931	0.008*
	Half time	0	1	1.034	0.309
	Latter half	4	7	0.959	0.328
	Total	105	102		

In a tie situation, 105 tactical substitutions were used in Euro 2016, and 102 tactical substitutions were used in Euro 2020. By cardinality analysis, significant differences were identified in the number of substitutions at the end of the second half, at the final break and in the first half of overtime in 2020 compared to 2016 ($p<0.05$). After the enactment of the new substitution regulations, Euro 2020 coaches made fewer tactical substitutions at the end of the second half and significantly more substitutions in the first half of overtime, indicating that coaches in this Euro tournament were generally able to accept the status quo of their teams' draws and that coaches would use the remaining places in their hands in the initial phase of overtime.

In the fall-behind situation, Euro 2016 coaches used 92 tactical substitutions and Euro 2020 coaches used 151 tactical substitutions. Through cardinal analysis, a significant difference in the number of tactical substitutions at right wingback was noted in 2020 compared with 2016 ($P<0.05$), indicating that because the European Cup is a group stage plus single-elimination tournament system, coaches will use as many substitutions as possible in falling behind situations, which are mainly characterized by bold adjustments to the forward line personnel, a reduced number of defensive players such as center backs and wing positions, and active mismatch substitutions and formations. A change in formation has also become a corresponding means to break the game. Compared with observations under the new rules, coaches tended to change their players at the end of the second half when they fell behind in Euro 2020. The reason may be that the coaches intended to impact the opponent's physical decline and slack attention in the last stage of the game, or the team fells behind near the end of the game, and the coaches

adjusted quickly to change the status quo by making more mismatches.

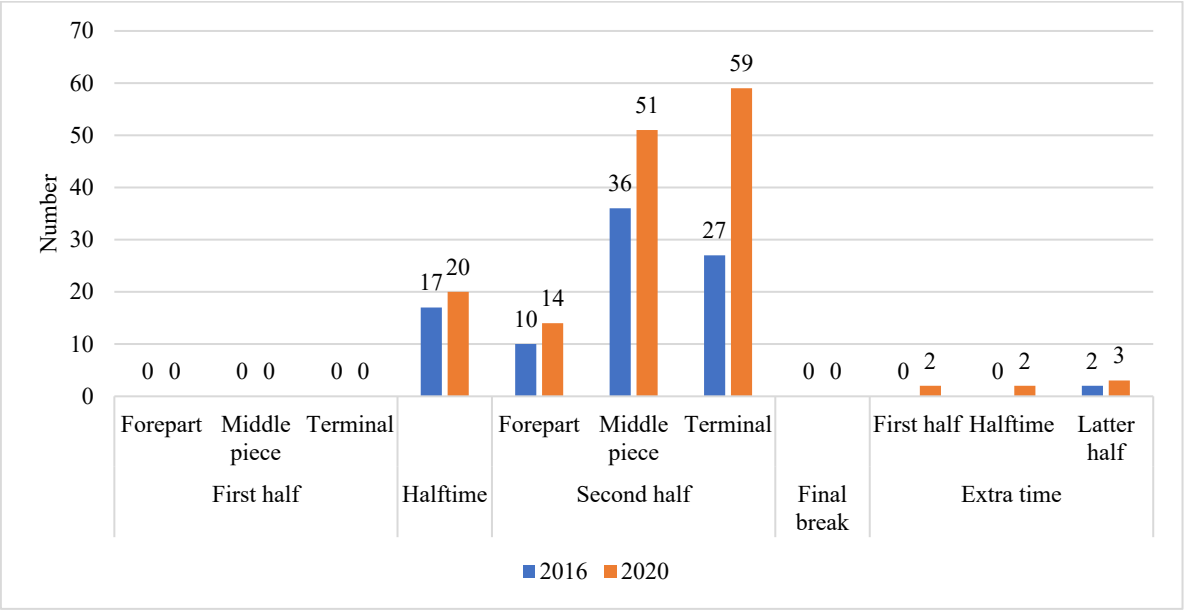

Figure 3. Time distribution of tactical substitutions in fall-behind situations in Euro 2016 and Euro 2020

Table 5. Cardinal analysis of tactical substitution positions in fall-behind situations in Euro 2016 and Euro 2020.

Location	2016	2020	X^2	P
Center forward	21	23	2.224	0.136
Left wing forward	4	4	0.518	0.472
Right wing forward	6	5	1.363	0.243
Attacking middle fielder	9	11	0.472	0.492
Left midfield	9	21	0.899	0.343
Right midfield	8	18	0.622	0.430
Center midfield fielder	3	3	0.385	0.535
Left center midfield	2	4	0.054	0.817
Right center midfield	4	7	0.011	0.917
Center defense midfield	14	20	0.185	0.667
Left back	2	4	0.054	0.817
Right back	1	4	0.692	0.405
Left wing back	1	4	0.692	0.405
Right wing back	0	8	5.04	0.025*
Centre back	8	15	0.102	0.749
Goalkeeper	0	0	--	--
Total	92	151		

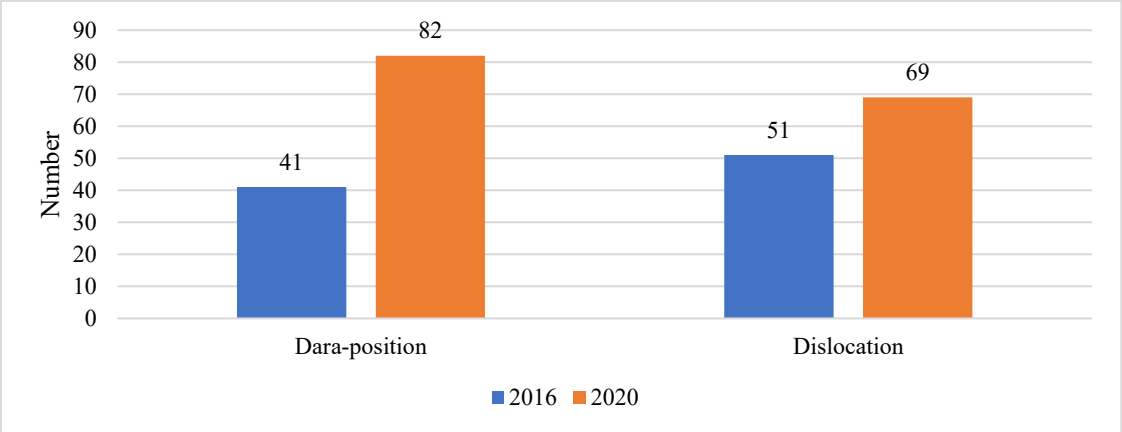

Figure 4. Pairing and mismatching of tactical substitutions in fall-behind situations in Euro 2016 and Euro 2020

Trend analysis of the characteristics of nontactical substitution

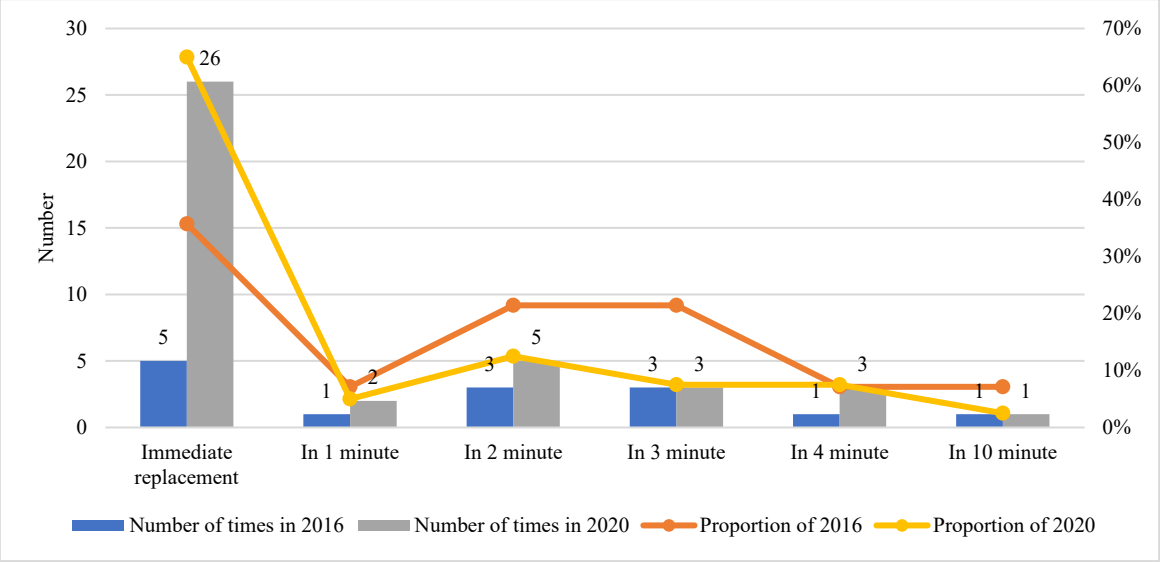

Figure 5. Intervals between nontactical substitutions after player injuries in Euro 2016 and Euro 2020.

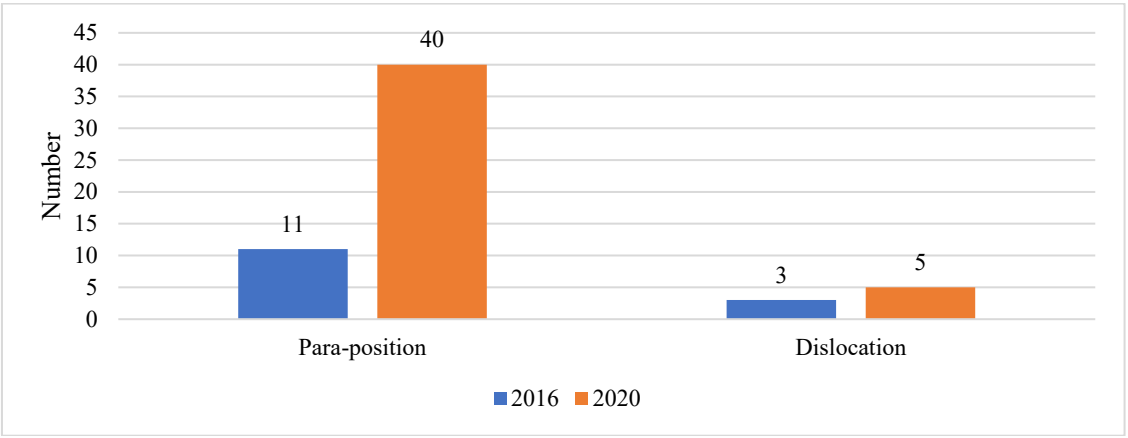

Figure 6. Right and wrong positions of nontactical substitutions after injuries to players in the European Cup in 2016 and 2020

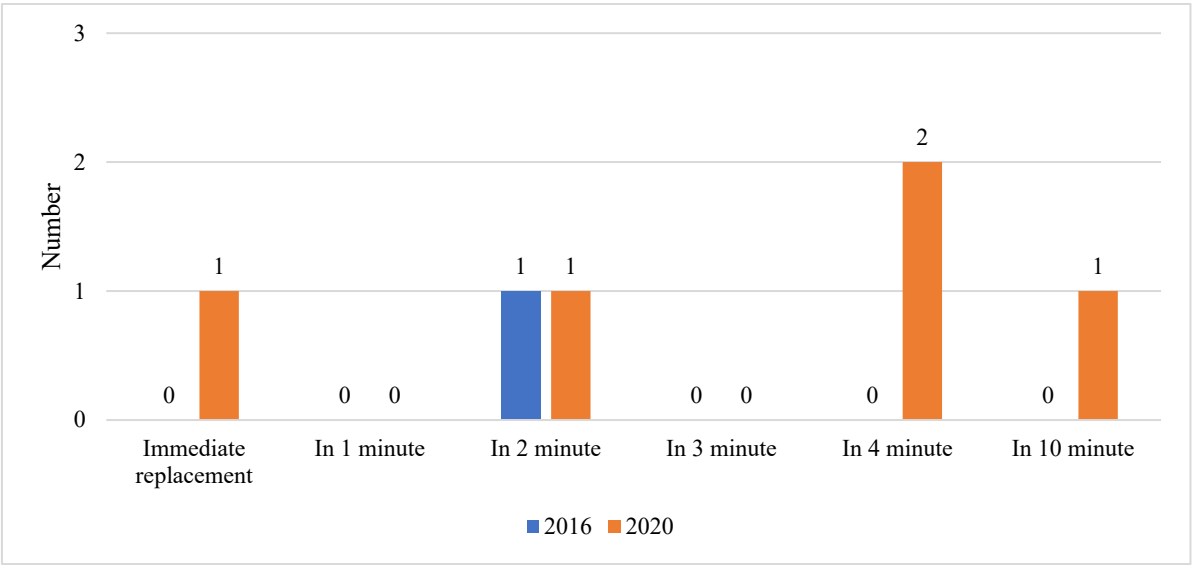

Figure 7. Intervals between nontactical substitutions after a player is sent off in Euro 2016 and Euro 2020

The coaches used a total of 14 nontactical substitutions in 2016 and 45 nontactical substitutions in 2020 in the face of player injuries. Euro 2020 saw a significant increase in the number of players replaced due to injuries, and the proportion of immediate substitutions (65%) and opposite substitutions (88.89%) increased significantly, indicating that the intensity and number of matches after the new crown epidemic led to an increase in the likelihood of player injuries. When players have strains, bruises and other injuries due to a confrontation, coaches can immediately make substitutions within a short

period, and sufficient substitutions can ensure that each position always has the ability to run and confront with high intensity, avoid "limping" in individual positions, and prevent opponents from finding obvious loopholes that can cause the team to be in an unfavorable situation. This approach reflects how the new rules of substitution better protect players from more serious injuries with good continuation of the excitement and confrontation of the game.

One instance of a coach using a nontactical substitution after a player was sent off in Euro 2016 was noted two minutes after the red card occurred, and five instances of nontactical substitutions were observed after a player was sent off in Euro 2020, with an average time of 3.75 minutes. Coaches in Euro 2016 relied on the remaining field players as the main means of response after a player was sent off, and only chose to make nontactical substitutions when necessary. After the promulgation of the new substitution rules, the 2020 coaches observed the direction of the game within a short period when a player was sent off and implemented targeted substitutions to stabilize the emotions of the players on the field and the game situation to minimize the loss of team strength, indicating that the new substitution rules provide coaches with more means to deal with unexpected situations in the game.

4. Discussion

Football, as a sport with a high injury rate (Elias,2001; Wong & Hong, 2005) is characterized by a highly intensive load (Rienzi et al, 2000). Previous studies showed that injury rates are 10 times higher during matches as compared to during training, with the incidence of injuries increasing at the end of each half (López-Valenciano et al, 2020). The allowance of a few substitutions was mentioned as one of the main factors contributing to the high demands of football (Mota et al, 2020), and past epidemiological studies have suggested that the rules of substitution should be modified (Jørgensen, 1984). In addition, substitutions are an important tool for football coaches to adjust team tactics in the field, and studies have found that substitutions provide a physical or tactical boost (Hills et al, 2020), allowing coverage of a larger area with medium- and high-intensity running (Bradley et al, 2014; Mohr et al, 2003; Carling et al, 2010), and thus helping the team to win the game.

Rule changes can bring novelty to the sport aiming for a safer environment (shin guards), healthier (hydration timeouts), fairer (video assistant referees), or more entertaining (beneficial to sponsors and fans) (Vamplew & Wray, 2007). Analyzing such changes is the basis for modifying the rules, and a few years have passed since the introduction of the new FIFA substitution rules as an important reform to the football rules, and the permanent retention of this rule was confirmed in June 2022, which has been widely implemented in leagues, cups, and even youth soccer competitions around the world. These news rules are considered by some scholars as able to reduce the impact of a crowded schedule, reducing the game time and internal load (i.e., RPE and workload-RPE), aiding in the restoration of player form (i.e., TQR) (Kobal et al, 2022) and reducing the likelihood of player injuries (Mota et al, 2021).

Our study evaluated the effects of the new substitution rules by comparing data collected from the exact same competition five years apart, the first under the old substitution rules and the second under the new substitution rules. As expected, the number of substitutions increased, as well as coaches used the non-tactical substitutions (particularly those due to injury) much faster than they did before. The European Cup is a group stage plus single-elimination tournament system. In the 2016 European Cup, coaches used the substitution quota more in the situation of draw or backwardness, and sought to reverse the backward situation or gain the lead by changing the tactical play or enhancing the impact of the team through new players.

The characteristics of the substitution time show that the coaches in the 2020 European Cup can command the team more calmly by having more substitutions. In 2020, coaches were more likely to make adjustments in the leading situation. Substitute players with more physical strength cope with the opponent's attack in the final stages of the match, which also saved the physical strength of the team's core positions or older players to ensure smooth advancement and helped avoid the possibility of prolonged confrontation among players. We also found that coaches in the 2020 Euro tournament were generally able to accept the status quo of their teams' draws and would save some substitutions to use in the initial phase of extra time.

Our study also found that coaches will use as many substitutions as possible in falling behind situations, which are mainly characterized by bold adjustments to the forward line personnel, and a reduced number of defensive players such as center backs and wing positions. Compared with the 2016 Euro Cup, coaches were more likely to change their players at the end of the second half when they fell behind in Euro 2020. Some reasons may include coaches intending to take advantage of the opponent's physical exhaustion and lack of attention in the last stages of the match.

In Euro 2020, we observed a marked increase in the number of players replaced due to injuries and red cards as compared to the 2016 tournament, suggesting a possible impact of the Covid-19 pandemic and intensive schedules. When players have strains, bruises and other injuries due to a confrontation, coaches can immediately make substitutions within a short period, as they now have a larger number of substitutions to use. This approach reflects how the new rules of substitution better protect players from more serious injuries with the good continuation of the excitement and confrontation of the game. Coaches in Euro 2016 relied on the remaining field players as the main means of response after a player was sent off, and only chose to make non-tactical substitutions when necessary. After the promulgation of the new substitution rules, the 2020 coaches observed the direction of the game within a short period when a player was sent off and implemented targeted substitutions to stabilize the team and minimize the loss of team strength, indicating that the new substitution rules provide coaches with more means to deal with unexpected situations in the match.

5. Conclusion

A total of 454 substitutions were used in Euro 2020, with 92.16% of games using three or more substitutions. Compared to substitutions in Euro 2016, substitutions were used more often in leading situations, with teams taking significantly more hits on the right and middle of the defense. When leading, tactical substitutions tended to be made in the middle of the second half, with coaches replacing more physical players earlier to deal with the opponent's impact. In the case of a tie, the coaches tended to keep the remaining spots in their hands and use them in the first half of overtime. When in a fall-behind situation, the substitution time tends to

be late in the second half, and the coaches will change the formation by staggering the number of defensive players to change the status quo of the team.

When a player is injured or sent off, sufficient substitutions allow the coach to make a short substitution to avoid "limping" in individual positions, prevent the opponent from finding obvious loopholes, and reduce the negative impact of unexpected situations on the team. This study concludes that the new FIFA substitution rules are applicable to matches played after the new epidemic, which is in line with the development of soccer, and they effectively protect the health of players while providing coaches with more opportunity for tactical adjustments and improving the excitement of the game.

Acknowledgments

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