

No Pain no Game or More Game More Pain? The Effects of Summer Congested Games Periods on Professional European Male Football Players' Injury Occurrences for the Following Season: A Data Analytics Approach

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Keywords: Football/Soccer Injuries, Injury Risk, Data Analytics, Games Congestion, Fatigue, Sports Trauma, Big Data.

Abstract: Two recent congested periods, the post Covid19 lockdown period (May-August 2020) and Euro 2020 (June-July 2021) forced European male footballers to consistently play games for nearly three years with long duration of congested games and insufficient rest days. This phenomenon has not been previously observed to such extent. This study uses data analytics and statistics to investigate how these two congested periods during seasons 19/20, 20/21 and 21/22 affected the injuries occurrences in European male footballers who both participated in Euro 2020 and played in one of the seven major European leagues, using Transfermarkt data. The results indicate that the severity and injury days out for each injury were significantly increased when comparing the 20/21 and 21/22 seasons (before and after Euro 2020), but not for 19/20 and 20/21 seasons. In contrast, there were no significant differences on injury rates and occurrences when comparing the congested games period after March 2020 lockdown with the season before lockdown or the 20/21 season. Furthermore, the players whose national teams reached the group of 16 stage onwards in Euro 2020, exhibited more fitness-related occurrences during the 21/22 season. With regards to the injuries each player exhibited, there was a significant difference on their total days out, and days out for their first and longest injury when comparing seasons 20/21 and 21/22. Also, there was a significant increase on the severity of injuries each player exhibited as well as the how soon each player was reported with an injury. However, no similar results were observed when comparing the 19/20 season (before the Covid19 March 2020 lockdown) and the 20/21 season.

1 INTRODUCTION

The increase of games and competitions in European male football has led to even more congested fixture periods during each calendar year, starting with the introduction of the Nation's League back in 2018. This matter was magnified after the first Covid19 pandemic lockdown, in March 2020. The European leagues were interrupted, only to resume in May 2020, along with the European club competitions (UEFA Champion's League, UEFA Europa League) and finish around mid-August 2020 with the two European Competitions finishing towards the end of August. From the seven most successful European leagues according to the UEFA coefficient (UEFA, 2023) (Premier League, La Liga, Bundesliga, Ligue 1, Serie A, Eredivisie and Primeira Liga), we observe that Ligue 1 and Eredivisie did not complete their re-

maining fixtures. The Premier League with 10 games remaining, Bundesliga with 9 games remaining and Serie A with 12 games remaining were completed in the time-span of approximately 40 days. The La Liga 11 remaining games were conducted in approximately 36 days and the Primeira Liga 10 remaining games in 51 days. We also note that selected teams from this set of European leagues played additional games in both domestic and European competitions.

Undoubtedly, this issue contributed to the increased congested games period. Provided that many of the teams returning back into play also had to compete in other domestic competitions as well as international ones, they had to face a challenging congested games period ahead. In practice, this yielded at least 1.75 games per week for the Premier League teams, 2.1 games for the Serie A teams, 1.57 games for the Bundesliga teams, 2.14 games for the La Liga teams,

and 1.37 for the Primeira Liga teams. Less than a month later, 20/21 football season commenced, giving little to no sufficient time to the male footballers to recover properly. All the seven major European leagues finished mid-end of May, with the Euro 2020 competition only starting in at 11/6/2021. The conduction of a back-to-back nearly full summer of football games has left the majority of male European football players with, once again, insufficient time to rest, properly recover, and appropriately participate in the pre-season training sessions (Julian et al., 2021).

1.1 Motivation and Contribution

The literature consists of notable studies investigating congested games periods, including seasons interruptions (e.g. winter break) (Leventer et al., 2019), pre-training seasons (Ekstrand et al., 2020), congested schedules (Dupont et al., 2010b), (Lago-Peñas et al., 2011), (Dellal et al., 2015), (Julian et al., 2021), (Trewin et al., 2017) and so on. However, this 3-year period with such a long duration of congested games and insufficient rest days between seasons has not been previously observed and what it could mean for the players' fitness, health and overall well-being.

In this study we aim to investigate on whether and how this 3-year period (seasons 19/20, 20/21 and 21/22) has affected the injury occurrence and rates in male European footballers, competing in both one of the seven most difficult European leagues according to the UEFA coefficient (UEFA, 2023) and Euro 2020. In summary, this period was special for the following reasons:

1. Season 19/20 was interrupted for approximately 40 days in each country, only for the players to return back and complete the season in approximately 40 days.
2. Season 20/21 started in less than a month later on, giving insufficient time for the players to rest, recover and receive proper pre-training. This was more evident for the players who also participated in the international competitions (e.g. Champions' League/Europa League). In addition, to the already congested programme experienced so far, the Euro 2020 competition was held during summer 2021.

Hence, we are interested in following research questions:

1. RQ1: Has the Euro2020 competition increased the overall number of injuries for the following season?
2. RQ2: Has the congested games period after Covid19 lockdown (March 2020) increased the

overall number of injuries for the remaining of the season (summer 2020) or season 20/21?

3. RQ3: Have these two congested games periods (Remaining of 19/20 season after March 2020 lockdown and Euro 2020 held in summer 2021) increased fatigue and fitness related occurrences for the respective following season?
4. RQ4: Has the Euro2020 congested period affected the injuries per player for the following season?

The rest of the paper is organised as follows; in Section 2, we review the relevant literature. Proceeding, we investigate the Research Questions using the data extracted from Transfermarkt and discuss the results. Then, we discuss the paper's limitations and future work. Finally, we make our concluding remarks.

To the best of our knowledge, no other study attempted to perform such in-depth investigation of injuries related to European male football players from seven European major leagues for three consecutive seasons (19/20, 20/21 and 21/22) which consisted of two summer congested games periods in-between. In addition, no other study attempted to investigate how each of these two games congested periods affected the injury occurrence and/or rates for the following season. Our work is summarised through the following contributions:

1. Total Injuries Dataset: Construction of a dataset of all the injuries of male footballers who participated in Euro 2020 and played for a club from one of the seven European leagues with the highest UEFA coefficient and their labelling based on their severity and category according to (Del Coso et al., 2018) using the Transfermarkt platform for seasons 19/20, 20/21 and 21/22.
2. Injuries per Player Dataset: Construction of a dataset of injuries for each player with the calculation of various metrics based on their total number of injuries, first and longest injury for each of the three seasons.
3. Data analysis of injuries reported for 340 different male footballers using both datasets explained in 1) and 2).

2 REVIEW OF THE LITERATURE

It is estimated that footballers can be exposed from 10-20 consecutive weeks of congested games, both domestically and internationally (transfermarkt, 2023) in a single season. Inevitably, this leads to players having fewer days between games, thus unable

to rest and recover properly (Nédélec et al., 2012), (Ispirlidis et al., 2008), (Bengtsson et al., 2013a).

There are different studies proving the link between congested games periods and injury incidence rates. Carling et al. (Carling et al., 2016) investigated injuries in short periods of games congestion in 25 players who participated in the French Ligue 1 and European competitions over seasons 2009-2015. The authors monitored the exposure time and reported injuries during congestion periods and non-congestion periods. The results demonstrated a higher risk of injury during the final 15 minutes of the second game of a congested period, in contrast to the respective non-congested periods. Also, they reported an overall higher risk of injury, a risk of ankle sprains and non-contact injuries during the final game of a three-match congestion period in contrast to the respective time-frame of a non-congested period.

Similarly, Bengtsson et al. (Bengtsson et al., 2013a), also aimed to investigate how congested game periods affected 27 teams over 11 seasons. Linear regression was used to investigate on whether there was an association between the recovery time, game load, injury rates and performance from each team. They reported an association between games lost and short recovery time in Europa League. They also reported an increased rate of injury and muscle injury (hamstring and quadriceps), when there was a game in equal or less than 4 days, compared to 6 days. There was also an increase in ligament injuries during the training session after the congested games period. Similarly, the authors in (Dupont et al., 2010a) monitored 32 football players from a team participating in the Champions League to investigate the possible effects a 2 weekly game congestion period for 52 home games had for their performance over a 2-season period. Injury rate was significantly increased during the congestion game period compared to non-congestion period (1 weekly game).

Aiming to investigate how congested game periods affect both performance and injury rate, Dellal et al. (Dellal et al., 2015) monitored 16 players competing in the French League, French Cup and the Champions' League. The period monitored was during the 2011-2012 season's three different congested periods of games (=six games in 18 days). In their results, they report no significant differences in any of the six games during the congested period or in-between congested games periods when it came to the players' physical and technical performance. Furthermore, even though there was also no change in the total incidence of injuries, the injury rate during game-play was significantly higher during the congestion period. On the other hand, the mean lay-off

duration for injuries was significantly shorter during congested periods than in non-congestion periods.

Multiple studies aimed to investigate a potential differentiation in physical game performance and injury rates and occurrences before and after the Covid19 March 2020 lockdown in different European football leagues, including Bundesliga and Serie A (Thron et al., 2021), (Krutsch et al., 2022), (Marotta et al., 2022a). In their findings they report that there were no significant differences with regards to the injury rates and occurrences before and after the first lockdown. Thron et al. (Thron et al., 2022) rightfully claim that the increase in substitutions from 3 to 5 has a positive effect in reducing the injury risk. Similarly, a study conducted for the Japanese league was also unable to prove a significant increase on injury occurrences before and after the March 2020 lockdown (Matsunaga et al., 2023). However, the authors report that muscle-related injuries were notably increased during the first two months after the initial suspension period.

From the studies presented, injury incidence was higher during congested periods, but not after the Covid19 March 2020 lockdown. This is of special interest since it directly contradicts previous findings proving a notable increase on injury occurrences after short breaks (e.g. winter break) (Leventer et al., 2019), (Ekstrand et al., 2020). A notable difference between a normal congested games period (which involves international games) compared to the Covid19 lockdown after season, was travelling to and from away matches (Fowler et al., 2015), (Abbott et al., 2018) or/and playing during the night (Fullagar et al., 2016). This could potentially play a potential roles in the players being exposed to injury risk, something which holds especially true for the Euro 2020 competition with all the excessive travelling conducted.

However, the fact remains that these two congested games periods occurred in two-consecutive summers, in 2020 and 2021. To the best of our knowledge, there has been no previous work conducted investigating the effects of both these two congested games period across such a large number of male footballers who player across seven different European leagues. Most importantly, to the best of our knowledge, there has been no other study investigating how these two congested games periods could have impacted the injury rates and occurrences for the following season. Our study aims to fill in these gaps and investigate the possible effects on injury rates and occurrences due to this back-to-back summer games congested period for the next seasons respectively.

3 METHODS

3.1 Experimental Testbed Implementation

For the extraction/analysis and visualisation of the data, Python 3.8, Pandas, Seaborn and Selenium libraries were used. All the data our implemented software scrapped through, was from Transfermarkt (transfermarkt, 2023). Only the players who participated in Euro 2020 and belonged to a team of the seven following football leagues presented in the Introduction section were considered.

3.2 Injuries Classification and Data Collection

Unfortunately, footballers can suffer from a plethora of different injuries due to the high physical demands and the high risk of physical impact of the sport. There are various types of injuries and with different severity. Injury severity describes the severity of an injury based on how many days each individual was out. Hence, we followed the injuries classification method proposed by (Del Coso et al., 2018). In total, there are four different classifications, presented below: Minor injuries which lasted less than 7 days; Mild injuries which lasted 7-13 days; Moderate injuries which lasted 14-20 days; Severe injuries which lasted more than 20 days. Based on this information, we classified each injury based on its severity, as previously described.

Using (Del Coso et al., 2018), we classified each injury based on the description by Transfermarkt. We briefly explain how the type of an injury is conducted based on the authors' proposed model. Bone-related injuries include fractures and other-bone related injuries. Joint and/or ligament injuries include dislocations/subluxations, ligament stretching, tear or rupture, meniscus/cartilage wearings, tears or ruptures and so on. Muscle and/or tendon injuries include muscle cramps, tears or ruptures, tendon injuries and so on. Contusions injuries include hematomas, abrasions or lacerations. Nervous system injuries include concussions and other nervous-related injuries. Knocks include all types of knocks.

Table 1: Euro 2020 Players by Country.

Country	Players No.
Austria	20
Belgium	20
Croatia	12
Czech Republic	9
Denmark	17
England	24
Finland	3
France	26
Germany	26
Hungary	4
Italy	26
Netherlands	22
North Macedonia	3
Poland	11
Portugal	26
Russia	3
Scotland	9
Slovakia	8
Spain	24
Sweden	8
Switzerland	16
Turkey	11
Ukraine	3
Wales	9

3.3 Data Collection and Dataset Construction

3.3.1 Injuries Dataset Construction

It was important to firstly collect all the necessary information for the players who participated in Euro 2020. We obtained the full lists of the squads participating from (UEFA, 2021). Then, we picked up the players who participated in one of the seven European leagues considered, namely Premier League, La Liga, Bundesliga, Ligue 1, Serie A, Eredivisie and Primeira Liga. The total number of players considered for the present study was 340. Only the players who both participated in Euro 2020 and belonged to one of the seven European leagues stated in the Introduction were considered and summarised in Table 1. The general information we extracted for each player was the following: player's name, player's age (at the start of the season), player's position, player's club, player's league and player's birth country. For the purpose of the study, we extracted injury information for the set of player explained above for three consecutive seasons, specifically 19/20, 20/21 and 21/22 seasons. The total number of injuries per season is presented in Table 2. All non-injury related reasons for absence (e.g. due to illness) records have been omitted. For each injury occurred to each player, the following information was extracted:

Table 2: Total Injuries and Fitness Occurrences per Season.

Season	Injuries No.
19/20 (before/after March Lockdown)	455(377/78)
20/21	449
21/22	498

- Injury Season: Season the injury occurred.
- Injury Description: Injury Description the Transfermarkt platform provided.
- Injury Start Date: Date the injury occurred.
- Injury Start Month: Month the injury occurred.
- Injury End Date: Date returned from injury.
- Injury Days Out: The total number of days the player was out due to injury.
- Injury Severity: Based on the days injured, the classification of the injury’s severity.
- Injury Type: Type of the injury based on the "Injury Description" field.

3.3.2 Injuries per Player Dataset Construction

For the purpose of this study, it is equally important to investigate on how the different injuries occur not only in overall, but also on each player individually. Proceeding, we calculated the relevant information for each player’s injury history. Specifically, the information extracted for each player per season included:

- Injuries Total Number: Total number of injuries a player had for the season.
- Injury Total Days Out: Total number of days the player was out due to injuries for the season.
- Injury Maximum Days Out: Number of days the injury from which the player recovered the longest lasted.
- Injury Maximum Severity: Severity the injury from which the player recovered the longest.
- Injury Maximum Category: Category the injury from which the player recovered the longest.
- Injury Maximum Month: Month the injury from which the player recovered the longest occurred.
- Injury First Days Out: number of days the player had their first injury for the season lasted.
- Injury First Severity: Severity the player had their first injury for the season.
- Injury First Category: Category the player had their first injury for the season.
- Injury First Month: Month the player had their first injury for the season.

4 RESULTS AND DISCUSSION

For the analysis of the results and the investigation of the research questions defined in the Introduction presented in this paper, the following techniques were used:

- Descriptive Analytics and Statistics (mean, standard deviation, median, mode, min, max and quartiles) to calculate, describe, and summarise collected injury data, including rates per season, days out, severity, and start date.
- Inferential Statistics and Diagnostic Analytics (Mann Whitney U test) to investigate significance on the difference between the injury days out
- Bar Charts, Pie Charts and Tables to visualise the data extracted.

4.1 RQ1: Has the Euro2020 Competition Increased the Overall Number of Injuries for the Following Season?

Based on the injuries for the two seasons presented in Table 2, we observe an increase of 10.9% (3 s.f.). Hence, we cannot support that the conduction of additional congested games through Euro2020 significantly increased the total number of injuries occurred. However, it appears that the conduction of Euro2020 significantly increased the number of injury days out for each injury. Based on Table 3, the mean/median values for the injury days during the 20/21 season were 19.95 and 12 respectively while for the 21/22 season 28.22 and 15. Also, there is a notable difference between the values for the maximum injury days variable between the two seasons. By performing Mann-Whitney U test, we conclude that there is a significant difference between the injury days out between the two seasons ($p=0.0001$). We proceed by analysing in further the injuries for both seasons, focusing on the distribution of the severe and moderate type injuries as well as the types of injuries observed for the two seasons.

For the 20/21 season, 127 severe injuries were reported, while for the 21/22, 185, exhibiting a 45.67%

Table 3: RQ1 Descriptive Statistics.

Season	Mean (St.Dev)	Mdn.	Md.	Min/Max	Quartiles
20/21	19.95 (24.99)	12	7	1/242	6 (25%) 25 (75%)
21/22	28.22 (41.38)	15	7	1/383	7(25%) 31.5 (75%)

increase. With regards to the moderate injuries, for the 20/21 season 49 were reported and for the 21/22 season, 64, exhibiting a 30.61% increase. In addition to the significant difference in the number of severe and moderate injuries, we also observe that such a notable difference is also observed on the injury out days variable for the severe and moderate types of injuries. Specifically, the mean/median of injury out days for the severe injuries during the 21/22 season were 56.9 (3 s.f.) and 36 respectively, while for the 20/21 season they were 45.6 (3 s.f.) and 34. For the moderate injuries, the mean/median of injury days during the 21/22 season were 18.4 (3 s.f.) and 18 respectively, while for the 20/21 season they were 18.3 (3 s.f.) and 18. Based on the results presented, we believe that the conduction of the Euro2020 competition had an impact not only on how many days an injury lasted for the players who participated in, but also on how many severe and moderate types of injuries, as well as for the former's overall number of injury days out for the severe injuries. Based on Figure 1 results, we observe that in both seasons, the distribution of injuries based on their type remained unchanged. As expected, the muscle and tendon injuries were the most frequent amongst the players investigated, followed by joint and ligament injuries. The rest of the injury categories did not demonstrate any significant differences. Even though we do not have sufficient information on the nature of the injury and whether it was caused due to overuse, it is clear that there is a significant rise in the overall numbers of muscle/tendon and joint/ligament injuries when comparing the 20/21 and 21/22 seasons.

In addition, based on the results in Figure 2, we observe that the Italian players had the highest number of injuries total for both seasons 20/21 and 21/22. This is possibly the case due to two reasons. Firstly, the Italian national team reached the final of Euro 2020 and eventually won the trophy. This indicates that the Italian players eventually played more games and the longest with little break between them during the competition and had less time to rest before the start of the pre-season training. Secondly, the majority of Italian players belong to the Serie A league, where during the rest of the 19/20 season, the Italian teams played at least 2.1 games per week. A full congested-games period (summer 2020), followed by a full season and the, undoubtedly, overperformance a team requires to win a European competition is likely to have contributed to the high injury occurrences for the Italian players.

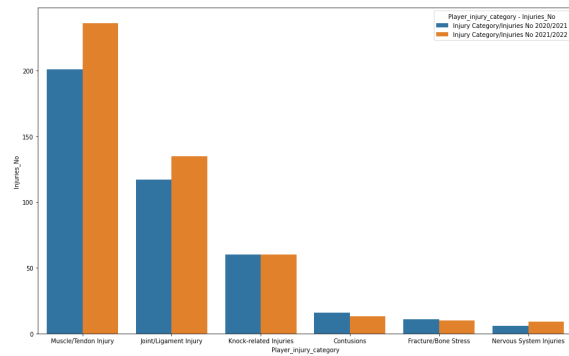


Figure 1: Injuries Categories Distribution for 20/21 and 21/22 Seasons.

Table 4: RQ2 Season 19/20 Injury rates per League.

Season	Premier League	Bundes-liga	La Liga	Serie A	Primeira Liga
19/20 Phase A	3.65	2.64	1.86	1.07	0.29
19/20 Phase B	1.79	1.24	1.03	0.48	0.07

4.2 RQ2: Has the Congested Games Period after Covid19 Lockdown (March 2020) Increased the Overall Number of Injuries for the Remaining of the Season (Summer 2020) or Season 20/21?

For the purpose of this research question, we decided not to include the records of injuries from the two fully interrupted leagues during the 19/20 season due to Covid19 (Ligue 1 in France and Eredivisie in the Netherlands). For the remaining of this subsection, we refer to the 19/20 season until March 2020 as Season 19/20 Phase A (lasted for 34.5 weeks) and from April 2020 to August 2020, as Season 19/20 Phase B (lasted for 14.5 weeks). In Table 4, the weekly injury rates per league for season 19/20 Phases A and B. By performing a Mann-Whitney U test on the injury rates between the two phase, we conclude that there are no significant differences between the two distributions ($p=0.2113$). Therefore, there are no significant differences on the injury rates between the two phases and no changes between the injury rates between the leagues. Our findings are consistent with the related studies presented in the Review of the Literature section.

To ensure consistency when comparing the 19/20 season (Phase A) and the 20/21 season, we only considered the injuries from the start of each season until

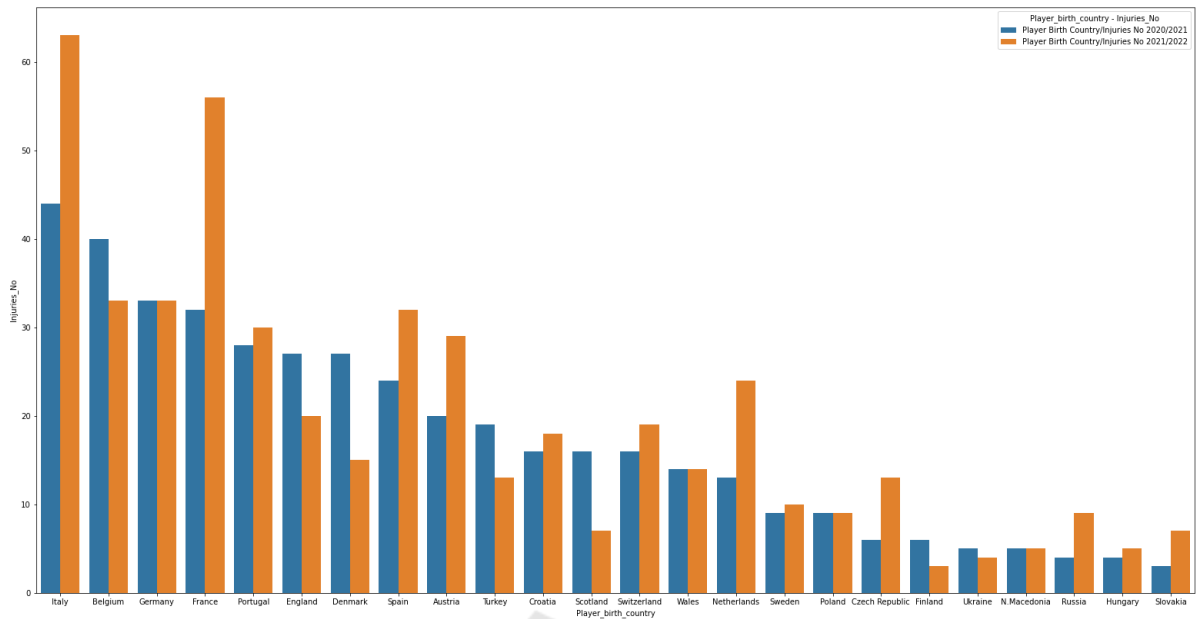


Figure 2: Total Injuries per Country for 20/21 and 21/22 Seasons.

March 2021. The total number of injuries reported during the 19/20-Phase A season was 313, while for the 20/21 season was 343. Based on the results obtained, we observe an 9.58% increase in the overall number of injuries. Regarding the injury days out variable, Table 5, we observe that interestingly, the average days out value for the 19/20 season is 29.73 (± 39.26) days, while for the 20/21 season was 19.10(± 21.07) days. By performing a Mann-Whitney U test, there is a significant difference ($p=0.00164$). Hence, we conclude that the injuries did not exhibit any increase rates of injury out days due to Covid19 after the first-lockdown congested period.

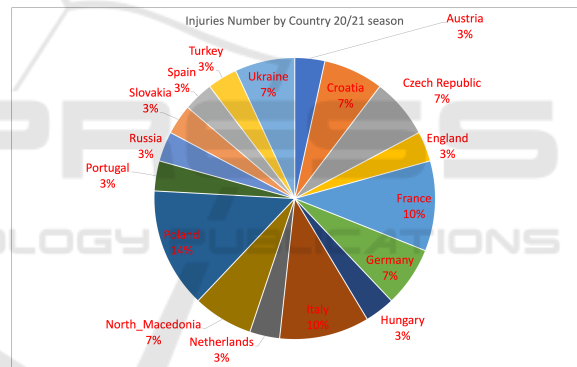


Figure 3: Fitness-related Occurrences by Country for Season 20/21.

4.3 RQ3: Have These Two Congested Games Periods Increased Fatigue and Fitness Related Occurrences for the Following Season Respectively?

Based on the literature, we assume that in a season following a congested period of games, more fitness-related occurrences will be observed. The occurrences we consider as fitness-related ones are reported by Transfermarkt as "Fitness", "Muscle Fatigue", and "Rest". Hence, we made two comparisons:

- Comparison No.1: Comparison between the players who participated in the Euro 2020 competition for seasons 20/21 (before Euro2020) and 21/22 (after Euro2020).
- Comparison No.2: Comparison between the play-

ers whose leagues were not fully interrupted after the first Covid19 lockdown, specifically season 19/20 (until March 2020) and season 20/21.

4.3.1 Comparison No. 1 Results

To gain a more accurate view of the injuries' occurrences we considered only the injuries until March 2021. With regards to the total number of fitness-related occurrences, there is no significant difference between the two seasons, 30 for 20/21 and 28 for 21/22. By performing a Mann-Whitney U test, we observe that there is no significant difference between the distributions of the injury days out for the two seasons ($p = 0.448$). Therefore, we conclude that there is no significant increase in the number of injury days out for each injury occurrence from one season to

Table 5: RQ3 Descriptive Statistics - Comparison No.2.

Season	Mean (St.Dev)	Mdn.	Md.	Min/Max	Quartiles
19/20	30.3 (40.7)	15	7	0/263	7(25%) 33(75%)
20/21	18.9 (23.5)	11	7	0/242	6(25%) 23(75%)

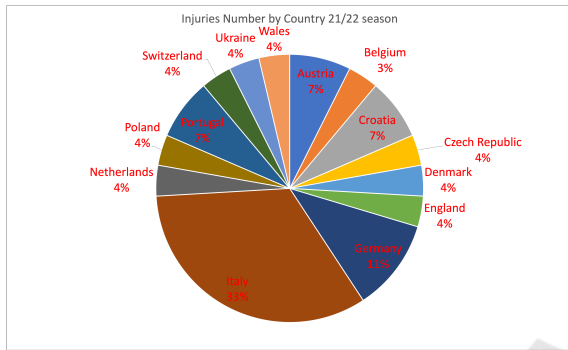


Figure 4: Fitness-related Occurrences by Country for Season 21/22.

the other. However, based on Figures 3 and 4, we note that for the 21/22 season, more than 50% of the fitness-related occurrences were observed on players whose national teams reached the quarter-final stage of the Euro2020 competition. From the remaining 50%, only 3.5% of fitness-related occurrences happened to players whose teams did not pass through the group stages phase of the Euro2020 competition, with the remaining 46.5% occurring to players whose national teams reached the group of 16 stage. In contrast, for the 20/21 season, the fitness-related occurrences of players whose national teams would reach the quarter finals stage was only 20%.

In addition, the percentage of the moderate and severe fitness-related occurrences the 21/22 season was 21.4% (3 s.f.) while for the 20/21 season was 13.3% (3 s.f.). Concluding, the congested games period of Euro2020 competition seems to not have significantly increased the number of fitness-related occurrences or their days out. However, it potentially had an impact on which players experienced such occurrences based on how far they went through the competition, given that Italy (Euro2020 champions) demonstrated the most fitness-related problems.

4.3.2 Comparison No.2 Results

For the second comparison, the results are presented in Table 5. Firstly, in contrast to the previous comparison, we observe that for the 19/20 season (until March 2020) the total number of fitness-related occurrences was only half the total number, compared

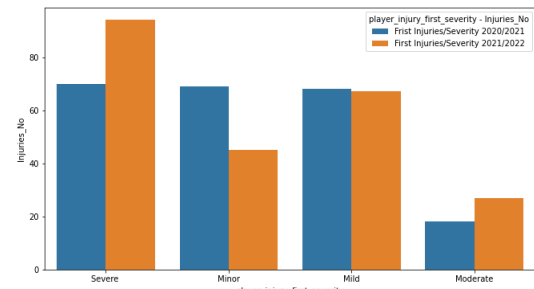


Figure 5: First Injury Severity for 20/21 and 21/22 Seasons.

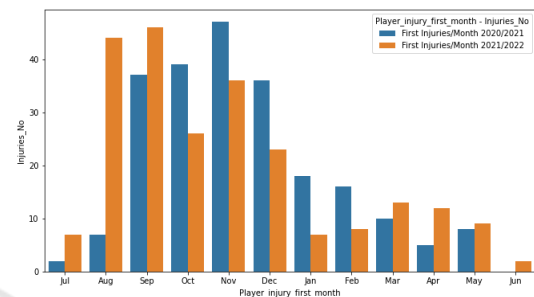


Figure 6: First Injury Month Occurrence for 20/21 and 21/22 Seasons.

to the 20/21 season (until March 2021), specifically 12 and 25, yielding an increase of 108.33%. However, we observe that during the 19/20 season, the days out between the two seasons was not significantly different by using a Mann-Whitney U test ($p=0.4965$). Based on the two sets of results presented, the congested games period after the Covid19 pandemic first lockdown (March 2020) possibly affected the fitness-related occurrences, compared to the 19/20 season, but it did not significantly affect the days out for each fitness occurrence reported.

4.4 RQ4: Has the Euro2020 Congested Period Affected the Injuries per Player for the Following Season?

A possible increase in the total number of injuries, when comparing two or more seasons does not necessarily mean that all the of the players considered exhibited a higher number of injuries personally. A plausible scenario would consist of certain players who are more injury prone, due to various reasons, injured more frequently. Therefore, it was essential to investigate on whether the conduction of Euro2020 or the Covid19 March 2020 lockdown had a negative impact on the injuries occurrence for each individual player. Hence, we aimed to investigate on how the injuries, were classified based on the severity system chosen in Section 3.2, as well as what month each in-

Table 6: Injuries for Seasons 20/21 and 21/22.

Season	Players No.	Mean (Stand. Dev.)
20/21	225	1.99(1.15)
21/22	233	2.13(1.43)

jury for every individual player was reported.

In Table 6 we summarise the total number of injured players and the mean and standard deviation of injuries per player for seasons 20/21 and 21/22. In general, based on the results in Table 6, the total number of players injured between the 20/21 and 21/22 seasons was increased by only 4%. In addition, the mean(stand.dev.) number of injuries per player for the 20/21 and 21/22 seasons was 1.99(1.15) and 2.13 (1.43) respectively and their difference cannot be considered significant ($p=0.881$). The mean number of injuries each player suffered from during both seasons results agree with previous studies (Ekstrand et al., 2011). Hence, we conclude that the number of injured players and the total number of injuries per player was not significantly altered in seasons 20/21 and 21/22.

However, based on the results presented in Table 7, we observe that there is a significant difference on the injury days out the players have experienced between the two seasons. Specifically, there is a significant difference in the total days out variable ($p=0.0002$), the first injury days out variable ($p=0.00308$), and the maximum injury days out variable ($p=0.00308$). Hence, it is evident that a player has spent significantly more time being out due for all of their injuries, for their first injury as well as for their maximum days out injury.

Furthermore, with regards to the first injury each player has experienced when comparing the seasons 20/21 and 21/22, we firstly observe that the total numbers of severe and moderate injuries has been considerably increased, as illustrated in Figure 5. Therefore, we believe that the conduction of Euro2020 has contributed not only on earlier injuries during the season, but also on more serious injuries being reported. In addition, the number of injuries for July, August, March, April, May and June was significantly increased, when comparing the two seasons, based on Figure 6. This is due to the players coming back to full-training almost immediately, following the Euro2020 competition, hence why during the first two months (July and August), a considerable increase in injuries was observed. Regarding the rest of the months (March, April, May and June), we believe this is due to the overplaying from the players due to the high number of games to play with insufficient resting periods between them, followed by the conduction of Euro2020.

Table 7: Injuries Mean and Stand.Dev for Seasons 20/21 and 21/22.

Season	Days Out	1st Injury	Max Injury
20/21	38.04(36.86)	21.41(29.59)	28.24(30.83)
21/22	57.95(60.87)	29.93(43.77)	43.86(53.49)

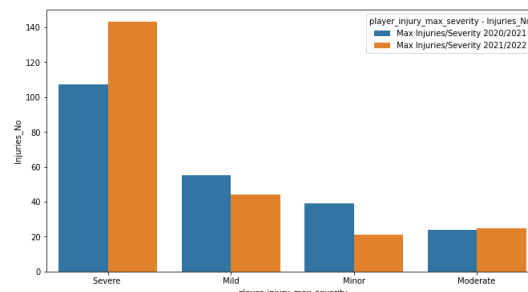


Figure 7: Maximum Days Injury Severity for 20/21 and 21/22 Seasons.

In Figures 8 and 7, the injuries that kept the players out of game for the maximum amount of time during the seasons and their severity classification are presented respectively. Evidently, there is a significant difference on the maximum days out injuries during August and September for season 21/22 compared to season 20/21. We believe this is once again to the congested games of Euro2020, since these injuries occur soon after the end of the competition. We also observe a considerable increase on the maximum days out injuries during April and May. We believe the same case applies as for the first injuries results already described. In addition, we observe that there is a considerable increase on the maximum days out injuries which were of severe type for the 21/22 season, compared to the 20/21 season, with approximately 15 days of an increase. Hence, we conclude that Euro2020 has affected the maximum days out injuries both from a month occurrence but also from a severity point of view.

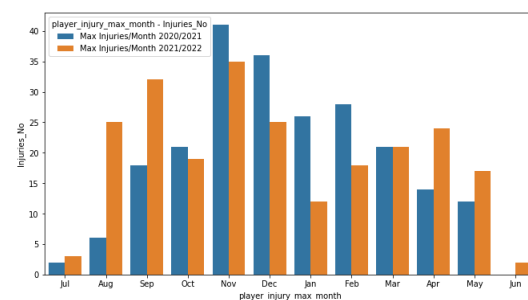


Figure 8: Maximum Days Injury Month Occurrence for 20/21 and 21/22 Seasons.

4.5 Limitations and Future Work

Unfortunately, injuries records are not always accurate and reliable, including the records from the Transfermarkt platform. However, as authors in (Thron et al., 2022) have effectively pointed out, injury surveillance can be inconsistent and can negatively impact the data. However, notable studies used it (Grassi et al., 2020), (Niederer et al., 2018), (Manino et al., 2023), (Marotta et al., 2022b) for injuries reporting, so we believe it is a reliable source for players who compete in major European leagues. Future work could include collecting data for male football players who did not participate in Euro 2020 but went through the congested games period after the Covid19 March 2020 lockdown to investigate in further depth if the competition had a greater influence on injury rates of players competing in one of the seven major European leagues. In addition, since Copa America was conducted around the same time, it would be interesting to investigate on whether players who competed in this competition were injured differently. A more in-depth study on what factors could affect the injury rates of players. In that way, intelligent techniques such as A.I. and machine learning could be adopted for possible predictions on how much a player is at risk of being injured.

5 CONCLUDING REMARKS

Undeniably, players' availability can be proven pivotal for a team's success over a season (Eirale et al., 2013), (Bengtsson et al., 2013b). Injuries in professional football can be proven costly for clubs (Ekstrand, 2013). It is essential for injury risk to be significantly minimised. Unfortunately, with the increase of congested games periods this has become a considerable challenge. This study was conducted to investigate on whether two specific summer congested game periods (Covid19 congested games in summer 2020 and Euro 2020 in summer 2021) affected the European players' injury rates and occurrences, injury days out period and severity.

From the results obtained, we observed that the severity and injury days out for each injury were significantly increased from the 20/21 to the 21/22 season. In contrast, there were no significant differences on either the injury rates or occurrences when comparing the congested games period after Covid19 March 2020 lockdown with the season before the lockdown. Furthermore, the Euro2020 competition is likely to have played a role in players who reached the stage of 16 onwards and exhibited increased fitness-

related problems the following season. This was mostly evident in Italian players who won the competition. Although the injuries per player were not significantly increased, the injury total days out each of them had was significantly increased. Similarly, the first injury each player has endured has significantly lasted longer than the 20/21 season. This was also the case for the injury each player needed the longest to recover from. In addition, it was evident that both the first injury and the maximum in days out injury each player has exhibited occurred significantly sooner than the 20/21 season. Finally, we observed a significant increase on the severity of injuries each player has exhibited. Hence, we believe that these two congested games periods had a negative effect on the players' injury rates and injury days out, as well as their severity. Concluding, we believe a more appropriate management of the workload of players should be considered, so not only injuries can be avoided but also minimise the risk for serious injuries that can be season ending for the players.

REFERENCES

- Abbott, W., Brownlee, T. E., Harper, L. D., Naughton, R. J., and Clifford, T. (2018). The independent effects of match location, match result and the quality of opposition on subjective wellbeing in under 23 soccer players: a case study. *Research in sports medicine*, 26(3):262–275.
- Bengtsson, H., Ekstrand, J., and Häggglund, M. (2013a). Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the uefa champions league injury study. *British journal of sports medicine*, 47(12):743–747.
- Bengtsson, H., Ekstrand, J., and Häggglund, M. (2013b). Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the uefa champions league injury study. *British journal of sports medicine*, 47(12):743–747.
- Carling, C., McCall, A., Le Gall, F., and Dupont, G. (2016). The impact of short periods of match congestion on injury risk and patterns in an elite football club. *British journal of sports medicine*, 50(12):764–768.
- Del Coso, J., Herrero, H., and Salinero, J. J. (2018). Injuries in spanish female soccer players. *Journal of sport and health science*, 7(2):183–190.
- Dellal, A., Lago-Peñas, C., Rey, E., Chamari, K., and Orhant, E. (2015). The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. *British journal of sports medicine*, 49(6):390–394.
- Dupont, G., Nedelec, M., McCall, A., McCormack, D., Berthoin, S., and Wisløff, U. (2010a). Effect of 2 soccer matches in a week on physical performance and

- injury rate. *The American journal of sports medicine*, 38(9):1752–1758.
- Dupont, G., Nedelec, M., McCall, A., McCormack, D., Berthoin, S., and Wisløff, U. (2010b). Effect of 2 soccer matches in a week on physical performance and injury rate. *The American journal of sports medicine*, 38(9):1752–1758.
- Eirale, C., Tol, J. L., Farooq, A., Smiley, F., and Chalabi, H. (2013). Low injury rate strongly correlates with team success in qatari professional football. *British journal of sports medicine*, 47(12):807–808.
- Ekstrand, J. (2013). Keeping your top players on the pitch: the key to football medicine at a professional level. *British journal of sports medicine*, 47(12):723–724.
- Ekstrand, J., Hägglund, M., and Waldén, M. (2011). Injury incidence and injury patterns in professional football: the uefa injury study. *British journal of sports medicine*, 45(7):553–558.
- Ekstrand, J., Spreco, A., Windt, J., and Khan, K. M. (2020). Are elite soccer teams' preseason training sessions associated with fewer in-season injuries? a 15-year-analysis from the union of european football associations (uefa) elite club injury study. *The American journal of sports medicine*, 48(3):723–729.
- Fowler, P., Duffield, R., Waterson, A., and Vaile, J. (2015). Effects of regular away travel on training loads, recovery, and injury rates in professional australian soccer players. *International journal of sports physiology and performance*, 10(5):546–552.
- Fullagar, H., Skorski, S., Duffield, R., and Meyer, T. (2016). The effect of an acute sleep hygiene strategy following a late-night soccer match on recovery of players. *Chronobiology international*, 33(5):490–505.
- Grassi, A., Macchiarella, L., Filippini, M., Lucidi, G. A., Della Villa, F., and Zaffagnini, S. (2020). Epidemiology of anterior cruciate ligament injury in italian first division soccer players. *Sports health*, 12(3):279–288.
- Ispiridis, I., Fatouros, I. G., Jamurtas, A. Z., Nikolaidis, M. G., Michailidis, I., Douroudos, I., Margonis, K., Chatzinikolaou, A., Kalistratos, E., Katrabasas, I., Alexiou, V., and Taxildaris, K. (2008). Time-course of changes in inflammatory and performance responses following a soccer game. *Clinical journal of sport medicine: official journal of the Canadian Academy of Sport Medicine*, 18(5):423–431.
- Julian, R., Page, R. M., and Harper, L. D. (2021). The effect of fixture congestion on performance during professional male soccer match-play: A systematic critical review with meta-analysis. *Sports medicine (Auckland, N.Z.)*, 51(2):255–273.
- Krutsch, W., Hadji, A., Tröß, T., Szymiski, D., Aus der Fünten, K., Gärtner, B., Alt, V., and Meyer, T. (2022). No increased injury incidence in the german bundesliga after the sars-cov-2 virus lockdown. *Archives of orthopaedic and trauma surgery*, 142(7):1571–1578.
- Lago-Peñas, C., Rey, E., Lago-Ballesteros, J., Casáis, L., and Domínguez, E. (2011). The influence of a congested calendar on physical performance in elite soccer. *Journal of strength and conditioning research*, 25(8):2111–2117.
- Leventer, L., Eek, F., and Lames, M. (2019). Intra-seasonal variation of injury patterns among german bundesliga soccer players. *Journal of science and medicine in sport*, 22(6):661–666.
- Mannino, B. J., Yedikian, T., Mojica, E. S., Bi, A., Alaia, M., and Gonzalez-Lomas, G. (2023). The covid lockdown and its effects on soft tissue injuries in premier league athletes. *The physician and sportsmedicine*, 51(1):40–44.
- Marotta, N., de Sire, A., Gimigliano, A., Demeco, A., Moggio, L., Vescio, A., Iona, T., and Ammendolia, A. (2022a). Impact of covid-19 lockdown on the epidemiology of soccer muscle injuries in italian serie a professional football players. *The Journal of sports medicine and physical fitness*, 62(3):356–360.
- Marotta, N., de Sire, A., Gimigliano, A., Demeco, A., Moggio, L., Vescio, A., Iona, T., and Ammendolia, A. (2022b). Impact of covid-19 lockdown on the epidemiology of soccer muscle injuries in italian serie a professional football players. *The Journal of sports medicine and physical fitness*, 62(3):356–360.
- Matsunaga, R., Nagao, M., Akagi, R., Fukai, A., Sando, T., Ikeda, H., and Taketomi, S. (2023). Impact of the covid-19 pandemic on injury incidence in japanese male professional soccer players. *Orthopaedic journal of sports medicine*, 11(2):232596712211493.
- Niederer, D., Engeroff, T., Wilke, J., Vogt, L., and Banzer, W. (2018). Return to play, performance, and career duration after anterior cruciate ligament rupture: A case-control study in the five biggest football nations in europe. *Scandinavian journal of medicine & science in sports*, 28(10):2226–2233.
- Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., and Dupont, G. (2012). Recovery in soccer: part i - post-match fatigue and time course of recovery: Part i - post-match fatigue and time course of recovery. *Sports medicine (Auckland, N.Z.)*, 42(12):997–1015.
- Thron, M., Düking, P., Härtel, S., Woll, A., and Altmann, S. (2022). Differences in physical match performance and injury occurrence before and after the covid-19 break in professional european soccer leagues: A systematic review. *Sports medicine - open*, 8(1):121.
- Thron, M., Härtel, S., Woll, A., Ruf, L., Gross, T., and Altmann, S. (2021). Physical match performance and injuries in professional soccer before and after the covid-19 break. *Science and Medicine in Football*, 5(sup1):31–34.
- transfermarkt (2023). <http://transfermarkt.de>.
- Trewin, J., Meylan, C., Varley, M. C., and Cronin, J. (2017). The influence of situational and environmental factors on match-running in soccer: a systematic review. *Science and Medicine in Football*, 1(2):183–194.
- UEFA (2021). All the euro 2020 squads.
- UEFA (2023). Uefa leagues coefficients.