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ORIGINAL RESEARCH



Injury rates in the National Football League during the 2020 COVID-19 season

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ABSTRACT

Objectives: The National Football League (NFL) altered the 2020 season due to the COVID-19 pandemic, which resulted in canceled preseason games and a dynamic regular season schedule to accommodate for canceled games. The purpose of this study was to evaluate if the disrupted training and preseason schedule lead to increased injury rates as seen in other professional sports. We hypothesized that the overall injury rate would be higher in the 2020 season compared to the 2018–2019 seasons and that this increase will affect all body regions equally.

Methods: Publicly released NFL weekly injury reports were queried to identify players listed as out or placed on the injured reserve for at least one game in the 2018–2020 seasons. Injuries were categorized into upper extremity, lower extremity, spine/core, head, illness, not injury related and undisclosed injuries. Incidents per 1000 athlete exposures were calculated for the prior two seasons (2018–2019) and for the 2020 season separately. Percentage of injuries occurring in each position was calculated separately for the pre-COVID-19 (2018 and 2019) and post-COVID-19 (2020) cohorts. Incidence rate ratios (IRR) and confidence intervals were used to compare injury rates in 2018–2019 versus 2020. The z-test for proportions was used to determine significant differences between injury incidences.

Results: The overall incidence rate per 1000 athlete exposures in 2020 was not significantly different compared to pre-COVID-19 seasons (21.6 versus 23.1, IRR 0.94, 95% CI: 0.9–1.0 $p > 0.999$). The proportion of injuries by position did not change before and after COVID-19 either ($p > 0.999$). Out listings due to illness were significantly increased during the 2020 season (0.8 versus 0.3, IRR 2.8, 95% CI: 1.4–5.2, $p = 0.004$).

Conclusion: The incidence of NFL injuries did not significantly change in 2020. The distribution of injuries did not change with respect to position.

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Football; American football; injury; epidemiology; COVID-19

Introduction

Coronavirus disease 2019 (COVID-19) has had dramatic effects on the day-to-day lives of every person including those involved with professional sports. Significant adjustments to the football season and training were required prior to resuming safe play. Despite the uncertainty associated with COVID-19, the National Football League (NFL) had ample time to prepare their protocols for the 2020 season. This included a shortened preseason and modified training camps [1].

Although NFL players reported to training camp at their usual time on July 2019 [1], teams were not able to practice on the field in the off-season, and the four preseason games were canceled [1]. Previous studies have reported the epidemiology and the anatomic distribution of NFL injuries in normal seasons [2,3]; however, it is unknown how overall injury incidence would be affected by season changes. In several sporting environments, decreased physical preparation, aerobic conditioning, and preseason strength are associated with increased injury rates [4–6]. An increase in injury rates may be attributed to stress theory, which states that a sufficiently large stimulus applied to an inadequately adapted tissue may result in injury [7]. Season changes, such as a decrease in official preseason

training time, may result in relative deconditioning and insufficient fitness and physiologic adaptations needed for the stimulus of competition. Additionally, it has been reported that COVID-19 mandated quarantines are more detrimental to physical conditioning than traditional off-seasons in professional football (soccer) players [8]. Several analyses of the effects of the COVID-19 pandemic on injury rates in professional sports demonstrate increased injury rate and alterations in patterns of injury [9–11].

The purpose of this study was to determine the incidence and epidemiology of NFL injuries in the 2020 season compared to typical NFL seasons (2018–2019 seasons). By investigating these data, we aim to add to the discussion of the importance of official team-based pre-season conditioning versus individual conditioning in the off-season in order to prevent injuries in season. We hypothesized that the injury incidence in the NFL would be increased, and the increase in injury rate ratio would affect all body regions equally due to a rapid increase in workload without a typical preseason schedule, representing increased acute to chronic work ratio (ACWR), which has been shown to be associated with injury in a variety of athletes [12–14]. Furthermore, we hypothesized that the early season (weeks 1–4) would represent a higher

ACWR in 2020 compared to previous seasons leading to higher injury rates.

Methods

Data collection

Data from NFL injury reports for 17 weeks of the regular season and 4 weeks of the playoffs from 2018 to 2020 were extracted from *fftoday.com* [15] as previously used by Sheth et al. to investigate NFL Injury epidemiology [2]. This database compiles and formats injury reports that are released publicly by the NFL. These public injury reports have been used in multiple peer-reviewed NFL epidemiologic studies [3,16–19]. Data from the 2018–2020 seasons were collected because these injury reports provided more consistent and complete information than earlier seasons. Furthermore, a recent study reported that NFL injury rates have not changed significantly from 2010 to 2019 [2]. Therefore, two seasons give a representative sample of injury incidence in the current era.

Data collected on an Excel spreadsheet included position, player, team, injury (body part injured) and status (e.g., Out or Injured reserve). We collected occurrences of the most serious injury grades in the injury reports, those players listed as 'out' for that week's game and those players placed on injured reserve (IR). Of note, in 2020, those placed on the injured reserve were allowed to return after 3 weeks in order to mitigate the impact infections may have on rosters by the end of the season, whereas those in previous seasons were to sit out the remainder of the season [20]. Injuries were tabulated for each game missed as noted in the injury reports. If one injury resulted in multiple games missed for a single player, this was still tabulated as a single injury. If one player reported multiple injuries accounting for one game missed, this was counted as multiple injuries. Injuries were sorted by position and body area injured. Body areas were subdivided into lower extremity, upper extremity, spine and core, head injuries, illness (including viruses such as COVID-19, gastrointestinal illnesses, and atraumatic organ dysfunction), not injury related (such as personal issues or holdouts), and undisclosed.

Statistical analysis

Injury incidence was calculated per 1000 player exposures using a similar method used by Posner et al [21] to analyze injury incidence in Major League Baseball. One player exposure was defined as one game per athlete. Therefore, for the pre-COVID-19 cohort (2018 through 2019 seasons), total exposures were calculated using a 16-game season, 46-man active roster, and 32 teams in the NFL with individual playoff weeks consisting of 12 teams, 8 teams, 4 teams, and 2 teams. In 2020, exposures were calculated using the expanded 48-man active roster, expanded for the COVID-19 season [20]. This leads to a total number of exposures of 25,824 exposures in the 2020 season, and 56,056 exposures in total for the 2 seasons prior. Incidence rate for the pre-COVID-19 (2018 through 2019 seasons) cohort was calculated using the cumulative number of injuries and exposures over the course of 2 years. Incidence rate ratio (IRR) was calculated by dividing incidence in the

2020 group by incidence in the pre-COVID-19 group for overall injury rates and injury rates for each anatomic zone. Significant differences were determined using the z-test for proportions. We also analyzed injury incidence over the first 4 weeks of the regular season and the final 17 weeks of the regular and post-season separately. This was done to analyze how the 'early season' may have differed between 2018 and 2019 four preseason games and the 2020 season with an abbreviated preseason. We chose 4 weeks as the cutoff for early season as 4–6 weeks is the most commonly referenced cutoff for acute versus chronic workload [13,22]. In addition, with the four pre-season games canceled [23], 4 weeks was an accurate estimate of the transitional phase between pre-season and in-season workload.

Finally, the proportion of injuries occurring in each position was analyzed. Fisher's exact test was used to determine significant overall differences between groups in injury distribution by position as the infrequency of injuries to certain positions made the chi-square test less accurate [24]. Due to the nominal nature of the data, no normality assumption was required [25]. Post-hoc testing was done using z-test for proportions as appropriate. P-values were adjusted for the number of comparisons within each table using Bonferroni correction. R software version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria) [26] was used for data analysis. Statistical significance was set at $P \leq 0.05$.

Results

In the two seasons prior to COVID-19, there were 1317 individual injuries leading to an 'out' or 'IR' listing for at least 1 week, with an incidence of 23.5 injuries per 1000 player exposures. In 2020, there were 617 such injuries leading to an incidence of 23.9 per 1000 player exposures in 2020 for an IRR of 1.0 (95% CI: 0.9–1.1, $p > 0.999$). The incidence of illness (IRR = 3.0, 95% CI: 1.6–5.7, $p = 0.004$) and non-injury related reasons (IRR = 3.5, 95% CI: 1.8–7.0, $p = 0.001$) for the 'out' or 'IR' listing significantly increased in 2020 over the course of the whole season (Table S1, Figure 1).

Over the course of the first 4 weeks of the season there were no significant differences in injury incidence overall or in any individual category (Table S2, Figure 2). Over the subsequent 17 weeks, the 2020 season showed a significantly increased rate of illness-related (IRR = 4.8, 95% CI: 2.2–10.5, $p < 0.001$) and non-injury related out listings (IRR = 3.8, 95% CI: 1.8–8.4, $p = 0.002$) (Table S2, Figure 3).

Fisher's exact test showed that there were no significant differences in the proportion of injuries suffered by position before and after COVID-19, with the most often injured individuals being offensive linemen, linebackers/defensive backs, defensive linemen, wide receivers, and cornerbacks (Tables 1,2,3).

Discussion

The principal finding of this study is that the injury rate did not significantly change in 2020 despite the disruptions in the pre-season schedule caused by COVID-19. In addition, no

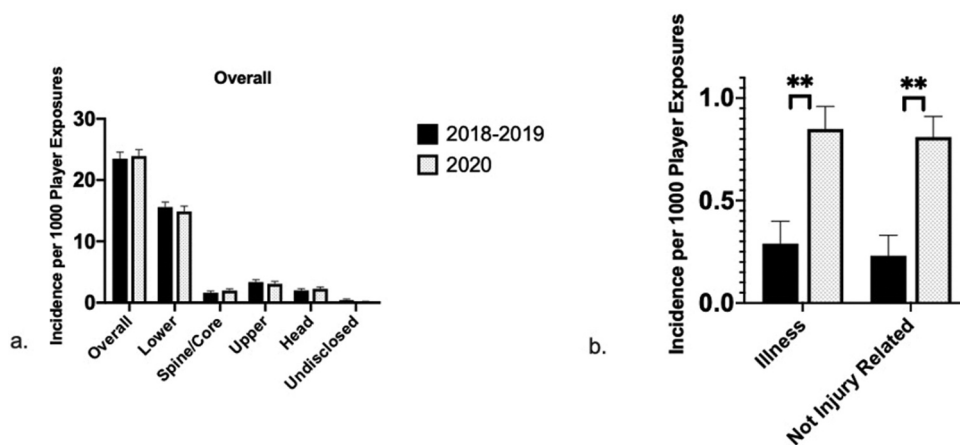


Figure 1. (a) Non-significant injury incidence findings per 1000 player exposures by anatomic zone throughout the season, (b) Significant injury incidence differences throughout the whole season $**p < 0.01$.

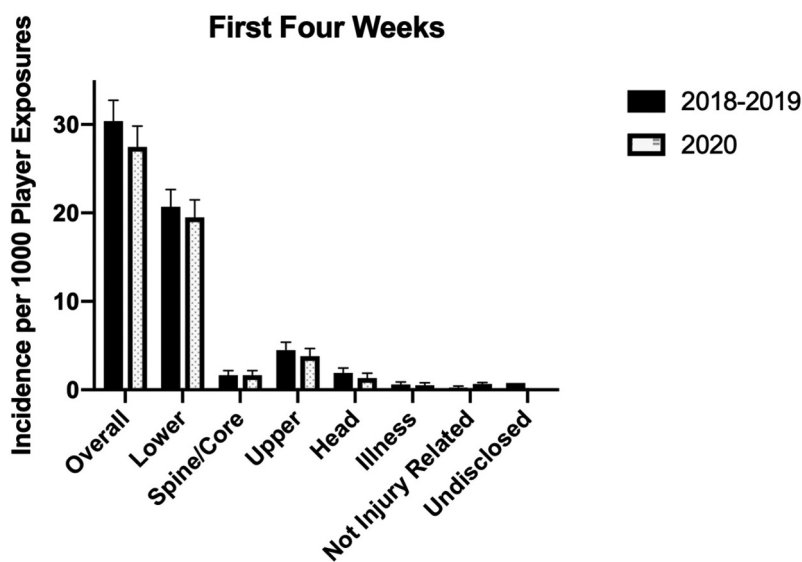


Figure 2. Injury incidence per 1000 player exposures by anatomic zone in the first four weeks of the season.

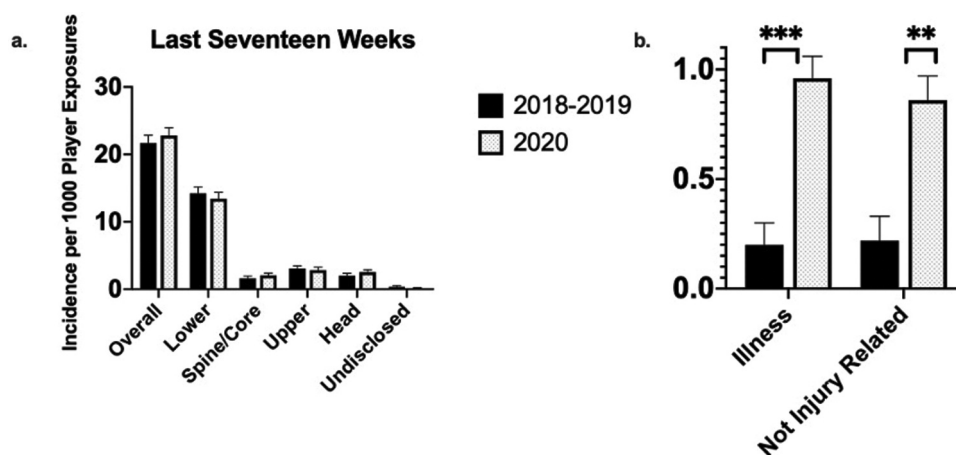


Figure 3. (a) Non-significant injury incidence findings per 1000 player exposures by anatomic zone in the final seventeen weeks of the season; (b) Significant injury incidence differences in the last 17 weeks of the season $**p < 0.01$, $***p < 0.001$.

Table 1. Comparison of proportion of all injuries by position through the entire season, Fisher's exact test $p > 0.999$; DB = Defensive Back, DL = Defensive Lineman, K/P = kicker/Punter, LB = linebacker, L = offensive lineman, QB = quarterback, RB/FB = running back/fullback, TE = tight end, WR = wide receiver.

	2018–2019		2020		Difference
	Players	Percentage	Players	Percentage	
DB	275	21.3%	173	28.5%	7.2%
DL	160	12.4%	84	13.8%	1.4%
K/P	16	1.2%	6	1.0%	-0.3%
LB	153	11.9%	54	8.9%	-3.0%
OL	236	18.3%	108	17.8%	-0.5%
QB	30	2.3%	13	2.1%	-0.2%
RB/FB	123	9.5%	63	10.4%	0.8%
TE	101	7.8%	37	6.1%	-1.7%
WR	197	15.3%	70	11.5%	-3.8%
Total	1291	100.0%	608	100.0%	

Table 2. Comparison of the proportion of injuries by position in the first 4 weeks, Fisher's exact test $p > 0.999$. DB = Defensive Back, DL = Defensive Lineman, K/P = kicker/Punter, LB = linebacker, OL = offensive lineman, QB = quarterback, RB/FB = running back/fullback, TE = tight end, WR = wide receiver.

	2018–2019		2020		Difference
	Players	Percentage	Players	Percentage	
DB	67	19.1%	44	27.2%	8.0%
DL	52	14.9%	23	14.2%	-0.7%
K/P	5	1.4%	1	0.6%	-0.8%
LB	39	11.1%	20	12.4%	1.2%
OL	61	17.4%	25	15.4%	-2.0%
QB	7	2.0%	4	2.5%	0.5%
RB/FB	32	9.1%	13	8.0%	-1.1%
TE	29	8.3%	9	5.6%	-2.7%
WR	58	16.6%	23	14.2%	-2.4%
Total	350	100.0%	162	100.0%	

Table 3. Comparison of proportion of injuries by position in the second 17-weeks, Fisher's exact test $p > 0.999$; DB = Defensive Back, DL = Defensive Lineman, K/P = kicker/Punter, LB = linebacker, OL = offensive lineman, QB = quarterback, RB/FB = running back/fullback, TE = tight end, WR = wide receiver.

	2018–2019		2020		Difference
	Players	Percentage	Players	Percentage	
DB	208	22.1%	129	28.9%	6.8%
DL	108	11.5%	61	13.7%	2.2%
K/P	11	1.2%	5	1.1%	-0.1%
LB	114	12.1%	34	7.6%	-4.5%
OL	175	18.6%	83	18.6%	0.0%
QB	23	2.4%	9	2.0%	-0.4%
RB/FB	91	9.7%	50	11.2%	1.5%
TE	72	7.7%	28	6.3%	-1.4%
WR	139	14.8%	47	10.5%	-4.2%
Total	941	100.0%	446	100.0%	

difference was found despite the change in the injury reserve in which those placed on IR could return later in the season instead of being unavailable for the remainder. Furthermore, the distribution of injuries among positions did not change. The only other times that the NFL season was similarly disrupted were during the players' strikes in 1982 and 1987 [27] and a lockout in 2011 [28]. These instances did not contend with pandemic effects. Unfortunately, we lack detailed historical injury data to directly compare the effects of these interruptions on injury rates. However, an editorial written after the 2011 lockout suggested an increased incidence of specifically

Achilles injuries when players returned to play after a layoff from May to July [28].

As expected during the pandemic, there was a significant increase in 'out' and 'injured reserved' listing related to illness. While only one of these listings was specified in the injury reports as due to COVID-19, it can be assumed that the coronavirus was responsible for the illness increase directly by infection and indirectly through players reported as out due to exposures leading to quarantine. According to the NFL Players' Association, there were only 18 positive COVID-19 test in players in 2020 [29]. Quarantining and opt-outs are also potentially responsible for the increase in "not injury related" reasons for being listed as out.

An increase in injury risk may be expected based on greater acute to chronic work ratio (ACWR). This correlation has been reported in multiple sports, including American football [13,14]; however, our findings do not demonstrate an increased reported injury rate. Contrary to our hypothesis, no overall difference was shown in the early season. We hypothesized that the early season would represent a higher ACWR in 2020 compared to previous seasons due to the pre-season changes of 2020, including the cancellation of 4 weeks of preseason games. Our hypothesis was driven by the reported findings in professional athletes that COVID-related quarantines and training disruptions were more detrimental to the athletes physical fitness [8,30,31]. It appears these changes did not lead to increased injury risk for players. ACWR could be increased without a concomitant increase in injury rates. Additionally, if one examines the season as a whole, fewer total games played may be protective by both decreasing the workload and the number of athlete exposures.

Another interesting finding is that despite the flexibility of IR placement with the 2020 rules updates, significantly more players were not placed on the IR. Prior to 2020, once a player was placed on the IR, that player was not permitted to return to play for the remainder of the season. Players on the IR in 2020 were only required to sit out for 3 weeks. Increased IR usage was expected because of the ability to return in season even after IR placement; however, our data do not support this theory. This supports the finding that there was no significant increase in musculoskeletal injuries in 2020 in the NFL.

Our findings in the NFL contrast with those of MLB in 2020. Major League Baseball demonstrated a significantly increased overall rate of injuries overall, upper extremity injuries, and spine/core injuries compared to 2018 and 2019 [32]. There are several potential reasons for this. First, the 2020 MLB pre- and regular seasons were dramatically more affected by the pandemic compared to the NFL seasons. Whereas the NFL was able to play all 16 regular season games and have players report to training camp on time (July 28) [1], the MLB experienced a four-month layoff between spring training in March and a brief inter-squad preseason in July [33]. While the NFL canceled its preseason games [23] and its players experienced many training limitations during the early phase of the pandemic, the MLB appears to have been more dramatically affected, which may have led to relatively higher ACWR. Further, the longer overall layoff of the MLB likely led to

more muscular deconditioning and weakening of tendinous and ligamentous attachment sites or entheses [34].

Another major difference between the MLB and the NFL is the distribution of injuries experienced by players. In the NFL, the most commonly affected anatomic zone injured is the lower extremity as shown by both our data and previous epidemiologic studies [3,35]. In contrast, upper extremity injuries make up the highest proportion of injuries in the MLB due to the volume of overhead throwing [21,32]. Notably, in the 2020 MLB season, there was no significant difference in the incidence of lower extremity injury compared to pre-COVID seasons with normal preseasons. The authors hypothesized that the ability to prepare for the stress of sport in the lower extremity is more accessible under a pandemic lockdown compared to overhead throwing due to lack of access to teammates to throw to or training facilities with adequate space for intense throwing [32]. In comparison, many NFL players appear to have been able to adequately prepare their lower bodies for the 2020 season despite the restrictions caused by the pandemic. A focus on home training and conditioning in professional athletes has demonstrated positive effects on players' mental and physical well-being, even if fitness was not maintained at peak performance [31,36].

As with all studies, this investigation has limitations. The specific population of NFL players renders these results not generalizable to all athletes. Utilizing publicly accessible data also limits the ability to consider all details of each injury. We were only able to account for injuries that resulted in at least one missed game; therefore, injuries that players sustained, yet continued to play with, were uncounted. This limitation suggests we may be underestimating the true injury incidence; however, if the player can continue playing despite the injury, the injury is inherently less severe. Additionally, we were limited in the amount of injury details that were made publicly available. While more complete information was available in the injury reports included in our analysis compared to previous years, leading to a minimal number of injuries being sorted into the 'undisclosed' category, most injuries could not be analyzed in any more detail than general anatomical areas. We elected to analyze the most recent seasons of 2018–2020 because of increased detail in reporting metrics to better capture injuries and their affected body parts. While analyzing more seasons would allow for an enhanced ability to find general trends, this strategy would come at the expense of the detailed injury reporting. In the future, more in-depth data about player injuries should be used in conjunction with large, publicly available data sets to identify risk factors for specific pathologies.

Conclusion/summary

The incidence of NFL injuries did not significantly change overall in 2020 despite limitations from the COVID-19 pandemic. The distribution of injuries did not change with respect to position. There was a potentially lower risk for lower extremity injuries in the late season in 2020 compared to previous seasons.

Disclosure statement

Dr Stone reports the following potential conflicts of interest: AOSSM and AANA membership; education for Smith and Nephew, Arthrex, and MedWest Associates; travel and lodging from Smith and Nephew and Styker; food and beverage from Styker, Smith and Nephew, CDC Medical LLC, Vericel Corporation, Wright Medical Technology Inc; consultant Smith and Nephew, Allosource; Research support Flexion therapeutics, Allosource.

Dr Johnson reports the following potential conflicts of interest: Consulting for Smith and Nephew, royalties from Smith and Nephew, travel and lodging from Smith and Nephew, food and beverage from Smith and Nephew, Medtronic Vascular, and DJO LLC.

Dr Jacobs reports the following potential conflicts of interest: Consulting for Flexion Therapeutics and grants from Flexion Therapeutics and Smith and Nephew.

Dr Stockwell reports the following potential conflicts of interest: Education for Medical Device Business Services, Inc., food and beverage from Depuy Synthes Sales Inc. and Stryker.

Drs Platt and Collofello report no potential conflicts of interest.

Data availability statement

The data supporting the findings of the study are available within the article, supplementary materials, and via the following link <https://docs.google.com/spreadsheets/d/19axN3Xa-RXWW2IIJJ22PY-nxlv8YQrMgIS-b3QnipsQ/edit?usp=sharing>

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