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Hamstring injuries in the national football league: An epidemiological study

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ABSTRACT

Background: While numerous studies have evaluated National Football League injuries, there is limited literature evaluating hamstring injuries sustained in games. Our primary aim is to analyze the effect of player position on the relative incidence of hamstring injuries in the National Football League. Our secondary aims are to analyze the effects of field surface, week of the season, and short rest weeks.

Methods: Official National Football League game books containing injury data from the 2013–2016 regular seasons were used. Data were analyzed to determine the incidence of hamstring injuries by field surface, rest, and week of the season. Field surface was considered either turf or grass. Short rest was considered four days. Relative incidence of hamstring injuries by position was performed with standardized incidence ratios. P values < 0.05 were considered statistically significant.

Results: Seventy-eight qualifying hamstring injuries were identified and included in our analysis. Linebackers had the highest relative incidence per play with a standardized incidence ratio of 2.02 (CI: 1.14–2.91), followed by Defensive Backs (1.62; 95% CI: 1.14–1.62). Offensive linemen and defensive linemen had standardized incidence ratios significantly less than 1. Fifty-seven percent of hamstring injuries occurred on turf fields ($p = 0.082$). There was no significant difference between the proportion of hamstring injuries that occurred on short rest and the proportion of games played on short rest ($p = 0.959$). Hamstring injuries were not more likely to occur than the pooled group of all other types of injuries on short rest ($p = 0.861$). With a 17-week season, the mean week of hamstring injury was 8.05 (95% CI: 7.06–9.04), while the median week was 7.5.

Conclusions: Linebackers and Defensive Backs have the highest relative incidence of hamstring injuries compared to other position groups, while offensive and defensive linemen have the lowest. Field surface and a short rest period did not show significance.

1. Introduction

The National Football League (NFL) is one of the most popular sports leagues in America, averaging over 17 million viewers per regular season and over 208 million viewers during the 2022 super bowl.[18,26] The NFL has 32 teams each containing 53 players. The physical nature of football subjects players to numerous injuries. At least one injury is sustained in 97.7% of NFL games.[16] The risk of an NFL player sustaining a lower extremity injury in one season is 41%, with the most common injury being a hamstring strain.[17]

Previous studies have sought to analyze how various factors affect NFL in-game injuries, including the effects of field surface and the amount of time between games. Field safety has been a topic of discussion at the highest levels of the NFL administration and amongst NFL athletes. Currently, 14 NFL teams play home games on turf while the other 18 teams play on grass. Several studies studying field surface found a higher injury rate in games played on turf,[14,20,23] while one study found no difference.[10] Furthermore, while most NFL games are hosted on Sundays, games are increasingly scheduled on other days of the week, such as Thursday night. Perez et al. (2020) found that having less time between games resulted in a lower injury rate (1.26 vs 1.53; $P = 0.03$).[21]

While injury rates in the NFL have been well-studied as a whole, there is a paucity of literature focusing specifically on HSIs. Hamstring injuries can be particularly devastating as they can sideline players for multiple weeks and have a high recurrence rate.[5] In an effort to better

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understand hamstring injuries and potential risk factors, this study analyzes the standardized incidence ratios (SIR) of HSIs, which take into account how many players of each position are on the field per play. The primary aim of this study is to analyze SIRs by NFL position for HSIs. The secondary aims are to determine the effects of field surface, games played on short rest, and week of the NFL season on regular season in-game HSIs in NFL players.

2. Methods

Publicly available official NFL gamebooks were obtained for each game played from the 2013 through the 2016 NFL regular season. Gamebooks were then used to identify in-game injuries. These books only report injuries that occurred during an NFL game. Therefore, injuries that occurred during practice and the off-season were excluded. The in-game injury report was cross-referenced with Foxsports.com to determine which injuries were sustained by the hamstring. These methods were used in previous studies from our research group to analyze NFL injuries.[6,21] Inclusion criteria were all HSIs that occurred during NFL regular season games. An HSI was defined as any strain, partial tear, or complete tear to the hamstring. Each HSI was recorded individually, therefore, HSI re-injuries to the same player were recorded. Data were analyzed to determine the relative incidence of HSIs by position, field surface, rest, and week of the NFL season. As all data were publicly available, this study was exempt from institutional review board approval. The NFL provided written consent authorizing the use of game books before the present study was conducted.

For each NFL position group (quarterback (QB), running back (RB), wide receiver (WR), tight end (TE), offensive lineman (OL), defensive lineman (DL), linebacker (LB), and defensive back (DB)), HSI frequency was compared to the overall frequency of plays on the field by each group. The frequency of plays on the field by position group was determined using offensive personnel data from the 2021 NFL season[22] and defensive personnel data from the 2020 NFL season.[3]

Field surface was considered as either turf or grass fields. Incidence of HSI was compared between field surfaces. The relationship between field surface and injury type (HSI or other) was also assessed. The proportion of grass and turf fields was determined using the distribution in the 2013–2016 NFL seasons.

Rest impact was assessed by comparing the proportion of HSIs incurred on short rest (4 days of rest) to the proportion of games played on short rest. The proportion of HSI incidence on short weeks was also compared to the proportion of all other injury types occurring on short weeks. The week of the NFL season in which each HSI occurred was also evaluated.

2.1. Statistical analyses

All data were analyzed using Microsoft Excel Version 16.16.27. If HSIs were distributed evenly across position groups, the relative positional incidence would be equal to the average proportion of players from a given position group on the field per play; therefore, this was defined as expected relative positional incidence. Ninety-five percent confidence intervals were then calculated for the actual relative positional incidences and were subsequently divided by the expected relative positional incidences to calculate the standardized incidence ratios (SIRs) for each position. An SIR of 1 indicates no deviation from expectation, while an SIR >1 indicates greater incidence than expected (and an SIR of <1 indicates less incidence than expected), where the expectation is defined as the relative incidence of HSI for a position group being equal to the average proportion of players on the field from that position group. The actual relative positional incidence of HSI was calculated by dividing the total number of HSIs seen for each position by the total number of HSIs seen in the sample.

A two proportion Z-test was used to compare incidence of HSI between field surfaces. Additionally, a Chi-Squared test of independence was used to test association between field surface and injury type (HSI or other). Two proportion Z-tests were also used to compare incidence of HSIs on short weeks relative to other types of injuries and relative to proportion of games occurring on short weeks. An unpaired two-sample *t*-test assuming equal variances was used to compare mean week of season in which hamstring and other injuries occurred.

3. Results

Seventy-eight qualifying HSIs were identified and all were included. Eight (10.3%) injuries were suffered by players who incurred a previous in-game HSI within our study period. LBs and RBs had the highest incidence of HSIs relative to the proportion of players on the field they made up, both with SIRs of 2.02. The actual proportion of HSIs in LBs (95% CI: 1.14–2.91), as well as in DBs (95% CI: 1.14–2.10), was greater than the expected proportion. For offensive (95% CI: 0.0429–0.521) and defensive lineman (95% CI: 0.0132–0.566), experienced a lower proportion of HSIs than expected (Fig. 1).

There was no relationship between injury type (HSI or other injury) and field type (turf or grass) ($p = 0.283$) (Table 1). There was no significant difference between the percentage of HSIs that occurred on turf and the percentage of games that were played on turf (57.7% versus 43.75%, $p = 0.082$).

There was no difference in the proportion of HSIs incurred on short rest compared to the proportion of games occurring on short rest ($p = 0.959$) (Table 2). There was no difference between the incidence of HSIs incurred on short rest compared to the incidence of other injuries incurred on short rest ($p = 0.861$) (Table 3).

Mean week of HSI was 8.05, while median week of HSI was 7.5, both earlier than the midpoint of the NFL season. The midpoint of the NFL season was within the 95% confidence interval for mean week of HSI (HSI: 95% CI: 7.06–9.04, season midpoint: 8.5). There was no difference between mean week of the season in which HSIs occurred versus the mean week of the season in which other types of injuries occurred (Mean: 8.84; CI: 8.58–9.10) (Table 4).

4. Discussion

Our findings demonstrate that LBs and DBs have a disproportionately high number of HSIs (SIRs of 2.02 and 1.62 respectively) whereas OL and DL have a disproportionately low number of HSIs (SIRs of 0.28 and 0.29 respectively). HSIs often have adverse effects on NFL player's careers. Hamstring strains are the second most common injury in the NFL and the third most common injury in college football.[7,12] It has been reported that NFL players have a HSI recurrence rate of 38.4% and a 13.4% increased risk of reinjury if the player returned to play (RTP) within two weeks.[5] In the present study, 10.3% ($n = 8$) of HSIs occurred in players with a history of HSI within our study period. This does not account for HSIs suffered during practice or non-regular season games. Repeated HSI may be consequential for a players time in the game and performance upon RTP. In other sports such as rugby and Australian football, player performance has been negatively affected after HSI, however, there is a paucity of literature describing performance outcomes following HSIs in NFL players.[4,9,27]

HSIs in NFL players have been shown to have a distribution of 88% strains, 11.3% partial tears, and 0.63% complete tears.[5] Risk factors for HSI include returning to play too soon, inadequate pre-exercise stretching, a hamstring to quadriceps strength ratio (H:Q) of <0.6, and a $>10\%$ strength difference between hamstrings on each leg.[8,11,13] A deficit in the H:Q causes the hamstring to be overpowered by the quadriceps. In this scenario, the strength of the quadriceps contraction surpasses the force able to be withstood from the hamstring which causes injury.[19] Hamstrings, if injured, are typically damaged at the myotendinous junction. This occurs during the onset of a sprint with rapid hip flexion and knee extension. LBs and DBs abruptly stop, start, and change directions many times per game which may partially explain

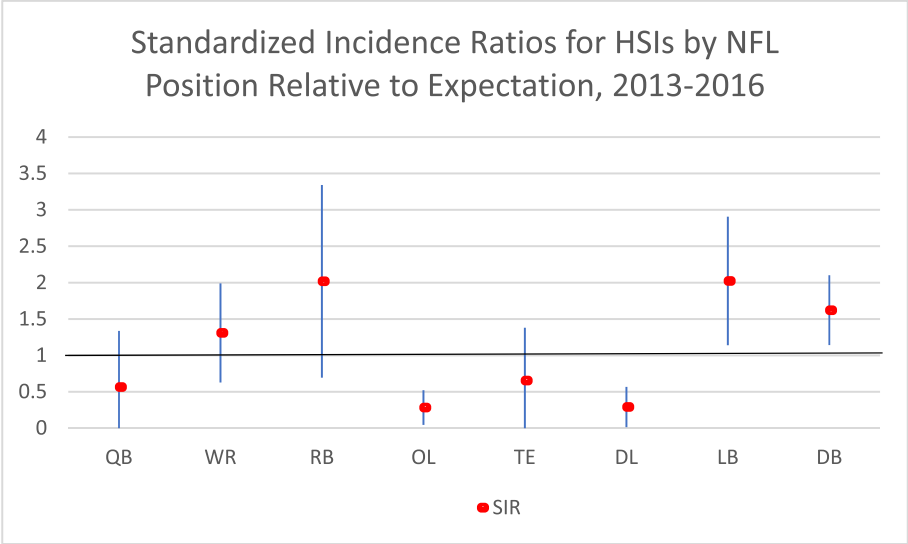

Fig. 1. Standardized Incidence Ratios (SIRs) for Hamstring Injury (HSI) by NFL position group, along with their 95% confidence intervals, are shown above. LBs and DBs had significantly more HSIs than expectation, while OLs and DLs had significantly less HSIs.

Table 1
Proportion of hamstring injury and other injury type that occurred on grass and turf fields, 2013–2016 NFL regular season games.

Injury Type	N	Grass Field (n = 18) (%)	Turf Field (n = 14) (%)
HSI	78	33 (42.3%)	45 (57.7%)
Other	1316	639 (48.6%)	677 (51.4%)
χ^2 for Independence	1.15		
P-Value	0.283		

NFL - National Football League. HSI - Hamstring Injury. Other refers to all injury types other than HSI.

Table 2
Proportion of hamstring injury and all games that occurred on 4-day weeks, 2013–2016 NFL regular season games.

	N	4-Day Week (%)
HSI	78	5 (6.41%)
All Games	1024	64 (6.25%)
Z	0.051	
P-Value	0.959	

NFL - National Football League. HSI - Hamstring Injury. All Games refers to each NFL regular season game played from 2013 to 2016. Note that each game includes two participating teams.

Table 3
Proportion of hamstring injury and other injury type that occurred on 4-day weeks, 2013–2016 NFL regular season games.

Injury Type	N	4-Day Week (%)
HSI	78	5 (6.41%)
Other	1316	78 (5.93%)
Z	0.175	
P-Value	0.861	

NFL - National Football League. HSI - Hamstring Injury. Other refers to all injury types other than HSI.

Table 4
Mean week of occurrence of hamstring injury and other injury type, 2013–2016 NFL regular season games.

Injury Type	N	Mean Week of Injury (NFL Midpoint: 8.5 weeks)	95% Confidence Interval	Median Week of Injury
HSI	78	8.05	[7.06, 9.04]	7.5
Other	1316	8.84	[8.58, 9.10]	9
t-statistic	1.41			
P-Value (two-tailed)	0.159			

NFL - National Football League. HSI - Hamstring Injury. Other refers to all injury types other than HSI.
Note: The NFL season was 17 weeks long at the time the data in this study was accrued. The NFL season is now 18 weeks as of 2021.

their higher SIRs. OLs and DLs, on the other hand, may have lower SIRs due to the fact that they are less likely to enter the takeoff phase of sprinting. Nonetheless, our findings warrant further research to investigate the causality between position and HSI in NFL athletes.

Previous literature has shown higher rates of lower extremity, ankle, and knee injuries in NFL players on turf compared to grass.[14,20,23] In 2010, the NFL surveyed 1619 active players regarding player perception on the effects of field type on injury rates. Eighty-two percent of players voted that turf was more likely to cause injury, 89.1% voted turf more likely to cause soreness and fatigue, 89.7% voted turf to shorten their career, and 64.4% voted turf to negatively affect their quality of life after football.[1] Despite prior studies and player perception, our analysis showed no statistical significance between field type and HSI ($p = 0.082$).

Although fatigue and overuse are considered risk factors for athletic injuries, the present study found no increased risk of HSI in games played on short rest.[25] Perez et al. analyzed 2846 in-game NFL injuries to compare short rest (4 days) and regular rest (6–8 days).[21] They found a lower injury rate in games with short rest.[21] These findings concur with data released by the NFL showing a lower rate of injuries in Thursday football games compared to games played on other days.[2] One explanation is that NFL teams may have fewer or less physically demanding practices between games played on short rest as compared to games played on normal rest, which may contribute to lower injury risk.

In a 17 week season, the mean week of HSI was 8.05 (median: 7.5),

whereas the mean week for all other injuries was 8.84 (median: 9). This suggests that HSI are more likely to occur in the first half of the regular season while all other injuries are likely to occur in the latter half of the season. The literature has shown mixed results with regard to injury rates according to time in the season. In an analysis of Canadian football league players, Robbins et al. (2021) found overall injury rates to decline by 1% per week.[24] Krill et al. (2020), reported that college football players were more likely to sustain injuries during the preseason or early in the regular season rather than later in the season.[15]

This study has limitations. Since data were derived from game books, no data regarding players' previous medical conditions was collected. Therefore, previous HSIs that occurred outside the study range were not identified. HSI recurrence incidence could be more accurately assessed with additional past medical history, including prior NFL and even collegiate injuries. Moreover, game books do not report data regarding the mechanism and severity of injury. Notwithstanding, this methodology has been used in previous studies and is accepted in the medical community.[6,21] Finally, the data used to determine proportion of plays on the fields for offensive (2021) and defensive (2020) players was not from the same seasons as the period that the injury data was collected (2013–2016). However, analysis of the available year-over-year positional data shows minimal changes in formation usages since 2018, indicating that the numbers we used for proportion of players on the field per position was not significantly different from our study period.

4.1. Conclusions

Linebackers and Defensive Backs have the highest relative incidence of hamstring injuries compared to other position groups, while offensive and defensive linemen have the lowest. Field surface and a short rest period did not show significance.

CRediT author statement

Dylan Luxenburg: conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review and editing, visualization, supervision, project administration, Nathan Wasserman: conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review and editing, visualization, Joseph Geller: conceptualization, methodology, writing – original draft, writing – review and editing, visualization, supervision, project administration, Jose Perez: conceptualization, methodology, writing – original draft, writing – review and editing, visualization, supervision, project administration, Jonathan Burke: conceptualization, methodology, writing – original draft, writing – review and editing, visualization, supervision, project administration, Lee Kaplan: conceptualization, supervision, project administration, writing – original draft, writing – review and editing.

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Institutional ethical committee approval

Not required as the data used for this study was publicly available.

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Declaration of competing interest

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