

Influence of Preseason Versus In-Season Play on Achilles Tendon Injuries in the National Football League

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Investigation performed at Brown University, Providence, Rhode Island, USA

Background: A ruptured Achilles tendon (AT) can sideline a player for 6 to 12 months and reduce their power rankings by more than 50%. Previous research has compared AT rupture rates in different game conditions.

Purpose: To determine environmental and physiological risk factors for AT tears, given the minimal amount of research on AT ruptures in the National Football League (NFL).

Study Design: Case series; Level of evidence, 4.

Methods: NFL players with a diagnosed AT tear between 2009 and 2016 were selected as the study population for this retrospective analysis. Data on NFL injury were collected from an established database composed of publicly available information. Player profiles were employed to determine position, team, and game statistics at the time of injury. The proportion of NFL rookies was approximated by summing the number of draft picks and the number of signed, undrafted free agents and measured against the number of roster spots before the season.

Results: Between 2009 and 2016, there were 101 documented AT tears. Of these, 64% (65/101) occurred before the official season, including preseason games. Of the 36 tears that occurred in-season, 34 were during games. Overall, 29% (19/65) of the preseason tears occurred in rookies and 100% (36/36) of the in-season tears affected nonrookies. Of the rookies with AT ruptures, 42.11% returned to play in the NFL, while 62.20% of the nonrookies came back to partake in future seasons. Despite an average age of 26.7 years, the tear distribution was bimodal with players aged 24 and 36 years exhibiting the highest rates of tear.

Conclusion: In our review of AT tears in NFL athletes, a large percentage of the tears occurred in rookie players, especially during the preseason. We also found that tears during the season occurred in only nonrookies, suggesting that the preseason is when rookies experience the greatest risk for injury.

Keywords: Achilles tendon; sports medicine; tendon injury; ankle injury; lower extremity injury

Injuries to the lower extremities can severely interrupt and, in some cases, end a National Football League (NFL) player's career. A recent study⁸ on the epidemiology of all major injuries in the NFL found that the highest number of injuries were to the knee, followed by those to the ankle. Of ankle injuries, a torn Achilles tendon (AT) can sideline a player for 6 to 12 months and reduce player power rankings by more than 50%.¹² Despite this, AT injuries have been given considerably less attention than knee or head injuries.⁷

While previous studies^{8,12} have assessed risk factors for AT tears in the NFL, there is a scarcity of studies assessing the relationship between player experience and their risk

of injury. Previous studies^{7,8,12} have examined return-to-play (RTP) rate, player position, power rankings, game environment, and player age and demographics. In addition, other epidemiologic studies^{5,7,8} have focused on the time in the season at which injuries were likely to occur, either in regular or postseason, but disregarding out-of-season training and preseason play. Although player demographics have been examined, player experience has not been studied within AT rupture data.

The purpose of this study was to evaluate tears throughout the entire year, both in season and out of season. Thus, in this study, we examined rates of AT tears and hypothesized that inexperienced athletes at the professional level ("rookies") would be at increased risk for tears. More specifically, this is suspected to occur during the preseason, given the increased workload and the large transition collegiate athletes undergo as they progress to the NFL.

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METHODS

Player Cohort

NFL players with a diagnosed AT tear between 2009 and 2016 were evaluated through an established database composed of publicly available information.^{5,6,17} As NFL teams are required to publicly disclose injury data, player information can be found in weekly injury reports. Data on NFL injuries were collected from NFL player profiles and used to determine player position, team, and game statistics at the time of injury. Each included player had to be on a team roster at the time of injury. All documented AT ruptures in the NFL that took place between 2009 and 2016 were reviewed and analyzed under such variables as position, season, air temperature, player weight, practice versus game, height, age, years in league, team, date, field type, draft pick, and timing during game. For players who sustained subsequent AT ruptures, only the index rupture was included in the data set. This was to prevent any possible confounding regarding residual impact of a prior AT injury.

In this data set, skilled players included the following positions: quarterback, running back, wide receiver, tight end, cornerback, linebacker, and safety. Unskilled players included center, guard, offensive tackle, defensive tackle, defensive end, and offensive guard. “Special teams” referred to kicker, punter, and long snapper. Players’ primary position was determined by the team roster at the date of injury, as athletes could shift positions in different seasons. RTP was defined as a player returning to play in at least 1 game: preseason, regular season, or postseason.

The proportion of rookies in the NFL was approximated by summing the number of draft picks (256 athletes) and the number of signed, undrafted free agents (456 athletes in 2017), totaling 712 players. This value was then measured against the total number of preseason spots (90 per team) before the roster was reduced to 53 when commencing the official season.^{1,2} With 32 teams in the NFL, there are initially 2880 athletes. Therefore, our approximation of rookies was 22 players per preseason team (712 players spread over 32 teams). Additionally, if the percentage of rookies in the league is calculated, these players represent approximately 24.72% (712/2880) of all preseason athletes, or 1 in 4 players before the roster thins to 53.

Statistical Analysis

Incidence of AT ruptures was computed by assuming 53 players per team, 105 practices per season, 16 games per season, and 32 teams in the NFL, as was the case for the NFL within the years of the study period.¹⁵ Incidence was thus expressed per 10,000 athlete-exposures, where an athlete-exposure was a single participation in a single practice or game. Generalized linear models were used to determine changes in incidence across time as well as changes in number of injuries with years of experience in the NFL. Comparisons between proportions were assessed through chi-square analysis or 2-tailed independent-samples *t* tests for continuous variables. Statistical analysis was performed using RStudio Version 1.1.442 (RStudio). An α value of 0.05 was used.

RESULTS

Between 2009 and 2016, there were 101 players with documented AT ruptures (Figure 1). The incidence of AT ruptures more than doubles across the study period from 0.341 injuries per 10,000 athlete-exposures in 2009 to 0.731 injuries per 10,000 athlete-exposures in 2016 at a linear increase of 0.055 injuries per 10,000 athlete-exposures per year ($P = .0088$).

Achilles Tendon Rupture Player Characteristics

Of players with AT ruptures, the average height of 1.88 m and average weight of 112.17 kg were similar to NFL averages of 1.88 m and 111.99 kg ($P > .05$). Most AT ruptures occurred in athletes aged 21 to 25 years (51.49%, 52/101), whereas 34.65% (35/101) occurred in those aged 26 to 30 years and 13.86% (14/101) occurred in those aged 31 to 36 years ($P < .0001$) (Figure 2).

Despite an average age of 26.7 years at the time of AT injury, the distribution of AT rupture risk by individual age was bimodal when the data were distributed by fraction of tears in each age group (Figure 3). The highest risk of AT rupture was observed in athletes aged 24 and 36 years ($P = .0061$).

Player Positions

Players in skilled positions represented the highest proportion of AT ruptures at 62.38% (63/101) of tears, whereas

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Ethical approval was not sought for the present study.

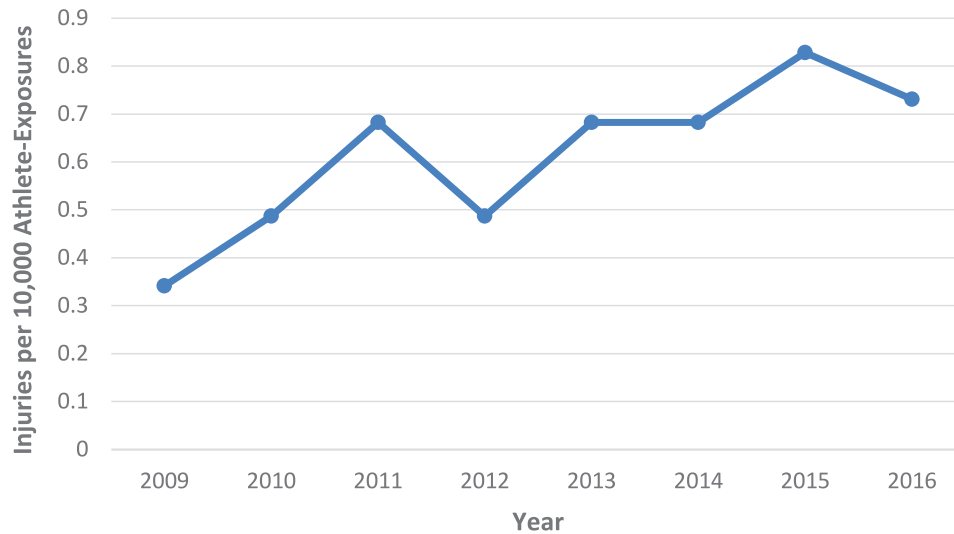


Figure 1. Incidence of Achilles tendon tears by year.

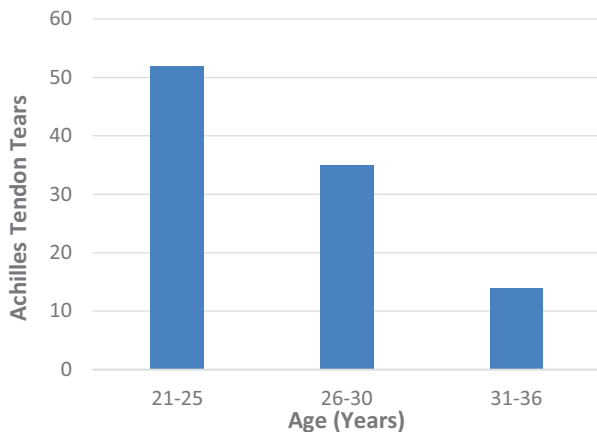


Figure 2. Number of Achilles tendon tears by age.

33.66% (34/101) occurred in unskilled position players and 3.96% (4/101) occurred in special teams players ($P < .0001$) (Figure 4); if athletes played more than 1 position, they were categorized based on their primary position.

Defensive players represented 55.45% (56/101) of the total injured, but this was not significantly different from the percent of total injuries seen in offensive athletes ($P = .274$). Quarterbacks did not experience any AT tears. The most common positions to tear were defensive end and linebacker at 19 (18.81%) and 16 (15.84%) tears, respectively (Table 1).

Timing

Of the AT ruptures, 64.36% (65/101) occurred during preseason. The remaining 35.64% occurred during the season with 34 ruptures during games and 2 during practices. Overall, 45 AT tears (44.55%) occurred during games (including preseason play), with only 1 (0.99%) occurring during the postseason. Close to 30% (19/65) of preseason

ruptures affected rookie players in their first NFL season. On the other hand, 100% (36/36) of the regular and post-season tears affected nonrookies; therefore, all rookie tears occurred before their first in-season game. In fact, the number of AT tears decreased with increasing years of experience in the NFL, with an estimated 1.18 fewer tears with each increasing year of experience ($P < .0001$) (Figure 5). We found that 36% (36/101) of all the documented tears occurred in undrafted free agents.

Return to Play

When looking at RTP, drafted athletes returned at a rate of 61.54% (40/65), although this was not significantly different from the return rate in undrafted athletes of 52.78% (19/36) ($P = .5191$). Of the rookies with AT ruptures, 42.11% returned to play in the NFL, while 62.20% of the nonrookies came back to partake in future seasons. The average draft pick of those with a career-ending injury was 106, excluding 17 undrafted players; those that continued to play postinjury averaged a draft pick of 93, excluding 19 undrafted players. Of the injured players, 57% (58/101) did not participate in a subsequent NFL season after their AT tear.

DISCUSSION

American football is an injury-ridden sport. These athletes are hurting themselves at high rates, with 8 injuries per 1000 athlete-exposures in high school and 36 injuries per 1000 athlete-exposures at the collegiate level.⁸ These events influence their careers and quality of life.

In this study, trends were analyzed, and various factors were identified relating to an increased risk of AT injuries. AT tears were found to have a notable impact on a player's ability to participate and progress in athletic competition, with our data showing that those injured required at least 5 months, and some more than 12 months, before returning

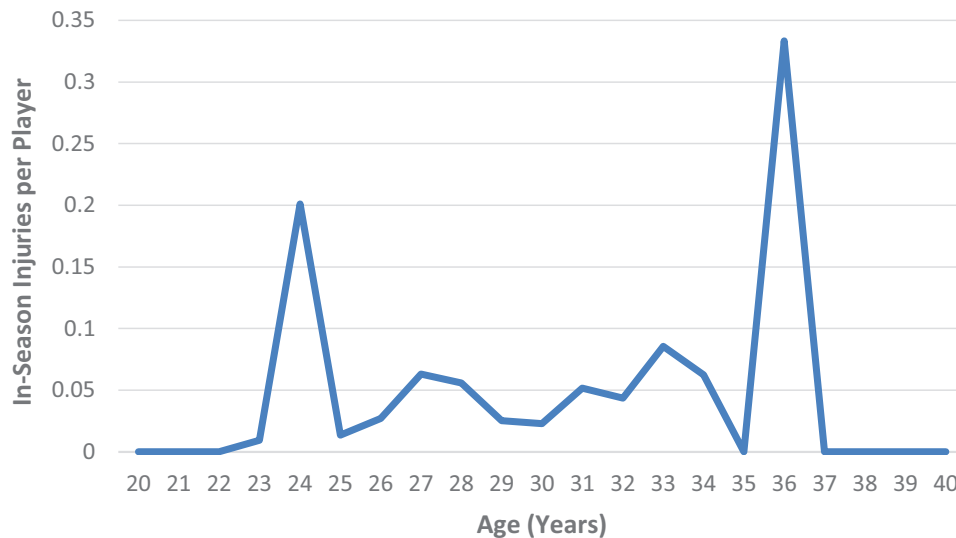


Figure 3. In-season Achilles tendon injuries per player stratified by age.

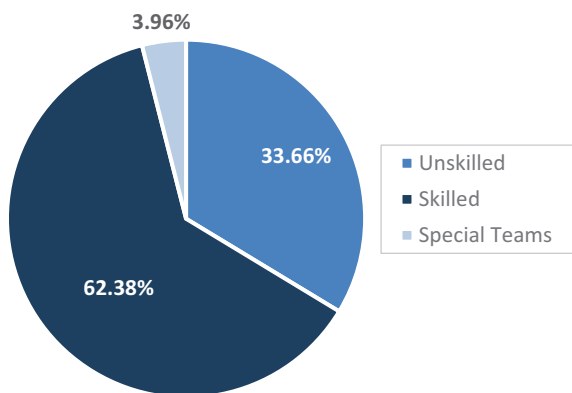


Figure 4. Achilles tendon tears by player position.

to full participation. Forty-two of the 101 athletes never returned to play a subsequent season in the NFL, having been released or retired. The majority of athletes returned to play (58.42%) after recovering. RTP was thoroughly studied in the paper by Yang et al,¹⁷ where the RTP rate was 63.75% and the mean RTP was 11.90 months. Yet, there was no breakdown by player’s rookie status. When comparing rookies to nonrookies, a much greater difference appeared in their RTP. Of the rookies with AT ruptures, only 42.11% returned to the NFL, while 62.20% of the non-rookies came back to partake in future seasons. This difference of 20% between these player subtypes emphasizes the variety in experience level and preparedness. Nonrookies are often proven or under long-term contracts, so perhaps NFL teams are more incentivized to make sure they return to play. Of the undrafted players, 52.78% (19/36) continued to play, with the other 17 athletes having career-ending injuries.

Regarding player age, there was a bimodal distribution of AT tears. This could be confounded by age distribution in

TABLE 1
Achilles Tendon Tears by Position

Position	No. of Tears
Defensive end	19
Linebacker	16
Wide receiver	14
Tight end	10
Running back	9
Cornerback	9
Defensive tackle	7
Safety	5
Offensive tackle	5
Guard	2
Kicker	2
Punter	1
Long snapper	1
Center	1
Quarterback	0

the NFL; with fewer older players, a smaller number with AT injuries could make the percentage of older players experiencing rupture appear greater. The young and old peaks could also correspond to 2 injury causes. For younger players trying to make the team and succeed in their transition to the NFL, they must push themselves to their physical maximums. This could increase the rate of injury early in the season, when their position on the team is uncertain. In contrast, older players may be tearing secondary to overuse later in the season, after experiencing many weeks of game time. The average age of tear (26.7 years) in NFL players is younger than that of the general population or that recorded for other professional athletes, such as National Basketball Association (NBA) players.⁹ This could be secondary to the increased AT loading in professional football, with shorter plays and greater physical contact.

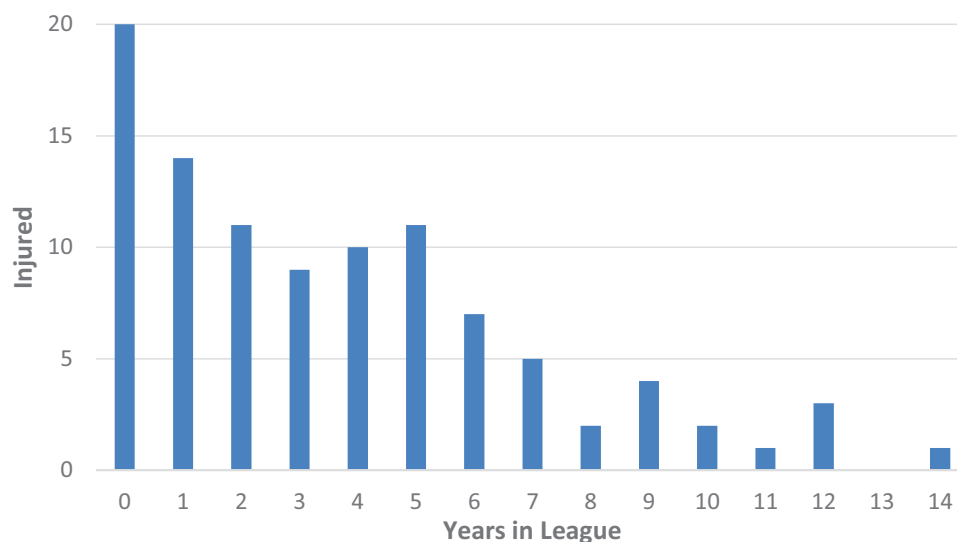


Figure 5. Number of AT injuries by years of experience in the NFL. AT, Achilles tendon; NFL, National Football League.

Certain player positions appear more vulnerable to AT rupture. Parekh et al¹² wrote that these injuries are seen in athletes who require “explosive acceleration, sudden changes in direction or maximal effort.” This often describes players in skilled positions on the field, which aligns with our results showing skilled players with a greater number of tears than their unskilled counterparts. In the skilled category, defensive end athletes are often expected to rush around offensive linemen, sprinting and relying on change of direction.¹⁴ These explosive motions may be putting them at a higher risk for AT rupture, as theirs was the most common player position to experience the injury.

When reviewing experience level, rookies represented 29.23% of the off-season tears yet represented only 24.72% of NFL athletes in preseason (no statistical significance). Rookies also surprisingly represent 0% of the in-season tears despite remaining on rosters and experiencing playing time. We deduce that young players such as rookies tend to tear earlier as they transition into the rigors of the NFL. This is aligned with prior research, which has shown that inexperienced players sustain more AT injuries.¹⁶ At the start of a player’s career, they have to prove their worth. Rookies may also be exposed to more field time in order to be evaluated, while proven veterans may save themselves for the season. An AT tear can make athletes unappealing to a franchise and often, as we found in this study, lead to their release from the team. The stratification of tear by month emphasizes the need to support younger athletes during the months of August, September, and October. The preseason and early season are the times of highest risk for tears. Informing players of this risk and preventative measures could therefore augment the health of up-and-coming players. There is currently a lack of preventative recommendations in the literature for Achilles tendinopathy. Lemme et al⁹ describe possible sources for AT tear, including increased running in preseason training, leading to gastrocnemius attenuation and more direct force on the AT.

With this in mind, adequate recovery during preseason training could be of focus. A prospective study of female soccer athletes found proprioceptive exercises to reduce the rate of AT injury, although the reduction was only significant for noncontact injuries.^{4,13} An increase in balance exercises could be incorporated to the training regimen to perhaps curtail the risk of rupture.

The effect of Thursday night football games was also examined. When playing on a Thursday, players have had only 3 days of rest after a Sunday game, as opposed to the 6 days they would have to recover when playing on Sundays alone. With reduced recovery time, recurrent microtears are likely to occur, increasing the risk of an AT tear.¹⁶ Thus, reviewing Thursday night football and its relation to injuries may be valuable to the entire franchise in extending athletic careers. Yet, we were able to show no increased risk of AT tear when comparing Sunday and Thursday games. Unlike the NFL injury data for 2014-2017, we did not find a reduction in injury for Thursday games.¹¹ Their data included all injuries that led to a removal from play.¹¹

With regard to game environment, we tabulated field surface and weather at time of game. Moreover, 43.75% of the games were on grass, with 43.18% of the tears also on grass; 56.25% of the games occurred on turf, with 56.82% of the tears also on turf. These values mirror their approximate field representation in games. We therefore hypothesize that field type does not factor into AT ruptures and that players are just as likely to tear on grass fields as on turf. We realize that this cannot necessarily be extrapolated to other bodily injuries. When examining temperature at time of game, there was great variation, with some players tearing in games played at 1°F and others tearing in games at 91°F. The average temperature across all games with AT rupture was 67°F, while the median temperature was 70°F. This challenges the notion that tears more likely occur in cold weather.^{3,7,10} One could argue that athletes preparing for colder weather games conduct an intensive warm-up,

thereby reducing the potential strain on the AT. Perhaps warmer games allowed players to engage in a shorter amount of time stretching and preparing, leaving them more vulnerable to rupture.

The primary limitation of this study was the accessibility of the data. The NFL does not publicly release the number of rookies each year; however, this was calculated and averaged over the study period. It was our intention to identify as many injuries from publicly available sites as possible, but there is the possibility that some were missed. Additionally, the study was limited by sample size. AT ruptures are relatively infrequent events, with only 101 documented tears over a 7-year time span. This reduced the possibility for significance in this retrospective data analysis. Lastly, the study identified a very specific patient population. NFL players' recovery rates and RTP likely differ from the rates of those who do not engage in sports or do so on a lesser level.

CONCLUSION

This is the first article to specifically compare AT rupture rates in rookies and nonrookie athletes. We also examined Thursday and Sunday games and found no significant difference in rates of AT rupture. When analyzing the rates of AT tear while comparing ground surfaces (grass and artificial turf), we revealed no significant difference in tear rates. In reviewing experience level, a large percent of the preseason tears occurred in rookie players. In this way, new NFL players were identified as an at-risk population for AT tears and a possible target for injury prevention. Preventative measures in rookies can be crucial in precluding AT rupture in the preseason, such as addressing overuse with adequate recovery and a focus on balance exercises. With more than half of rookies not returning to play post-AT rupture, future research should focus on this overlooked population and attempts to safely introduce athletes to a professional level of play.

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REFERENCES

- Breech J. 2017 undrafted free agent tracker: signings from all 32 NFL teams in one place. Published online May 5, 2017. Accessed June 29, 2018. <https://www.cbssports.com/nfl/news/2017-undrafted-free-agent-signings-all-32-nfl-teams-adding-players-following-draft/>
- Dulac G. 400 players on NFL rosters never heard their name called in the draft. *Pittsburgh Post-Gazette*. Published September 7, 2014. Accessed June 29, 2018. <http://www.post-gazette.com/sports/steelers/2014/09/07/400-players-on-NFL-rosters-never-heard-their-name-called-in-the-draft/stories/201409070235>
- Järvinen TAH, Kannus P, Maffulli N, Khan KM. Achilles tendon disorders: etiology and epidemiology. *Foot Ankle Clin*. 2005;10(2):255-266.
- Kraemer R, Knobloch K. A soccer-specific balance training program for hamstring muscle and patellar and Achilles tendon injuries: an intervention study in premier league female soccer. *Am J Sports Med*. 2009;37(7):1384-1393.
- Krill MK, Borchers JR, Hoffman JT, Krill ML, Hewett TE. Effect of position, time in the season, and playing surface on Achilles tendon ruptures in NFL games: a 2009-10 to 2016-17 review. *Phys Sportsmed*. 2017;45(3):259-264. doi:10.1080/00913847.2017.1343652
- Krill MK, Hoffman J, Yang J, Hodax JD, Owens BD, Hewett TE. Previous foot injuries associated with a greater likelihood of Achilles tendon ruptures in professional American football players. *Phys Sportsmed*. 2018;46(3):342-348. doi:10.1080/00913847.2018.1482188
- Lawrence DW, Comper P, Hutchison MG. Influence of extrinsic risk factors on National Football League injury rates. *Orthop J Sports Med*. 2016;4(3):2325967116639222.
- Lawrence DW, Hutchison MG, Comper P. Descriptive epidemiology of musculoskeletal injuries and concussions in the National Football League, 2012-2014. *Orthop J Sports Med*. 2015;3(5):2325967115583653. doi:10.1177/2325967115583653
- Lemme NJ, Li NY, Kleiner JE, Tan S, DeFroda SF, Owens BD. Epidemiology and video analysis of Achilles tendon ruptures in the National Basketball Association. *Am J Sports Med*. 2019;47(10):2360-2366.
- Milgrom C, Finestone A, Zin D, Mandel D, Novack V. Cold weather training: a risk factor for Achilles paratendinitis among recruits. *Foot ankle Int*. 2003;24(5):398-401.
- National Football League. 2017 Injury Data. Published online January 26, 2018. Accessed October 27, 2021. <https://www.playSMARTPLAYSAFE.com/newsroom/reports/2017-injury-data/>
- Parekh SG, Wray WH, Brimmo O, Sennett BJ, Wapner KL. Epidemiology and outcomes of Achilles tendon ruptures in the National Football League. *Foot Ankle Spec*. 2009;2(6):283-286. doi:10.1177/1938640009351138
- Peters JA, Zwerver J, Diercks RL, Elferink-Gemser MT, van den Akker-Scheek I. Preventive interventions for tendinopathy: a systematic review. *J Sci Med Sport*. 2016;19(3):205-211.
- Robbins DW. Positional physical characteristics of players drafted into the National Football League. *J Strength Cond Res*. 2011;25(10):2661-2667.
- Sahota S, Gibbs DB, Lawton CD, et al. Pectoralis major injuries in the National Football League. *Sports Health*. 2020;12(2):116-123.
- Schepesis AA, Jones H, Haas AL. Achilles tendon disorders in athletes. *Am J Sports Med*. 2002;30(2):287-305. doi:10.1177/03635465020300022501
- Yang J, Hodax JD, Machan JT, et al. Factors affecting return to play after primary Achilles tendon tear: a cohort of NFL players. *Orthop J Sports Med*. 2019;7(3):2325967119830139.