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The Influence of Time of Season on Injury Rates and the Epidemiology of Canadian Football Injuries

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ABSTRACT

Objective: To describe injury rates and injury patterns in the Canadian Football League (CFL) according to time during the season, player position, injury type, and injury location.

Design: Prospective, cohort study.

Setting and Participants: Eight seasons from CFL injury surveillance database.

Independent Variables: Depending on the analysis, time of season (preseason, regular, playoffs), player position, injury type, and injury location.

Main Outcome Measures: Medical attention and time loss injury rates per 100 athletes at risk (AAR); prevalence of time loss injuries per week.

Results: The average game injury rate was 45.2/100 AAR medical attention injuries and 30.7/100 AAR time loss injuries. Injury rates declined by 1% per week over the season for both medical attention (rate ratio=0.99) and time loss (rate ratio=0.99) injuries, with a substantial decline during the playoffs compared to preseason (rate ratio=0.70 to 0.77). The number of ongoing time loss injuries increased over the course of the regular season. Quarterbacks, offensive backs, and linebackers had the highest game injury rates. Joint/ligament and muscle/tendon injuries were the most common injury types for games and practices, respectively. The lower extremity was the most commonly affected area, specifically the lower leg/ankle/foot and hip/groin/thigh.

Conclusion: There was a 1% decline in injury rate per week during the season and a 30% decline during the playoffs. The number of ongoing time loss injuries increased over the regular season. Current results can aid league officials and medical staff in making evidence-based decisions concerning player safety and health.

Key words: Canadian Football League, football, injury rate

INTRODUCTION

Throughout their career, football players are at risk of sustaining injuries due to the inherent nature of the sport. Football has the highest injury rate in games and practices when compared to 14 other National Collegiate Athletic Association (NCAA) sports.[1] The time loss injury rate for NCAA football games is between 11.6 to 40.2/1000 athlete exposures (AE), which represents a substantial burden on medical teams.[2-5]

Football injury rates change throughout the season.[3] Injury data from over 100 NCAA football programs demonstrated that the time loss game injury rate during the regular season (36.11/1000 AE) was higher than preseason (7.55/1000 AE) and playoffs (23.71/1000 AE).[2] In contrast, the practice time loss injury rate during preseason (7.24/1000 AE) was higher than regular season (2.09/1000 AE) and playoffs (1.35/1000 AE).[2] These findings are supported by another study that examined 60 NCAA football programs.[5] In a study of one National Football League (NFL) team, time loss injury rates were higher in the first two weeks compared to the last three weeks of training camp.[6] Although these results generally suggest that injury rates decline over the preseason and regular season, there is limited data on professional football teams. In addition, the above results refer only to new injuries, and there is little information in regards to ongoing injuries.

Player position affects injury rate and the frequency of injury types and anatomical locations vary.[7] In the NCAA, running backs sustained the highest proportion (19.6%) and offensive lineman sustained the lowest proportion (9.9%) of injuries.[2] The most common game and practice injury types in NFL preseason are joint sprains and muscle strains respectively.[6] In

terms of location, the lower extremity (54.7%) accounted for the greatest percentage of game injuries, with the knee and ankle being most often injured.[2] Further data on professional players are not available, where differences in age, size, and skill could affect injury patterns.

The professional football league in Canada, the Canadian Football League (CFL), represents an unstudied context. Changes in weekly injury rates throughout the season have not been investigated in this league. CFL competition level (professional) differs from the NCAA (amateur), and CFL season length differs from both NCAA and NFL. Furthermore, differences in game rules could impact the style of play including fewer downs (three vs four downs), more players on the field (12 vs 11), and larger fields (110 by 65 vs 100 by 53.3 yards). These differences might affect injury rates, player position most at injury risk, injury types, and injury locations. Therefore, our primary objective was to describe variations in CFL injury rates over a season using eight years of play. We hypothesized that injury rate during the preseason would be high with a drop during the early regular season and plateau as the season progressed. Secondary objectives were to describe the burden of injury (prevalence of ongoing time loss injuries) over the season, as well as injury patterns according to player position, injury type, and injury location.

METHODS

Study Population and Data Collection

We used routinely collected data from the CFL injury surveillance database, which serves as the official electronic record for healthcare professionals from each team. Data were prospectively entered by team athletic therapists, physical therapists, and medical doctors. There

were eight teams for 2011-2013 seasons, and nine for 2014-2018 seasons. Game and practice injury data were extracted including: player position, anatomical location, injury date, diagnosis according to the Sport Medicine Diagnostic Coding System (SMDCS),[8] and medical clearance date. All CFL registered players in 2011 to 2018 were included.

Injury Definitions

We included non-traumatic and traumatic musculoskeletal and neurological injuries that occurred during games or practices during the season. We excluded injuries and illness categorized as cardiovascular, respiratory, dermatology, endocrine, environmental, fluid & electrolyte, gastrointestinal, genitourinary, haematology, infectious disease, psychology, metabolic bone, and unassigned. We also excluded blisters, abrasions, and lacerations which are often included in injury studies but have limited consequences and only accounted for 1.34% of all injuries. Non-football related injuries, injuries occurring in the weight room, offseason injuries, and preventative medical appointments were excluded. Analyses were conducted for both medical attention and time loss injuries. Medical attention injuries included those that occurred during games or practices and injured players sought assessment/treatment from team medical staff. We considered injuries to result in time loss if the medical clearance date was not the same as the first visit date. We also examined injury burden (i.e. ongoing injuries) over time, which we defined as the number of players with a time loss injury that were not medically cleared to play for one or more days during a given week.

Weekly Injury Rate

Injury rate corresponds to the number of injuries divided by a unit of person time.[9] We used athletes at risk (AAR) expressed as injuries per 100 AAR for our denominator of risk because the more commonly used athlete exposures (AE) method includes many athletes in the denominator who are not at risk of injury.[9] CFL has 12 players per team on the field at any point in a game who are at risk of game injuries during active play, except under exceptional circumstances. The total number of AAR in one week is 12 multiplied by the number of teams that played on a specific week, and the injury rate is equal to the number of injuries/AAR (expressed per 100 AAR, similar to per 1000 AE). Injury rates were calculated for both medical attention and time loss injuries that occurred during games. For practices, we present total number of injuries because we did not have data on the number of players practicing each week.

Time Period

For CFL seasons occurring from 2011 to 2013, there were 3 weeks of preseason and 19 weeks of regular season (18 regular season games and 2 preseason games with 1 bye week where some teams had no games). For 2014 to 2017, there were 3 weeks of preseason and 20 weeks of regular season (18 regular season games and 2 pre-season games with 2 bye weeks). In 2018, there were 3 weeks of preseason and 21 weeks of regular season (18 regular season games and 2 pre-season games with 3 bye weeks). There were 3 weeks of playoffs for all seasons, where teams could play 0, 1, 2 or 3 games.

To determine weekly injury rates, weeks were categorized according to the CFL website.[10] Preseason weeks were categorized as follows: 0 for the last preseason week before the beginning of the regular season, -1 for the second to last week before regular season, and -2 for

the third to last week. The first week of the regular system was categorized as 1, with subsequent regular and playoff weeks increasing by one number each week. Weeks were also coded according to whether they were preseason, regular season, or playoffs. Because season lengths differ, weeks 20 and 21 were sometimes regular season games and sometimes playoff games.

Player Positions

Player positions were categorized into offense, defense and special teams. Offensive players were further categorized into more specific positions: quarterback, lineman (centre, guard, tackle), offensive backs (running back, full back), and receivers (wide receiver, slot back, tight end). Defensive players were categorized into linemen (end, tackle), linebackers, and defensive backs (cornerback, safety). The positions kicker/punter, long snapper, and kick returner were categorized as special teams.

For game injury rates across offensive and defensive player positions, we calculated AAR using the number of players in each position during usual formations based on CFL depth charts and discussions with CFL personnel. Results refer to the risk of injury in each player of that position in order to compare injury risk of playing as a quarterback to playing as a lineman even through there are several linemen on the field at one time. The offensive formation included 1 quarterback, 5 offensive lineman, 2 offensive backs and 4 receivers. The defensive formation included 4 defensive linemen, 3 linebackers and 5 defensive backs. Team formations will vary throughout a game, but they represent the most common formations. For practices, we report only the frequency of injuries (overall count) by player position, as the number of players at each practice was not recorded.

Injury Types

Injuries were classified according to their type based on a nominal consensus model approach for soccer injuries (no consensus statement on American or Canadian football injuries has been reached to date).[11] Injury type groupings consisted of fractures, joint/ligament, muscle/tendon, contusions, central/peripheral nervous system, and other.

Anatomical Location

Consistent with previous studies, the anatomical location of injury was classified as head and neck; shoulder; upper extremity (upper arm, elbow, forearm, hand and wrist); trunk (abdomen, chest/ribs/upper back, pelvis/low back); hip, groin and thigh; knee; lower leg, ankle and foot; and non-specific musculoskeletal injuries.[4,7,12]

Analysis

We compared injury rates across weeks using Poisson regression, with weekly injury rate as the outcome, "CFL week" as the main exposure variable, time of season (preseason, regular season, playoffs) as a covariate (reference=preseason), and AAR as an offset to account for the different number of teams playing in any given week. We report rate ratios with 95% confidence intervals (95%CI). Separate regression analyses were conducted for medical attention and time loss game injuries. In addition, a sensitivity analysis was conducted for time loss injuries where only injuries that resulted in players missing eight or more days were considered as time loss injuries. Missing eight or more days would likely indicate that a player missed at least one game. Underlying assumptions of the models were verified.

Injury burden was operationalized as the number of players with a time loss injury that were not medically cleared to play for at least one day during a CFL week. We present the mean

injury burden per CFL week across the 8 years. Injuries by player position were reported as injury rates for game injuries and total counts for practice injuries. Proportions of injuries were determined based on injury types and anatomical locations. Statistical analyses were completed with R version 3.5.1.[13]

Ethical Considerations

This study was approved by the Institutional Review Board of McGill University Faculty of Medicine.

RESULTS

Original data included 15,618 injuries and illnesses. After applying inclusion/exclusion criteria, medical attention injuries included 7914 game and 3739 practice injuries, and time loss injuries included 5372 game and 2204 practice injuries (Figure 1). There were 69 preseason games, 621 regular season games, and 40 playoff games over eight seasons. The average medical attention game injury rate was 45.2/100AAR (95%CI: 44.4 to 45.9) and time loss game injury rate was 30.7/100 AAR (95%CI: 30.0 to 31.4).

Weekly Injury Rate

For medical attention injuries, there was a meaningful decrease in the weekly injury rate from preseason to playoffs (rate ratio=0.73; 95% CI: 0.62 to 0.86), but not from preseason to regular season (rate ratio=1.01; 95%CI: 0.93 to 1.10) (Figure 2). There was also a meaningful decrease in the weekly injury rate across the entire season of 1% per week, which represents a 22% decrease over a 20-game regular season (rate ratio=0.99; 95%CI: 0.99 to 0.99).

Similar to medical attention injuries, time loss weekly injury rates decreased from preseason to playoffs (rate ratio=0.70; 95%CI: 0.58 to 0.85), but not from preseason to regular season (rate ratio=0.97; 95%CI: 0.87 to 1.07). Time loss injuries also decreased by 1% per week

across the entire season (rate ratio=0.99; 95%CI: 0.99 to 1.00). The rate ratios were similar when we restricted injuries to those missing eight or more days [playoffs to preseason=0.77 (95%CI: 0.59 to 1.00); preseason to regular season=0.92 (95%CI: 0.81 to 1.06); weekly decline across the entire season=0.99 (95%CI: 0.99 to 1.00)].

Injury burden, or the number of ongoing time loss injuries, in a week increased throughout the regular season, and then declined during the playoffs (Figure 3).

Player Positions (Table 1)

Defensive players had higher game injury rates for medical attention and time loss injuries compared to offensive players. For specific positions, quarterbacks had the highest medical attention game injury rate and offensive backs had the highest time loss game injury rate. Linebackers had the highest game injury rates for defensive players.

When examining practice injuries, defensive players had higher numbers of medical attention and time loss injuries; defensive backs sustained the most practice injuries of any specific position. Because we did not have details on which position athletes attended practices, these numbers represent the total number of injuries for a position. Therefore, if a team has 10 offensive linemen and 2 quarterbacks practicing, one would expect 5 times the number of injuries if the injury risk was the same across positions.

Injury Types (Table 2)

For both medical attention and time loss injuries during games, joint/ligament injuries were the most common type, followed by a relatively equal number of injuries classified as muscle/tendon and contusions. For practice injuries, muscle/tendon was the most common injury type followed by joint/ligament for both medical attention and time loss injuries.

Anatomical Location (Table 3)

Locations most commonly injured during games and practices resulting in a medical attention injury included lower leg, ankle and foot; hip, groin and thigh; upper extremity; and knee. A similar trend was found for time loss injuries.

DISCUSSION

Few studies have examined injury rates in professional football and this is the first to examine the CFL. Medical attention and time loss injury rates over eight CFL seasons were 45.2/100 AAR and 30.7/100 AAR, respectively. Injury rate per week declined over the regular season, with a substantial decline during the playoffs. Although the number of new injuries declined during the season, there was an increase in the number of ongoing injuries as the season progressed (i.e. injury burden), although a decline again occurred during the playoffs. Medical staff can use this information to plan care and allocate resources to address new and ongoing injuries.

The CFL time loss game injury rate (30.7/100 AAR) was lower than in previous NFL studies. In one NFL study examining preseason games for one team over ten seasons, the injury rate was 53.0/100 AAR (converted from 64.7/1000 AE).[6] Using online NFL injury reports, another study found the combined game and practice injury rates was 39.6/100 AAR (reported as 395.8/1000 AAR in the original publication).[14] Differences in injury definitions, rate calculations, and player size could account for these discrepancies.

The decline in game injury rates throughout the season, with a substantial drop off during the playoffs, is consistent with NCAA studies.[2,3,5] One possible explanation for the decrease during the playoffs is that players may report less injuries since the season is ending and they feel they can manage injuries in the offseason. Alternatively, they may not report injuries due to fear of not being allowed to play during playoffs. Both hypotheses are speculative, and further

exploration into reasons why these changes occur should include an analysis of player training patterns, beliefs, and application of medical care.

Injury burden (i.e. ongoing time loss injuries) increased during the regular season. This means more injuries occurred each week than were healed each week. From a management perspective, this increases workload on medical staff near the end of the season when playoffs are approaching. Some teams may feel it helpful to hire additional staff later in the season. However, there was a sharp decline during the playoffs. Because fewer teams are playing during the playoffs, players on eliminated teams are likely to heal much faster, and there are fewer athletes at risk of incurring new injuries.

The most commonly injured positions were quarterbacks, offensive backs, and linebackers. This is similar to a previous NCAA study that calculated time loss injury rates by position using similar methods.[2] This finding is not surprising for running backs and linebackers since their collisions typically occur at higher speeds than other positions with the force in the opposite direction of their motion. For quarterbacks, they may be left exposed during passing attempts.

In regards to injury types, joint/ligament injuries were the most common game injury and muscle/tendon injuries were the most common practice injury. A similar pattern was found in the NFL preseason.[6] High proportions of joint/ligament injuries during games are not surprising given the increased number and speed of collisions and increased unpredictability. High proportions of muscle/tendon injuries during practice could represent overuse injuries[6] and potential training errors (e.g. large increase in training volume during the pre-season) could be addressed pre-emptively.

In terms of injury location, lower extremity was the most commonly injured area. Similar findings have been reported in other leagues.[2,12,14] These findings that address injury proportions based on position, type, and location can aid league administrators in making evidence-based decisions to improve current programs on player safety, and medical staff on planning the appropriate care.

Our study has some limitations. Firstly, data accuracy depended on information reported by players and medical staff. Underreporting of injuries by an athlete is a concern in every injury study and is difficult to compensate for, as injury rates can only be based on verifiable facts. Secondly, practice injury rates could not be calculated since we did not have data on which athletes attended practices. Finally, similar to other studies on football, our injury rate calculations considered two injuries to two different athletes the same as two injuries to the same athlete.

In conclusion, there was a slight decline in CFL injury rates over the season, with a substantial decline in the playoffs. The injury burden increased during the regular season, but declined during the playoffs. These findings underscore the need for continued proactive injury monitoring with appropriate offseason care. Quarterbacks, offensive backs, and linebackers had the highest injury rates. Joint/ligament and muscle/tendon injuries were the most common injury types with the lower extremity the most commonly affected area. Such information can aid league officials and medical staff in making evidence-based decisions concerning player safety and health.

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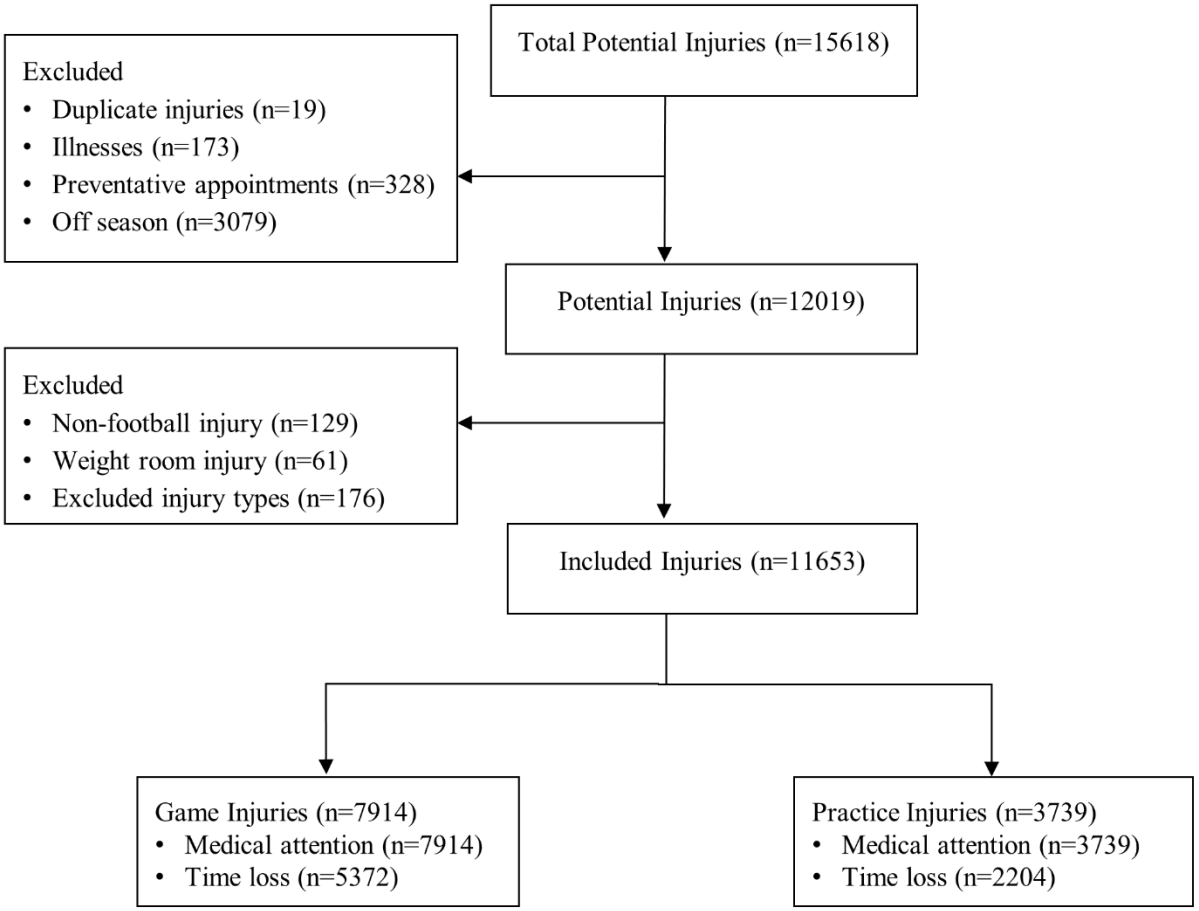

Figure 1. Flow diagram showing the exclusion criteria applied to the data and the final number of game and practice injuries.

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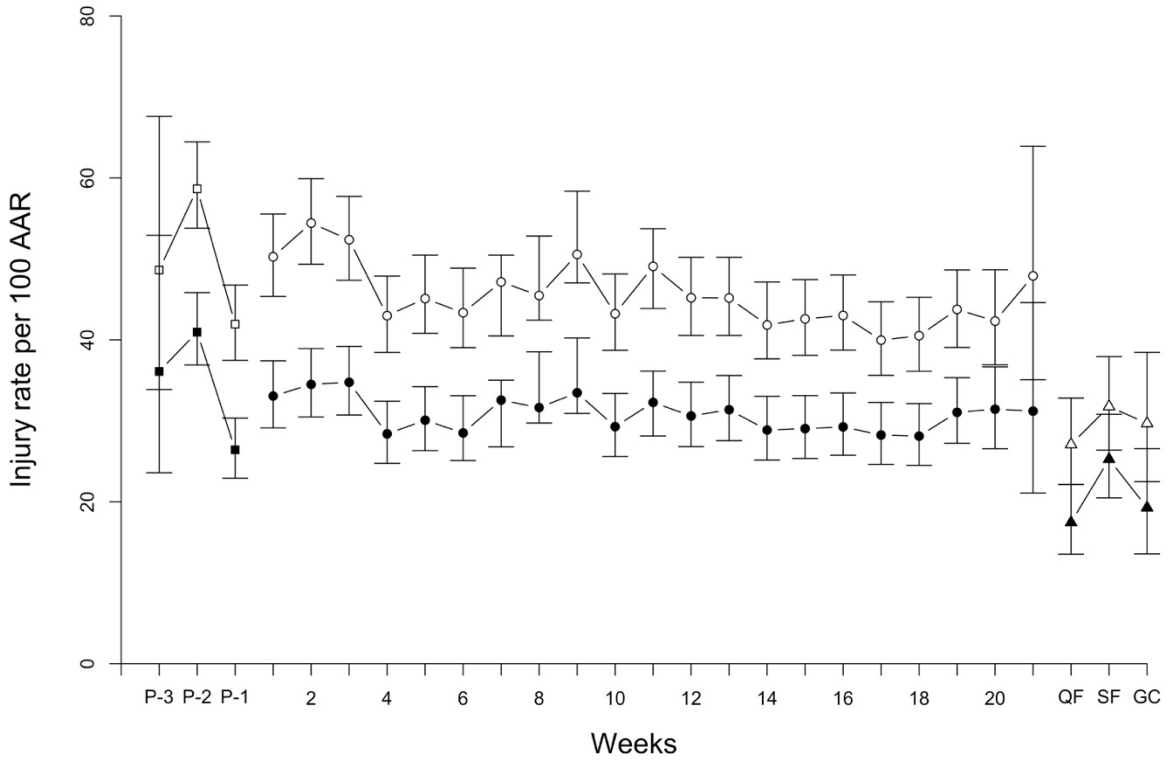

Figure 2. The average weekly injury rate for medical attention injuries (white) and time loss injuries (black) across the eight seasons for the preseason (squares), regular season (circles), and playoffs (triangle). Error bars represent 95% confidence intervals. The last preseason game before the regular season is P-1. The second and third to last preseason games are coded as P-2 and P-3 respectively. Playoffs are coded as quarterfinals (QF), semi-finals (SF), and Grey Cup final (GC). The length of the season varied over the eight years and for this figure, the playoff weeks were not continuous but aligned based on playoff game (QF, SF, GC). Weeks were treated as continuous in the Poisson regression with additional variables accounting for game classification (preseason, regular season, playoffs).

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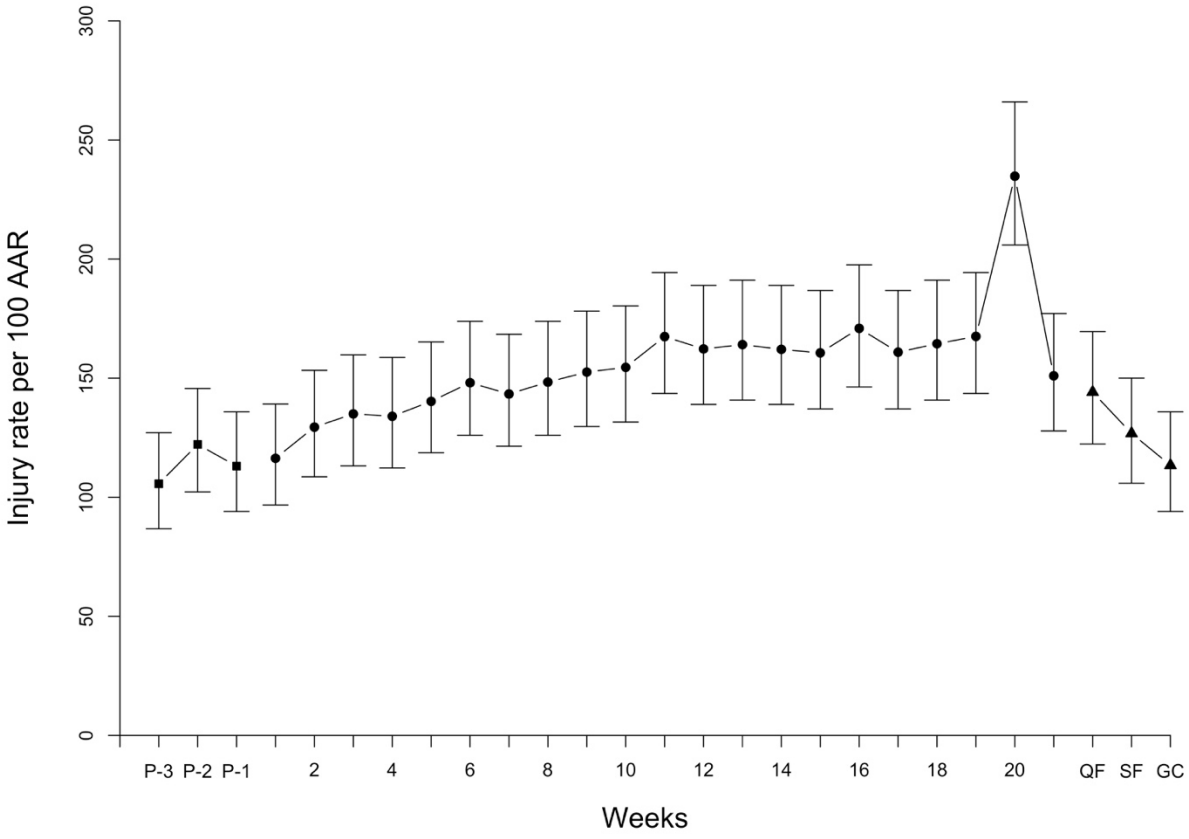

Figure 3. The injury burden representing the mean number of ongoing time loss injuries each week across the eight seasons for the preseason (squares), regular season (circles), and playoffs (triangle). Error bars represent 95% confidence intervals. The last preseason game before the regular season is P-1. The second and third to last preseason games are coded as P-2 and P-3 respectively. Playoffs are coded as quarterfinals (QF), semi-finals (SF), and Grey Cup final (GC).