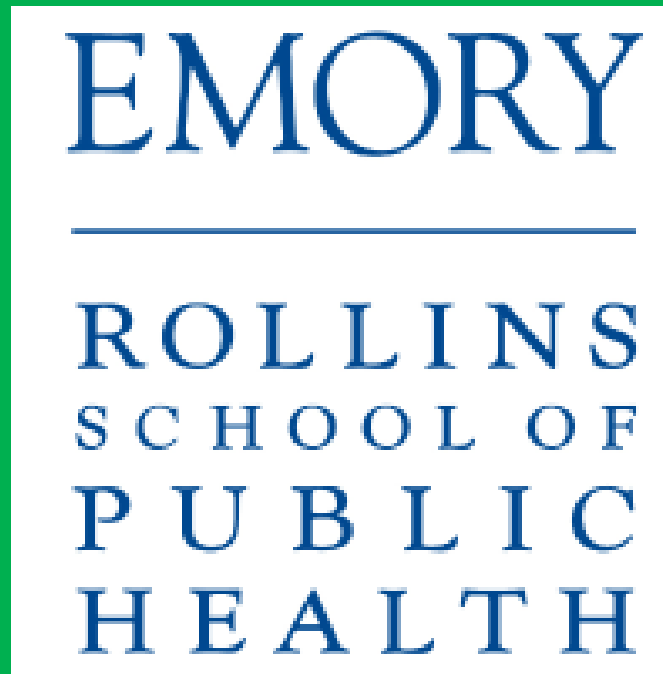


Using Survival Analysis to Estimate Injury Resolution Times and Positional Variation in the NFL



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Introduction and Objectives

When an NFL athlete is injured the public relies on team-provided estimates on when they will return to play (RTP) in games; time to recovery estimates are rarely given. Even the RTP estimates are often given not by training staffs but by coaches, and they are typically limited to a vague range such as “4-6 weeks.”

Objectives: 1. We sought to estimate empirical recovery and RTP times for common NFL injuries from historical injury report data. 2. We then investigated whether recovery times varied by position through stratified curves. 3. Finally, we tested the practicality of our position-specific RTP curves by applying them to two current NFL injuries.

Methods

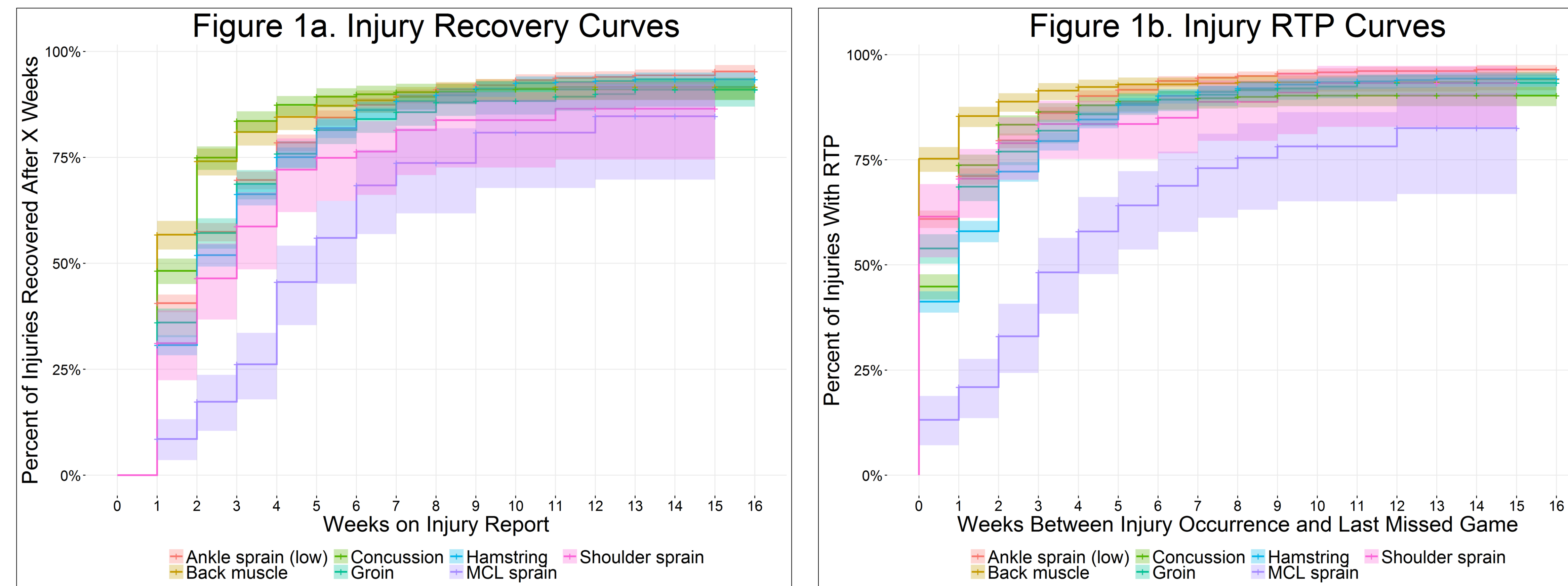
- Data source: prospectively-collected database of public NFL injury report data, supplemented with local media reports, from the 2007-2015 seasons
- Regular season injuries to players with at least one career NFL game were included
- To deal with incomplete observation of injury resolution times due to the end of the regular season (censoring), we constructed Kaplan-Meier (KM) survival curves. All times were censored at the end of the regular season
- Overall and applied curves include 95% confidence intervals (CIs) around the survival function
- “Injury Resolution” curves created for two events:
 - Return-to-play (“RTP”): the event is permanent return to competition from this injury. Survival time is the number of weeks between injury occurrence and the last game missed. The complement of the survival function at time zero ($1 - S_0$) is the estimated percent of injuries that resulted in zero games missed
 - Time-to-Recovery (“Recovery”): the event is the disappearance of an injury from the injury report for ≥ 2 weeks, byes excluded. Survival time is the number of weeks between injury occurrence and its last appearance on the injury report. The complement of the survival function at one week ($1 - S_1$) is the estimated percent of injuries resolving after only one week on the injury report
- We generated KM curves for several injury types: low (inversion) ankle sprains, concussions, back muscle injuries, groin injuries, hamstring injuries, shoulder sprains, and MCL sprains
 - Recovery curves were also stratified by position
- We used the injury- and position-specific curves to describe likely RTP times for two current NFL injuries

Results

- 19,389 player-seasons; 17,652 regular season injuries overall
- 2,139 low ankle sprains; 828 back muscle injuries; 1,070 concussions; 777 groin injuries; 1,459 hamstring injuries; 129 MCL sprains; 122 shoulder sprains

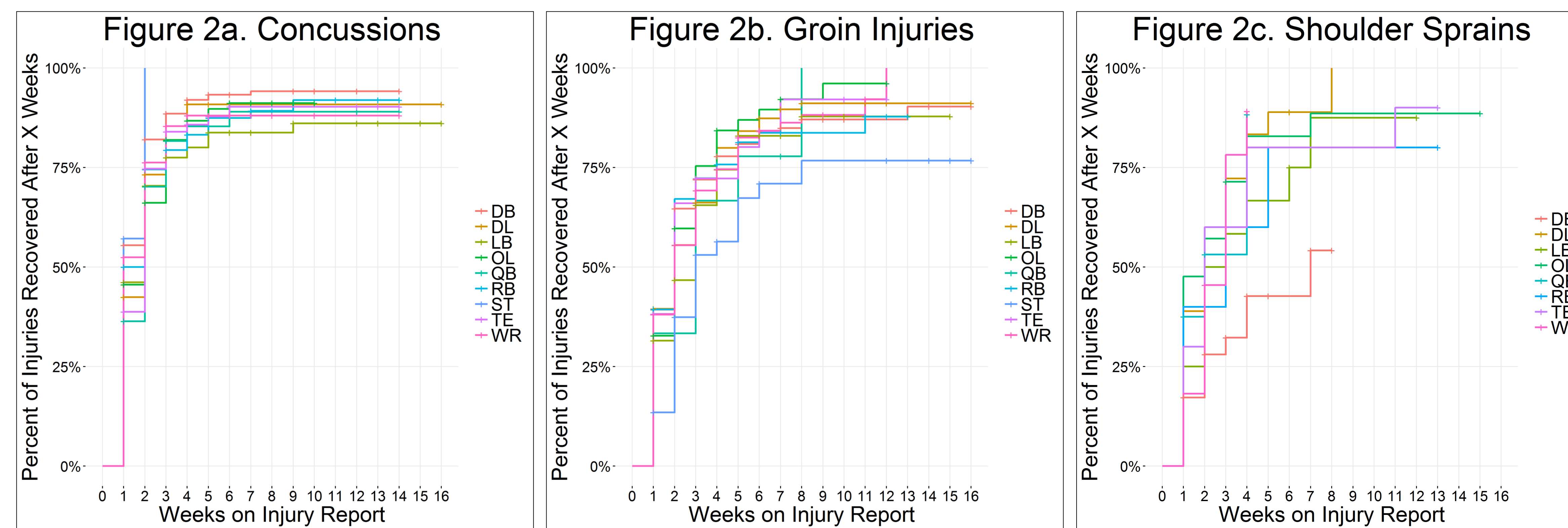
- Reading the Recovery Curves:** Y% of injuries are no longer listed on an injury report after $\leq X$ weeks. “Lower” curves indicate longer (worse) recovery times.
- Reading the RTP Curves:** Y% of injuries cause players to miss $\leq X$ games, counting byes as games. “Lower” curves indicate longer (worse) RTP times.

Injury Resolution Curves by Injury Type, with 95% CIs

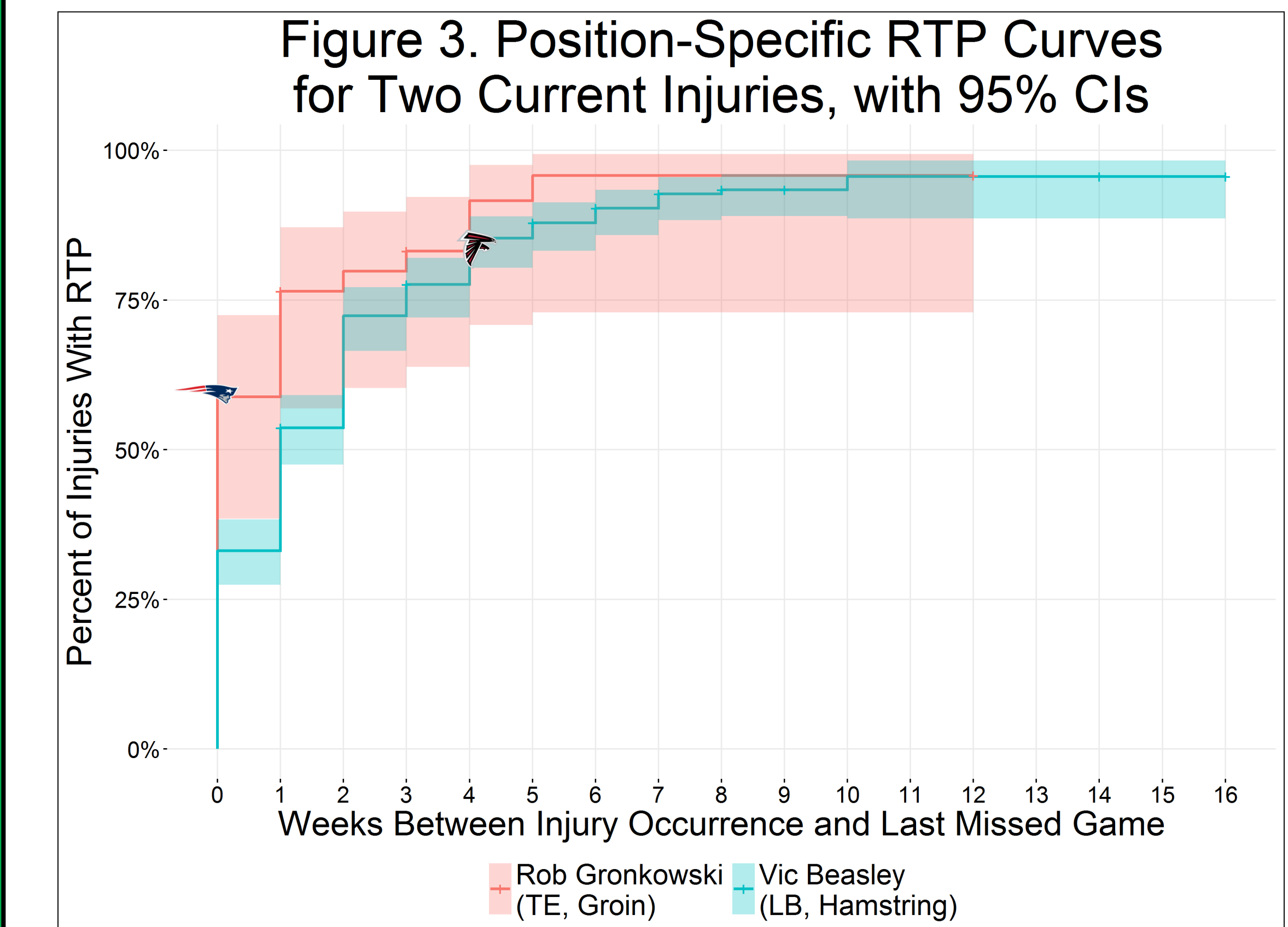


- Back muscle injuries, concussions exhibited the quickest recovery times (75% recovered after 3 weeks); MCL sprains were slowest (25% recovered after 3 weeks) (**Figure 1a**)
- RTP fastest for back muscle injuries (75% missed 0 games); MCL sprains slowest (>50% take 3+ weeks to return) (**Figure 1b**)
- Recovery times for concussions did not vary substantially by position (**Figure 2a**), but STs took longer to recover from groin injuries (**Figure 2b**) and DBs took longer to recover from shoulder sprains (**Figure 2c**)

Injury Recovery Curves Stratified by Position



Results (Cont'd)



- Gronkowski (Groin): self-reported “nothing serious”; 75% of such injuries for TEs have caused players to miss 0 or 1 games historically (**Figure 3, red line**)
- Beasley (Hamstring): Falcons say he has a “slight tear” that will keep him out “at least a month”; this would put him in the 20% longest recovery times historically, and a 4-7 week RTP is plausible (**Figure 3, blue line**)

Conclusions

- Among injuries we looked at, back muscle injuries exhibited the quickest resolution, while MCLs were slowest
- Concussion recovery similar across positions, but STs needed longer to recover from groin injuries and DBs were slower to recover from shoulder sprains
- Historical data can be used to supplement team estimates of player injury duration in real time

Limitations

- Lack of detail on injury reports and in local media means there is heterogeneity within each category and some injuries may be misclassified;
- Differential team injury reporting behaviors may also bias our results when applied to specific players
- Ranges of plausible resolution times often still wide

Acknowledgments

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