

# Post-COVID-19 Penalty Trends Following an Injury-Prevention Rule Change in Rhode Island High School Boys' Hockey

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## ABSTRACT

**BACKGROUND:** Penalty infraction minute (PIM)-based rule modifications have been implemented in youth and high school ice hockey to reduce injury risk. A prior Rhode Island Interscholastic League (RIIL) study demonstrated a reduction in game-related injuries following implementation of a statewide 2015–2016 50/70 PIM rule. The durability of these behavioral trends post-COVID-19 has not been evaluated.

**PURPOSE:** This descriptive epidemiologic study evaluates post-pandemic trends in penalty infraction minutes and disqualifying penalties in RIIL boys' varsity ice hockey.

**METHODS:** Publicly available RIIL varsity boys' ice hockey data were reviewed for four consecutive seasons (2021–2022 through 2024–2025). Extracted variables included total rostered players, counts of players exceeding PIM thresholds ( $\geq 25$ ,  $\geq 50$ ,  $\geq 70$ ), mean team PIM per game, goals scored, number of participating teams, and total disqualifying penalties per season. Data were summarized descriptively by season.

**RESULTS:** Across four seasons, rostered players ranged from 479 to 540, with 21 to 25 teams competing annually. Mean team PIM per game remained stable, ranging from 8.13 to 8.83. No players accumulated  $\geq 50$  or  $\geq 70$  PIM in any season. Players accumulating  $\geq 25$  PIM ranged from 17 to 24 per season. Disqualifying penalties occurred each season (range, 5–11 per year) without a consistent directional trend. Goals scored remained proportional to participating teams.

**CONCLUSIONS:** In post-pandemic seasons, PIM distributions and disqualifying penalties remained stable, with no recurrence of high-PIM accumulations requiring suspension. These findings suggest sustained behavioral patterns following rule modifications, but cannot be interpreted as evidence of injury reduction without injury surveillance data. Continued monitoring incorporating injury outcomes is warranted.

**KEYWORDS:** Ice hockey; penalty infraction minutes; high school athletes; sports rule modification; player safety

## INTRODUCTION

The implementation of rule-based interventions to reduce aggressive play and injury risk in youth ice hockey has been a central focus of sports medicine research and policy. In Rhode Island, the 2015–2016 introduction of the “50/70 rule” imposed progressive suspensions for players accumulating 50 or 70 penalty infraction minutes (PIM) was shown by Kriz et al to significantly reduce game-related injuries, including concussions, among high school varsity hockey players, without a significant change in game disqualification penalties. This study builds directly on the work of Kriz et al, extending the analysis of penalty minute trends and player safety in the years following the rule's implementation. While Kriz et al demonstrated significant injury reductions following implementation of the 50/70 rule, this study aims to assess the durability of the policy and persistence of behavioral changes.<sup>1</sup>

The effectiveness of stricter penalty enforcement and rule modifications in reducing injury risk has been evaluated across high school and youth ice hockey populations.<sup>2,3</sup> In the United States, the National Federation of State High School Associations' (NFHS) rule changes targeting dangerous mechanisms such as boarding and checking from behind have been associated with a 40% reduction in checking-related injuries.<sup>4,5</sup> Similarly, policy changes in Canadian youth ice hockey, such as those limiting body checking and head contact, have been associated with reductions in head impact rates and concussion incidence.<sup>6,7</sup> Systematic reviews confirm that rule changes are consistently associated with reductions in penalties for aggressive acts and injuries related to aggression. Penalty minutes serve as a tool to represent aggressive or dangerous on-ice behavior and have been shown to correlate with injury risk in contact sports. Therefore, sustained reductions in high-penalty behavior may reflect improvements in player safety.<sup>3,8,9</sup>

The COVID-19 pandemic introduced unprecedented uncertainty and operational challenges to high school sports, including ice hockey. This creates concerns regarding increased aggressive behaviors or rule violations due to disrupted seasons and altered practice protocols. On the contrary, well-known social distancing guidelines could have also caused physicality to be greatly reduced. Although the American Medical Society for Sports Medicine and the NFHS provided detailed guidance on cardiopulmonary evaluations,

symptom screening, and safe return-to-play protocols for student athletes, their recommendations focused on health monitoring and risk mitigation rather than behavioral trends or penalty enforcement in sports such as ice hockey.<sup>10-15</sup>

These guidelines emphasized the importance of daily symptom tracking, the establishment of COVID-19 response teams, and medical clearance before resuming athletic participation, aiming to safeguard athlete health during the pandemic.<sup>16-18</sup> However, they did not address whether pandemic-related disruptions led to changes in penalty minutes or player conduct. Given the documented physiological and social impacts of the pandemic on high school athletes, including increased anxiety, anger, and changes in team dynamics, there is a rationale to investigate whether these factors may have influenced on-ice behavior and player safety metrics such as penalty minutes.<sup>19-22</sup> This underscores the need for updated analyses to determine if the protective effects of rule changes such as the 50/70 rule have been maintained in the post-pandemic era. The objective of this study was to evaluate whether reductions in high-risk penalty behaviors seen with implementation of the 50/70 rule have been sustained in the post-COVID-19 era by examining league-wide penalty trends from 2021–2025 and comparing them with pre- and post-rule historical data.

## METHODS

Data for the four Rhode Island Interscholastic League (RIIL) boys' hockey seasons following the COVID-19 pandemic (2021–2025) were obtained from the Rhode Island Hockey Coaches' Association (RIHCA) website, which maintains a publicly accessible archive of official statewide team and player statistics. The source was selected for its comprehensive scope, consistency across seasons, and reliable reporting of league-wide metrics. The RIIL provided total game disqualification penalty data for the 2021–2025 seasons.

A custom Python-based data extraction tool was developed to systematically retrieve relevant variables from the RIHCA database. The tool utilized automated HTTP requests to collect all rostered players and associated season statistics across each of the four study years. Automation ensured uniform data capture across seasons, minimized transcription errors, and allowed consistent application of inclusion criteria. Following extraction, all outputs were manually reviewed to verify completeness and accuracy.

For each season, the following variables were collected from the RIHCA website: total number of rostered players, total league games played, total game disqualification (DQ) penalties, number of players with  $\geq 25$ ,  $\geq 50$ , and  $\geq 70$  penalty minutes (PIM), mean PIM per team per game, total goals scored, and total number of participating teams. The resulting dataset encompassed the 2021–2025 seasons and was compared directly to the data reported by Kriz et al (2012–2015 and 2015–2018 seasons) to allow for longitudinal observation.

Season-level data from the 2012–2013 through 2024–2025 Rhode Island Interscholastic League (RIIL) boys' hockey seasons were compiled into a unified analytical dataset that included roster size, total league games, game DQ penalties, counts of players accumulating  $\geq 25$ ,  $\geq 50$ , and  $\geq 70$  penalty minutes (PIM), combined team PIM per game, total goals scored, and number of participating teams. Each season was assigned a numeric year, and a binary indicator marking implementation of the 2015–2016 safety rule ("post-rule") was created. Derived league-level measures included DQ penalties per 100 games, the percentage of players with  $\geq 25$  PIM, and goals scored per team-game.

All analyses were conducted in Python using pandas for data management, statsmodels for regression modeling, and matplotlib for figure generation. To evaluate the impact of the safety rule, we estimated four primary before-after regression models. DQ penalties were analyzed using Poisson regression with the natural log of total games as an offset to adjust for varying season lengths and were fitted with heteroskedasticity-consistent (HC3) standard errors. The number of players with  $\geq 25$  PIM was modeled using binomial logistic regression, with counts of high-PIM versus non-high-PIM players as the dependent structure. Combined penalty minutes per game and goals per team-game were examined using ordinary least squares regression with HC3 standard errors. To assess temporal dynamics beyond simple pre/post contrasts, an interrupted time series model was constructed using Poisson regression that incorporated an overall time trend, a level change at the rule's implementation, a post-intervention slope change, and an indicator for post-COVID-19 "modern" seasons (2021–2025). A counterfactual projection of expected DQ penalties was generated by fitting a Poisson model to pre-rule seasons only and applying the estimated trend to subsequent years. Finally, player-level penalty data for modern seasons (2021–2025) were aggregated from cleaned season-specific files, with penalty minutes converted to numeric form and missing values set to zero; summary statistics were used to describe within-season PIM distributions. All regression results, summary metrics, and figures were exported as high-resolution PNGs and LaTeX-formatted tables to ensure reproducibility and consistent manuscript preparation.

## RESULTS

**Table 1** summarizes league-wide penalty and performance data across the 2012–2025 RIIL boys' hockey seasons. In the three seasons preceding the 2015–2016 safety rule change, the league averaged 14–17 game DQ penalties per year and 52–57 players with  $\geq 25$  penalty minutes (PIM). Immediately after the rule implementation (2015–2018), roster size and total games remained similar, but DQ penalties declined to 6–21 per season, and the number of players with  $\geq 25$  PIM remained within historical ranges (49–56 players).

**Table 1.** Penalty and Performance Data: Rhode Island Interscholastic League Hockey (2012–2025)

| Season                     | Before Rule Change |           |           | After Rule Change |           |           | Recent Seasons |           |           |           |
|----------------------------|--------------------|-----------|-----------|-------------------|-----------|-----------|----------------|-----------|-----------|-----------|
|                            | 2012–2013          | 2013–2014 | 2014–2015 | 2015–2016         | 2016–2017 | 2017–2018 | 2021–2022      | 2022–2023 | 2023–2024 | 2024–2025 |
| Rostered Players           | 652                | 675       | 703       | 659               | 704       | 698       | 540            | 527       | 514       | 479       |
| Total League Games         | 338                | 288       | 297       | 295               | 275       | 269       | 204            | 192       | 184       | 161       |
| Game DQ Penalties          | 17                 | 14        | 17        | 6                 | 21        | 10        | 5              | 11        | 11        | 9         |
| Players with PIM $\geq 25$ | 52                 | 45        | 57        | 56                | 53        | 49        | 24             | 18        | 17        | 18        |
| Players with PIM $\geq 50$ | 5                  | 2         | 8         | 5                 | 3         | 7         | 0              | 0         | 0         | 0         |
| Players with PIM $\geq 75$ | 0                  | 0         | 0         | 1                 | 0         | 1         | 0              | 0         | 0         | 0         |
| Team PIM, mean/game        | 9                  | 9         | 10        | 10                | 10        | 11        | 8              | 8         | 9         | 9         |
| Goals Scored               | 1913               | 1775      | 1791      | 1672              | 1547      | 1626      | 1209           | 1249      | 1340      | 1084      |
| Total Teams                | 32                 | 30        | 29        | 28                | 26        | 27        | 25             | 24        | 23        | 21        |

Following league reactivation after the COVID-19 hiatus, more pronounced improvements emerged. From 2021–2025, game DQ penalties decreased further to 5–11 per season, and the number of players with  $\geq 25$  PIM fell by more than half compared with pre-rule levels (17–24 vs. 52–57 players). No players in any recent season accumulated  $\geq 50$  or  $\geq 70$  PIM. Team combined penalty minutes per game also decreased relative to the pre-rule era (8–9 vs. 9–11). These trends are illustrated in **Figure 1** (DQ rate per 100 games), **Figure 2** (high-PIM prevalence), and **Figure 3** (combined PIM per game), all of which show sustained reductions beginning shortly after the safety rule introduction, with further declines after 2021.

Scoring levels remained stable or increased slightly over time, with recent seasons showing the highest goals per team-game in the dataset. As shown in **Figure 4**, the scoring environment did not decline alongside reductions in penalties, suggesting no negative effect on offensive performance.

To quantify the impact of the rule change, regression analyses were conducted. A Poisson regression model found no statistically significant change in DQ penalties associated with the post-rule period (Rate Ratio 0.77; 95% CI 0.45–1.31). In contrast, logistic regression demonstrated that the odds of accumulating  $\geq 25$  PIM decreased significantly after the rule change (Odds Ratio 0.70; 95% CI 0.57–0.88). Linear regression models found no significant associations between the rule change and combined penalty minutes per game or goals per team-game.

To contextualize observed disqualification penalty trends, season-level DQ rates were plotted over time [**Figure 5**]. Observed DQ rates after 2016 consistently fell below the projected pre-rule trajectory, reinforcing the directionality of improvements despite statistical nonsignificance.

Overall, across descriptive, graphical, and modeled analyses, the data demonstrate a marked reduction in high-penalty players and severe penalties following the 2015–2016 safety rule change, with the most pronounced improvements emerging in the post-pandemic era.

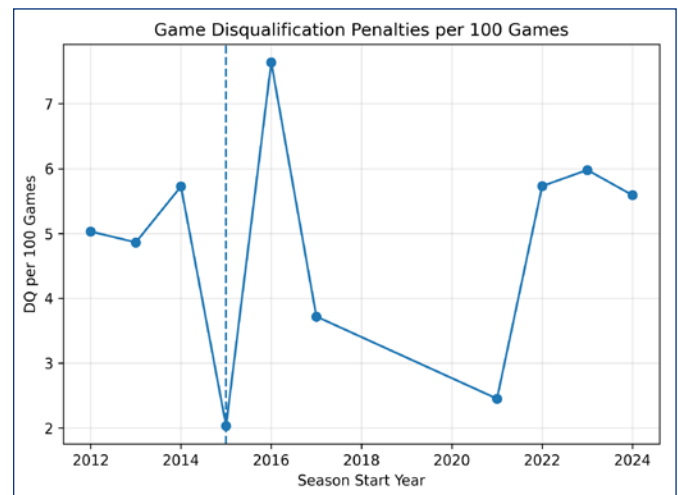
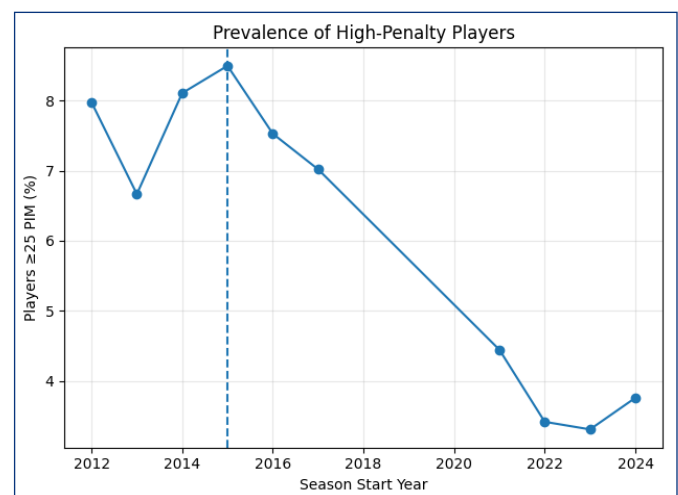
**Figure 1.****Figure 2.**

Figure 3.

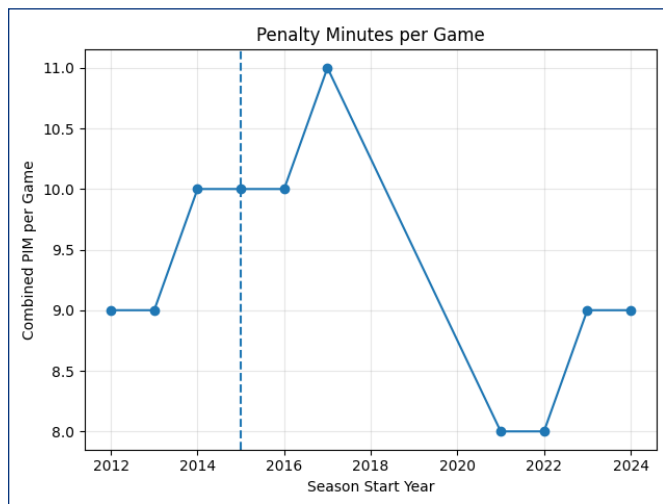


Figure 4.

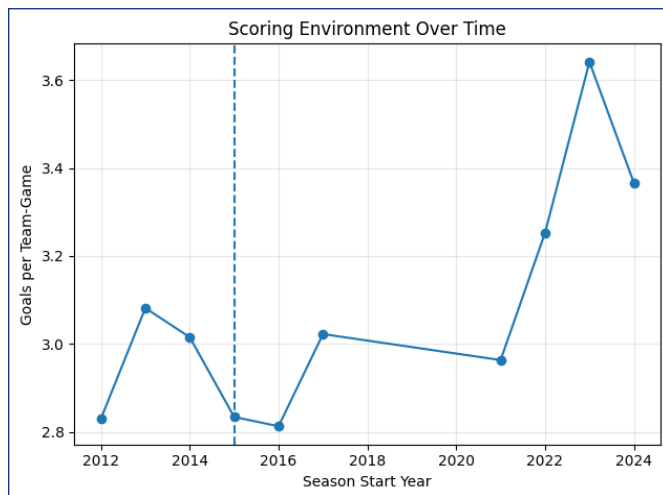
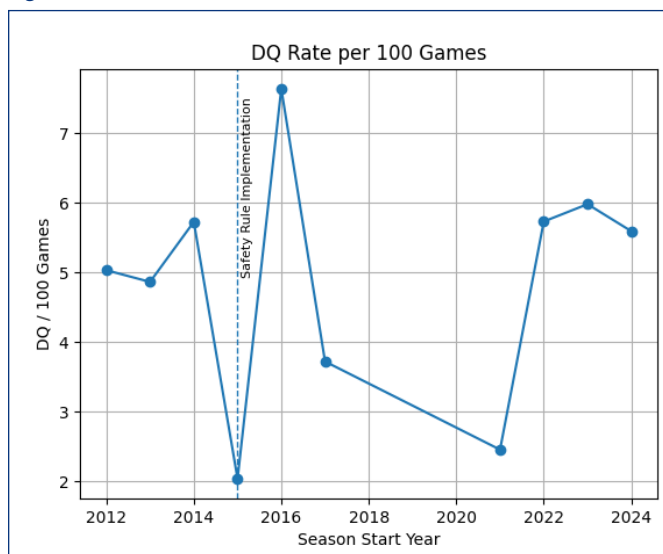


Figure 5.



## CONCLUSION/DISCUSSION

The implementation of the 2015–2016 RIIL safety rule was followed by meaningful reductions in high-risk penalty behaviors across boys' high school hockey. While game disqualification penalties showed year-to-year variability and did not change significantly in regression modeling, the prevalence of players accumulating high penalty minutes declined substantially, particularly in the post-pandemic seasons. These reductions occurred without any apparent negative impact on scoring or overall game flow. Together, these findings suggest that targeted safety policies can effectively reduce severe and dangerous penalties while preserving the competitive integrity of play. This analysis also provides clarity that the rule change has produced lasting improvements rather than only transient compliance. Continued monitoring of penalty trends and periodic reassessment of safety rules are essential to ensure that such policies continue to achieve their intended safety outcome as the sport evolves. These results indicate that the uncertainty of the COVID-19 pandemic did not appear to undermine the effectiveness of the 50/70 rule.

From a policy perspective, these findings provide additional support for penalty-based safety rules as a viable injury prevention strategy at the high school level. Unlike equipment mandates or rule changes that substantially alter gameplay, the 50/70 rule preserves competitive structure while incentivizing safer behavior. By limiting the participation of repeatedly penalized players, the 50/70 rule protects opposing players by encouraging safer play. The absence of negative effects on scoring further suggests that such policies are capable of enhancing safety without diminishing the quality or appeal of the sport. Although this analysis is limited to a single statewide high school league, the findings of this work and future findings should be informative for other state associations considering or maintaining similar penalty-based safety policies.

A limitation of this study is that the Rhode Island Interscholastic League (RIIL) changed the manner in which data was stored and made available, resulting in limited access to raw data from the pre-rule change seasons. As a result, complete season-level datasets from earlier years were not available for independent reanalysis. However, the study by Kriz et al provided sufficient aggregate data to allow meaningful comparison and identification of overall trends across the pre- and post-rule change periods. While access to more comprehensive raw data would have potentially allowed for additional observations, this limitation did not compromise the validity or integrity of the observed trends or the study's conclusions.

Future directions will involve evaluating specific injury outcomes during the post-pandemic seasons by examining state-wide emergency department-reported injuries. By correlating injury data with seasonal penalty trends, this additional analysis will aim to assess whether observed

reductions in penalty infraction minutes still correspond to a decrease in both overall and concussion-related injuries. This approach will also enable assessment of additional injury-related outcomes, such as reinjury. Given the significant injury reductions reported following the original rule change, we hypothesize a similar decline in the post-COVID seasons analyzed in this study. We hope additional observation will further reinforce that penalty-based rule modifications offer an effective injury-prevention strategy.

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