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Original Research

Injury and Illness Trends in the National Hockey League Following an Abrupt Cessation of Play

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Background

The National Hockey League (NHL) saw an unprecedented disruption to the competitive calendar due to the COVID-19 pandemic in March of 2020. Returning to play following an abrupt cessation of activity is a known risk factor for athletes.

Purpose

To analyze the occurrence and severity of events (injury and illness) in the NHL and to understand any differences in occurrence and severity between pre-pandemic seasons and seasons that immediately followed.

Study Design

Descriptive Epidemiology Study

Methods

Using a retrospective cohort inclusive of all players on active rosters in the NHL between 2016-2023, public access injury and illness data were collected. Outcome measures included event incidence, period prevalence, and severity (mean days lost; MDL), as well as incidence rate ratio (IRR) comparing pre- and post-pandemic seasons.

Results

IRR for illness peaked in December 2021 (IRR = 62.46; 95% CI 13.65 to 285.91). Incidence of upper body injuries was significantly higher in 2020-21 (IRR = 1.70, p = 0.001) and 2021-22 (IRR = 1.40, p = 0.044) compared to pre-pandemic seasons (Incidence = 17.58 injuries / 1000 player-hours). Injury incidence increased as the 2022-23 season progressed (p = 0.004); injury incidence was stable across all other seasons. Mean days lost (MDL) to injury was higher in 2020-21 (MDL = 18.12, p < 0.001), 2021-22 (MDL = 18.46, p = 0.015), and 2022-23 (MDL = 18.12, p < 0.001) compared to pre-pandemic seasons (MDL = 17.34).

Conclusion

Incidence of upper body injuries increased in the 2020-21 and 2021-22 NHL regular seasons while it decreased significantly in the 2022-23 regular season compared with the four pre-pandemic seasons. This suggests a need to examine if modifiable risk factors exist for determining optimal return to play strategies following an abrupt cessation of play.

Level of Evidence

3

INTRODUCTION

On March 12 2020, the National Hockey League (NHL) suspended regular season play due to the COVID-19 global pandemic.[1] The following season (2020-2021) saw significant league-wide measures implemented to mitigate the risk of contraction and spread of COVID-19 including an extended off-season and a shortened regular season of 56 games.[2] The 2021-2022 season returned to a standard com-

petitive calendar of 82 games with safety measures largely dictated by local, provincial/state, and federal regulations.[3]

There is strong historical evidence that abrupt disruptions to preparatory or competitive schedules in sport is linked with increased injury rates upon an athlete's return to competition.[4-6] Several statements from health professionals and medical representatives from professional sporting organizations warned against rapid resumption to play from pandemic related disruptions and to allow for adequate re-conditioning time.[7-9] Increased musculoskeletal injury occurrence in professional baseball,[10] American football,[11] soccer,[12,13] and basketball[14] relative to pre-pandemic seasons have already been reported.

Injury is present across each level of ice hockey, with frequency tending to be highest at the most elite levels largely due to higher speeds and aggressive nature of play.[15] Overall incidence in the NHL regular season between 2006 to 2012 has been reported to range from 39.4 to 41.3 injuries/1000 player game-hours, and 2.4 illnesses/1000 player game-hours.[16] Limited rest between games (≤1 day of rest) has been observed to increase the rate and severity of injuries in the NHL.[17]

While several studies have investigated injury and illness incidence and severity in the NHL,[16-19] at the time of writing no study has described injury or illness in the NHL seasons following the declaration of the COVID-19 global pandemic. The purpose of this study was to analyze the occurrence and severity of events (injury and illness) in the NHL and to understand any differences in occurrence and severity between pre-pandemic seasons and seasons that immediately followed. Due to the schedule disruption and fixture congestion upon returning to play, we hypothesized that injury and illness occurrence and severity increased in the two seasons played since the COVID-19 pandemic was declared compared to pre-pandemic seasons. We further hypothesized that injury trends returned to pre-pandemic levels by the 2022-23 season.

METHODS

STUDY DESIGN

This was a descriptive epidemiology study examining NHL injury and illness in the abbreviated 2020-2021 regular season (56 games), the 82 game 2021-2022 and 2022-23 regular seasons compared with a typical 82 game season in the pre-pandemic era (2016-2017 through to the 2019-2020 seasons).

DATA COLLECTION

Two examiners (AP and MD) extracted injury and illness (event) data logged between October 12 2016 and May 1 2023 from two online sources: www.prosportstransactions.com and www.sportsforecaster.com. Event data included player name, player ID, date of event, date of return to lineup, and anatomical region (of injury). Basic descriptive player information and player-game exposure data was extracted at www.NHL.com, www.moneypuck.com, and TheAHL.com. All events that resulted in at least one day of lost time were collected for analysis.[20] Only players who were injured during the NHL regular season calendar and were concurrently listed on the team's active roster were included. Any event that was found in one source but not in the other, differed in anatomical region of injury (e.g., one source coded the injury as head, but the other coded as upper body), or listed an event as undisclosed, was cross referenced with media reports and game footage. Events that could not be corroborated between sources were excluded from further analysis. All data was obtained from the public-domain; therefore, ethics approval was not required.

Given the lack of standardized policy for publicly disclosing or categorizing injuries in the NHL,[21,22] the available injury data were grouped into general anatomical regions: upper body, lower body, core, and head. Upper body injuries included any injury coded as upper body as well as those ranging from the sternoclavicular joint to the fingers, or the neck. Lower body injuries included any injury coded as lower body or those ranging from the pelvis to the toes. Core injuries included any injury coded in the torso or abdominal regions. Head injuries included any injury to the head or face, including facial lacerations and concussions. Illness included any non-injury events that resulted in time loss such as mental, flu, or COVID-19.[3] As it is common practice for players to move between their NHL team and minor league affiliate, any event that occurred while a player was on the active roster of an NHL team and played at least one (1) game for the minor league affiliate after the event but before returning to the NHL, was excluded from analysis as time of event may have been overinflated due to uncertain time to return to play. Analysis was conducted under the assumption that movement to the minors was not injury related.

ANALYSIS

Exposure was calculated using actual time on ice (TOI). Injury incidence rate, reported per 1000 player hours, was calculated as the quotient of number of injuries (numerator) and TOI summed for each player in the specified timeframe (denominator). Incidence rate was evaluated for overall injury and illness as well as for each general anatomical region. To account for variable season lengths between 2016-2023, injury and illness seasonal incidence was calculated using a standardized season length; each season was divided into ten equal sections, as defined by the first and last game of the respective season. Injuries that occurred during a given section were divided by TOI for each player in each game in the respective section. Period prevalence was calculated for each of the ten sections as the proportion of players with an injury (new injuries and those yet to return to play) out of all players in that given season. Period prevalence was calculated for each of the 2020-21, 2021-22, and 2022-23 seasons compared to pre-pandemic seasons. Injury/illness severity was calculated as the number of days the player was inactive due to the respective event.

Statistical analyses were conducted under the assumption of no difference in illness and injury incidence and severity for each (sub) category between pre-pandemic sea-

Table 1. Count data of event frequency and severity for each individual season. TOI reported in total ice time for all players in the season per 1000 player hours.

	Season						
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
# of players	982	984	999	997	1010	1121	1058
Player exposure	87.54	90.70	90.60	77.06	61.99	93.71	93.71
Total # of events	707	666	709	565	715	1483	471
Injury (%)	595 (84.16)	574 (86.19)	594 (83.78)	469 (83.01)	474 (66.29)	757 (48.89)	386 (82.0)
Illness (%)	112 (15.84)	92 (13.81)	115 (16.22)	96 (16.99)	241 (33.71)	726 (51.11)	85 (18.0)
Total days lost	10652	11075	11045	9301	9335	19790	9024
Injury (%)	10080 (94.63)	10590 (95.62)	10575 (95.74)	8818 (94.81)	6410 (68.67)	13988 (70.68)	8594 (95.23)
Illness (%)	572 (5.37)	485 (4.38)	470 (4.26)	483 (5.19)	2925 (31.33)	5802 (29.32)	430 (4.77)

sons and the 2020-21, 2021-22, or 2022-23 seasons. Distributions were checked prior to statistical test selection and a positive skew was detected for each incidence and severity outcome. Incidence was thus assessed by fitting a Poisson regression model for each outcome category with incidence as the dependent variable, and season (pre-pandemic, 2020, 2021, or 2022), stage of season (1-10), the stage and season interaction, and COVID-related illness (COVID or not) as covariates. Overdispersion was checked for each incidence model; dispersion statistics for the Overall (13.74), Injury (1.33), Lower body injury (1.52), Head injury (1.27), and Illness (21.48) categories warranted use of negative binomial regression. Dispersion statistics for Upper body injury (0.88) and Core injury (0.86) categories warranted use of Poisson regression. Severity was assessed by fitting a Poisson regression model for each outcome category with severity (days lost) as the dependent variable and season as the independent variable. Dispersion statistics for Overall (23.6), Illness (10.8), Injury (23.8), Lower body injury (23.6), Upper body injury (23.0), Head injury (16.4), and Core (40.1) warranted use of negative binomial regression. Statistical significance was set at $p < 0.05$. Python version 3.10.4 (Python Software Foundation) was used for data collection, analysis, and visualization.

RESULTS

A total of 1872 individual players were active in the league between 2016-17 and 2022-23 with 83.44% (1562/1872) of all players missing at least one day due to injury or illness over that duration (Table 1).

SEASONAL INCIDENCE & PREVALENCE

Incidence of injury and illness across the season are shown in Figures 1 & 2. There was a notable spike in illness from December 12, 2021, to January 19 2022 (31-50% of season completion, peaking at an incidence of 331.36 illness per 1000 player-hours (IRR=33.79, 95% CI 5.21 to 219.21).

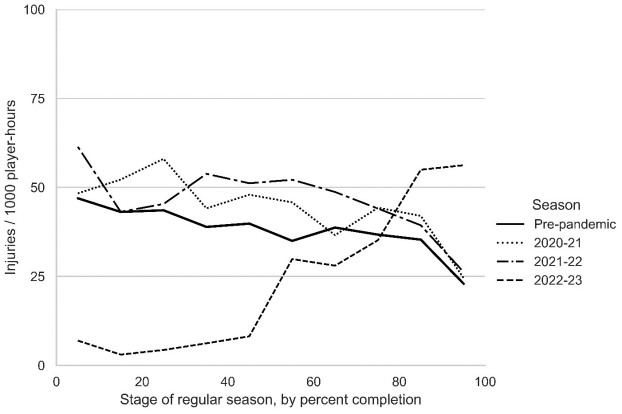

Figure 1. Incidence of injury over the duration of a regular season between pre-pandemic, 2020-21, 2021-22, and 2022-23 seasons. To account for variable season lengths, start and end dates, 0% stage of season corresponds to the first game and 100% to the last game of a given season.

Overall injury incidence did not differ significantly in the 2020-21 (IRR=1.19, 95% CI 0.26 to 5.40) or 2021-22 (IRR=1.22, 95% CI 0.27 to 5.55) seasons compared to the pre-pandemic seasons at any stage over the course of the season. Injury incidence was significantly lower in the 2022-23 season (IRR=0.05, 95% CI 0.01 to 0.27) relative to pre-pandemic seasons. IRR increased by 44.78% with each additional stage of the season in 2022-23 ($p = 0.004$). Period prevalence of injuries throughout the season can be seen in Figure 3. When adjusting for COVID-19 infection, incidence of non-COVID-19 related illness did not change in 2020-21 (0.95 illnesses / 1000 player-hours, $p = 0.164$), 2021-22 (6.63 illnesses / 1000 player-hours, $p = 0.572$), or 2022-23 seasons (0.49 illnesses / 1000 player-hours, p =0 .062) relative to pre-pandemic seasons (3.9 illnesses /1000 player-hours).

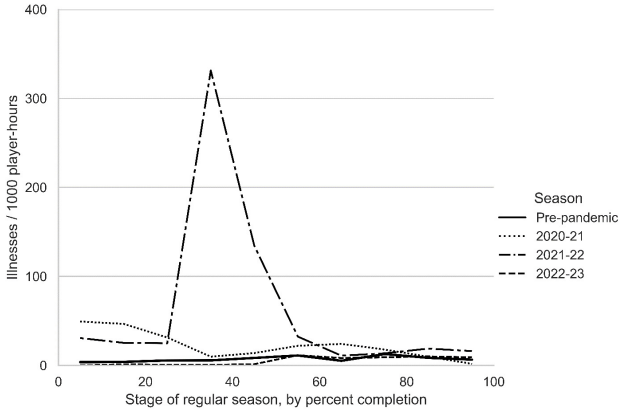

Figure 2. Incidence of illness over the duration of a regular season between pre-pandemic, 2020-21, 2021-22, and 2022-23 seasons.

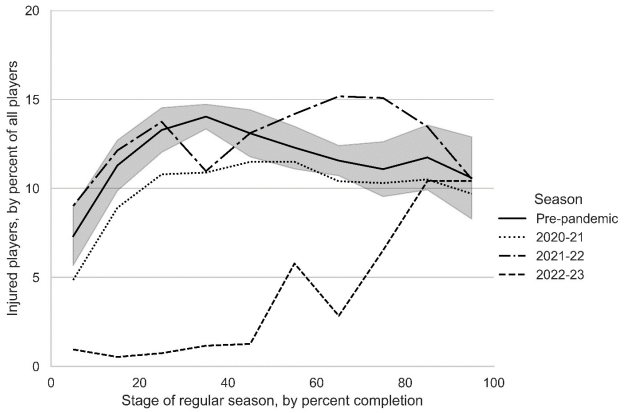

Figure 3. Period prevalence over the duration of the season. 95% confidence intervals for the pre-pandemic seasons shown by shaded area.

REGIONAL INCIDENCE

Incidence of overall injuries did not change across the 2020-21 and 2021-22 seasons while incidence decreased significantly in the 2022-23 season relative to pre-pandemic seasons (Table 2). Incidence of illness increased significantly in 2020-21 and 2021-22 though returned to pre-pandemic levels in the 2022-23 season. Upper body injuries were more frequent in 2020-2021 (29.95 vs 17.58 injuries / 1000 player-hours, $p = 0.001$) and 2021-22 seasons (24.65 vs 17.58 injuries / 1000 player-hours, $p = 0.044$) compared to pre-pandemic levels. In 2022-23, upper body injuries (1.64 vs 17.58 injuries / 1000 player-hours, $p < 0.001$) and lower body injuries (0.99 vs 23.03 injuries / 1000 player-hours, $p = 0.001$) decreased significantly compared to pre-pandemic values. Incidence of illness increased significantly during the 2020-21 season (IRR=16.40, 95% CI 3.53 to 76.19) and 2021-22 season (IRR=62.46, 95% 13.65 to 285.91) relative to pre-pandemic incidence of illness (3.67 illnesses / 1000 player-hours).

INJURY & ILLNESS SEVERITY

The average injury in 2020-21 was 0.78 days more severe than pre-pandemic seasons (18.12 vs 17.34 days lost, $p < 0.001$); the average injury in 2021-22 was 1.12 days more severe than pre-pandemic seasons (18.46 vs 17.34 days lost, $p < 0.001$); the average injury in 2022-23 was 1.29 more severe than pre-pandemic seasons (18.63 vs 17.34 days lost, $p < 0.001$) (Table 3). Increased severity of injury in 2020-21 can be accounted for by higher severity of lower body (0.74 days higher, $p < 0.001$) and upper body injuries (0.89 days higher, $p < 0.001$) compared to pre-pandemic seasons. Increased severity of injury in 2021-22 can be accounted for by higher severity of lower body (1.15 days higher, $p < 0.001$) and upper body injuries (1.15 days higher, $p < 0.001$) compared to pre-pandemic seasons. Increased severity of injury in 2022-23 can be accounted for by higher severity of upper body injuries (1.59 days higher, $p < 0.001$) compared to pre-pandemic seasons. There was no significant difference in severity of head or core injuries in post-pandemic seasons relative to pre-pandemic seasons. Severity of illness rose by 1.52 times in 2020-21 (7.35 vs 4.84 days lost, $p < 0.001$) and by 1.33 times in 2021-22 (7.35 vs 4.84 days lost, $p < 0.001$). Severity of illness in 2022-23 was no different from pre-pandemic seasons (5.88 vs 4.84 days lost, p = .0739).

DISCUSSION

The purpose of this study was to analyze the occurrence and severity of events (injury and illness) in the NHL and to understand any differences in occurrence and severity between pre-pandemic seasons and seasons that immediately followed. The incidence of upper body injuries was significantly higher in the 2020-2021 and 2021-2022 seasons compared to pre-pandemic seasons. Injury incidence in the 2022-23 season was significantly lower than pre-pandemic seasons but was the only season that had a notable increase in incidence as the season progressed. Severity of injury increased in the three seasons following the pandemic with upper and lower body injuries the most heavily impacted. The 2020-21 and 2021-22 seasons saw significant increases in illness incidence and severity while the 2022-23 saw illness incidence and severity return to pre-pandemic levels.

The increase in incidence of upper body injuries in the 2020-21 and 2021-22 seasons could in part be due to loss of sport-specific adaptations because of the interrupted competitive calendar.[5] Shoulder checking is the most common mechanism of injury (MOI) in ice hockey, accounting for 29.8% of all man-games lost in the NHL.[16] In addition, the 2020 offseason ranged from 10 months (for teams who did not make the adjusted playoffs) and < 5 months (for teams who did make the adjusted playoffs).[23] During this window, State, Provincial and League mandates presented several barriers to normal off-season programming (e.g., social distancing, closures of weight rooms and ice), increasing the difficulty for performance staff to design and implement effective programs and for players to adhere to said pro-

Table 2. Model-adjusted incidence of injury and illness categories. IRR = Incidence rate ratio. Boldface *p* values indicate statistically significant difference between pre-pandemic and respective season ($p < 0.05$).

	Pre-pandemic	2020-2021		2021-2022		2022-23	
Region	Incidence (events / 1000 player hours)	Incidence (IRR; 95% CI)	*p* value	Incidence (IRR; 95% CI)	*p* value	Incidence (IRR; 95% CI)	*p* Value
Overall	53.24	113.04 (2.12; 0.47 to 9.59)	.328	224.70 (4.22; 0.94 to 18.99)	.061	3.02 (0.06; 0.01 to 0.28)	**< .001**
Injury	49.99	59.46 (1.19; 0.26 to 5.40)	.822	61.12 (1.22; 0.27 to 5.55)	.794	2.72 (0.05; 0.01 to 0.27)	**< .001**
Lower body	23.03	26.71 (1.16; 0.25 to 5.32)	.849	32.98 (1.43; 0.31 to 6.56)	.643	0.99 (0.04; 0.01 to 0.30)	**.001**
Upper body	17.58	29.95 (1.70; 1.23 to 2.36)	**.001**	24.65 (1.40; 1.01 to 1.95)	**.044**	1.64 (0.09; 0.05 to 0.18)	**< .001**
Head	4.29	2.52 (0.59; 0.10 to 3.41)	.554	2.99 (0.70; 0.13 to 3.81)	.678	1.05 (0.24; 0.02 to 3.14)	.279
Core	1.65	1.65 (1.00; 0.31 to 3.23)	.997	1.41 (0.85; 0.22 to 3.29)	.817	0.47 (0.29; 0.04 to 2.06)	.213
Illness	3.67	60.16 (16.40; 3.53 to 76.19)	**< .001**	229.19 (62.46; 13.65 to 285.91)	**< .001**	0.49 (0.13; 0.01 to 1.19)	.071

Table 3. Model-adjusted severity of injury and illness. Boldface *p* values indicate statistically significant difference between pre-pandemic and respective season ($p < 0.05$).

	Pre-pandemic	2020-2021		2021-2022		2022-23	
Region	Mean days lost (95% CI)	Mean days lost (95% CI)	*p* value	Mean days lost (95% CI)	*p* value	Mean days lost (95% CI)	*p* value
Overall	15.38 (14.79-16.00)	16.23 (15.57-16.92)	**<.001**	16.26 (15.6-16.93)	**<.001**	16.63 (15.92-17.38)	**<.001**
Injury	17.34 (16.62-18.10)	18.12 (17.32-18.96)	**<.001**	18.46 (17.64-19.31)	**.015**	18.63 (17.77-19.53)	**<.001**
Lower body	18.21 (17.10-19.40)	18.95 (17.73-20.27)	**<.001**	19.36 (18.10-20.71)	**.038**	19.23 (18.00-20.65)	.422
Upper body	16.03 (15.77-16.29)	16.92 (16.89-17.21)	**<.001**	17.18 (16.89-17.48)	**<.001**	17.62 (17.31-17.94)	**<.001**
Head	16.29 (14.25-18.63)	17.17 (14.82-19.97)	.545	17.54 (15.17-20.34)	.165	17.68 (15.08-20.96)	.211
Core	23.28 (18.64-29.08)	23.97 (19.02-30.32)	.213	24.31 (19.25-30.84)	.911	24.18 (19.16-30.63)	.689
Illness	4.84 (4.36-5.38)	7.35 (6.48-8.35)	**<.001**	6.42 (5.75-7.18)	**<.001**	5.88 (5.17-6.73)	.739

gramming. Without adequate stimulus for players to adapt to game-specific exposures, such as shoulder checking, and with extended and irregular time off, injury risk is likely to remain high without providing the necessary re-conditioning time needed to regain protective factors.[5,24]

Injury prevalence was highest in the first half of the season for pre-pandemic seasons (14.81% at 40% of season completion) and in the 2020-21 season (11.49% at 50% season completion). Injury prevalence in 2021-22 peaked at 70% of season completion (15.17%, between February 20, 2022, and March 12, 2022) and was associated with backlogging of games. 131 games were either postponed or rescheduled during the 2021-22 season, with 76.3% (100/131) rescheduled during the month of February.[25] In a consensus statement from the International Olympic Committee on load and injury risk, it was emphasized that rapid increases in load, specifically, large week-to-week changes, are associated with placing athletes at significantly increased risk of injury.[26] In addition, schedule congestion results in deliberate downregulation of training load, as the

focus of training turns toward recovery between competitive bouts.[26] In a study focusing on NHL players exclusively, a condensed schedule and ≤1 day of rest between games were associated with increased injury risk.[17]

When adjusting for illnesses coded for COVID-19, there was no difference in incidence between pre-pandemic seasons and those that followed suggesting no impact of schedule disruption, abbreviated season, or schedule congestion on non-COVID-19 related illness. The incidence and severity of illness was significantly higher in the seasons following the pandemic compared to pre-pandemic seasons (2020-21: non-adjusted MDL=12.14; 2021-22: non-adjusted MDL=7.65). The increase in severity and difference between seasons following the pandemic is likely a reflection of the NHL's COVID-19 policy changes in each of the seasons. At the beginning of the 2020-21 season (January 2021), players who tested positive for COVID-19 were required to isolate for ten days. Midway through the 2021-22 season (December 29 2021), the isolation period was reduced to five days for fully vaccinated players.[27] Every notable change in incidence of illness in the seasons following the pandemic (Figure 2) was strongly correlated with patterns of disease transmission of COVID variants or revisions to the NHL's COVID protocol. For example, the league introduced increased physical distancing and air flow requirements on February 4, 2021;[28] incidence of illness for the 2020-21 season dropped shortly after (~25% of season completion) back to pre-pandemic levels of illness incidence. In December 2021 while the Omicron variant was spreading through North America,[28] illness incidence spiked at 331.36 illnesses per 1000 player-hours (~35% of season completion). Following this surge, all games were suspended for a week.[29] Illness incidence in the 2021-22 season returned to pre-pandemic levels around 55% of season completion (February 1, 2022); daily testing mandates for vaccinated players was removed on the same day,[27] suggesting reported illnesses are likely underreported in the current study due to lack of available data.

An acknowledged limitation of the current study is the use of public access injury data. Although it poses an attractive option given its ease of access, its accuracy is often called into question, especially when used in isolation, or from a single source, resulting in missing or misreported data. While previous studies have used multiple sources to improve validity of injury data,^17, 19, 31^ this paper utilized a systematic approach to ensure injuries and illnesses were included or excluded through the cross-referencing of sources and corroboration of public access data with game footage and media reports. Given there are no known studies validating public access injury data against the NHL's (gold standard) injury surveillance data, other means of validation are important for context and backing up the veracity of the claims. The non-model adjusted injury incidence between 2016 to 2019 (36.52 to 40.78 injuries per 1000 player-hours), was comparable to previous studies that utilized player-hours as a measure of exposure and utilized injury surveillance data directly from the respective league. McKay et al. reported injury incidence in the NHL from 2008-2012 to be 39.4 to 41.3 injuries / 1000 player-game hours[16]; Tuominen et al. reported injury incidence in U20 World Juniors tournaments between 2006-2015 as 43.3 injuries / 1000 player-game hours.[32] It should be noted that this task was time consuming, predominantly due to scrubbing through and watching days of game tape. With advances in motion detection and availability of vast historical footage it should be a realistic belief that artificial intelligence methods can be used in the future to replicate the methods presented in this paper for coding and classifying injuries.

Data inclusion involved the assumption that a movement of an injured player to a minor league affiliate was not injury related, though this is not always the case. Careful consideration was made as this would have likely overinflated injury severity. In doing so however, may have underreported injury occurrence. Another notable limitation is that a player would return to play when healthy. Return dates in the final month of the season often depend on the team's position relative to the playoffs and is common practice for a player to be shut down if out of playoff contention, thus inflating the severity of injury in latter stages of the season. As a retrospective design, it was assumed that pre- and post-pandemic seasons differed only by the exposure to a disruptive competitive calendar, and that all pre-pandemic seasons were not significantly different from one another.

CONCLUSION

Incidence of upper body injuries increased in the 2020-21 and 2021-22 NHL regular seasons while it decreased significantly in the 2022-23 regular season compared with the four pre-pandemic seasons. These effects lingered for the two seasons that immediately followed the abrupt disruption to the competitive calendar in the NHL. Although results show notable patterns and trends in injury and illness incidence and severity, the authors have been careful so as not to infer on the potential causal effects an abrupt cessation of play (due to the pandemic) has on injury occurrence and severity upon returning to play. Future studies focusing on the nuances of offseason training program design and or adherence in the seasons immediately following the pandemic are of notable interest. In addition, studies adjusting for potential modifiable risk factors (e.g., schedule congestion, variable offseason length) and adjusting for current study limitations (e.g., via quasi-experimental designs) are warranted to help sports medicine professionals determine optimal injury prevention strategies following abrupt cessations of play.

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