

# Epidemiology of Traumatic and Overuse Injuries in Swiss Professional Male Ice Hockey Players

Romana Brunner,<sup>\*†</sup> MSc, PT, Mario Bizzini,<sup>†</sup> PhD, PT, Karin Niedermann,<sup>‡</sup> PhD, PT, and Nicola A. Maffiuletti,<sup>†</sup> PhD

*Investigation performed at the Human Performance Lab, Schulthess Clinic, Zurich, Switzerland*

**Background:** Ice hockey injury patterns in Europe were last evaluated in the 1990s.

**Purpose:** The aim of this study was to assess the frequency, type, location, and incidence of traumatic injuries, as well as the prevalence and relative effect of overuse injuries in professional male ice hockey players.

**Study Design:** Descriptive epidemiology study.

**Methods:** Traumatic injuries were assessed using a standardized injury report form over a 1-year period (including the preparatory phase and season). The Oslo Sports Trauma Research Centre Overuse Injury Questionnaire was used to determine overall and substantial overuse injuries and their relative effect on ice hockey players.

**Results:** Five Swiss National League teams participated in the study. From a total of 321 recorded injuries, 179 led to time loss from sport. The game-related time-loss injury incidence during the season was 88.6/1000 player-game hours. Time-loss injuries affected mainly the hip/groin/thigh region (23%), followed by the head (17%). Most time-loss injuries were classified as muscle strains (24%), followed by concussions (18%). The most common injury mechanism involved collision with an opponent's body (31%), and right forward players (23%) were most likely to report a game-related injury. Most injuries (27%) occurred within the defending zone along the boards. The average prevalence rates of all overuse and substantial overuse injuries were 49% and 13%, respectively. The hip/groin displayed the highest average prevalence for all overuse problems (16%), translating to the highest relative effect.

**Conclusion:** Muscle strains and concussions were the most frequent time-loss injuries in Swiss professional ice hockey players. The hip/groin was the most affected region for both traumatic and overuse injuries.

**Keywords:** traumatic injuries; overuse injuries; epidemiology; ice hockey

Ice hockey is a popular high-impact sport, especially in North America and northern Europe. A number of injury risk factors, including high velocity on the ice, unintended collisions, rapid changes in direction, and injuries from the board, puck, and sticks, lead to a high risk of a wide variety

of player injuries.<sup>24,27</sup> Injuries can be categorized as a result of either a traumatic event (ie, a condition caused by an identifiable single external transfer of energy, such as a collision leading to bone fractures) or overuse (ie, there is no identifiable single external transfer of energy, but the condition is caused by multiple accumulative bouts of energy transfer, such as multiple microtraumas leading to, for example, tendon tears).<sup>26</sup> Depending on the surveillance methods used, the overall injury incidence in collegiate and professional men's ice hockey currently ranges from 4.9 to 15.6 per 1000 athlete-exposures, with approximately 50 injuries per 1000 player-game hours.<sup>11,20,27</sup>

Ice hockey injury patterns in Europe were last evaluated in the 1990s<sup>19,21-23</sup>, however, they may have changed over the past 2 decades as a result of increased player speed and aggressiveness.<sup>3,11</sup> Most traumatic injuries in previous investigations occurred at the head and face, followed by the thigh and knee region.<sup>20,27</sup> On the other hand, the most common types of overuse injuries mainly affected the groin, followed by the shoulder, elbow, and wrist region.<sup>23</sup>

Applying different surveillance methods and injury definitions has often led to reporting discrepancies in the frequency and type of both traumatic and overuse injuries.<sup>20</sup>

\*Address correspondence to Romana Brunner, MSc, PT, Human Performance Lab, Schulthess Clinic, Lengghalde 6, CH-8008 Zurich, Switzerland (email: romana.brunner@kws.ch).

<sup>†</sup>Human Performance Lab, Schulthess Clinic, Zurich, Switzerland.

<sup>‡</sup>Zurich University of Applied Sciences, School of Health Professions, Institute of Physiotherapy, Winterthur, Switzerland.

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Ethical approval for this study was obtained from the regional ethics commission of the Canton of Zürich (ID: 2017-00085).

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Previous surveillance systems mainly focused on traumatic injuries only and might not have captured the real number of overuse injuries because of the lack of surveillance methods.<sup>11</sup> In fact, the evaluation of overuse injuries in ice hockey is scarce, although proportions of 8% to 15% of all injuries have been reported.<sup>11,23</sup> A new method for the registration of overuse sport injuries has recently been developed,<sup>6</sup> although it has not yet been applied in ice hockey. The validated self-reported questionnaire contains 4 multiple-choice questions to document overuse problems of different anatomic regions, which are often underreported because most of these problems might not lead to time loss.<sup>6</sup> For ice hockey, there is still a lack of injury prevention research, as only 1 study has shown the effectiveness of a preseason exercise program to prevent adductor muscle strains in professional ice hockey players.<sup>28</sup>

The aim of this study was to assess the frequency, type, location, and incidence of traumatic injuries using a standardized report form,<sup>11</sup> as well as the prevalence and the relative effect of overuse injuries in professional male ice hockey players using the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire,<sup>6</sup> over a 1-year period (including the preparatory phase and game season).

## METHODS

### Participants

Approval for this study was granted by the local ethics committee. Study inclusion criteria were the ability to understand written/oral German or English and provide informed consent to use the collected survey data for research purposes. After the initial invitation was sent to 9 Swiss National League teams, including their medical staff (ie, physicians, sports physical therapists, massage therapists, and athletic trainers), 6 teams decided to participate in the study; the remaining 3 teams declined their participation because of either a language barrier (ie, Italian- or French-speaking medical staff) or an excessive amount of additional workload. Another team left the study during the preparatory phase after experiencing the workload associated with the study. Overall, 5 teams comprising 122 ice hockey players successfully completed the study.

### Data Collection

Data were collected for approximately 1 year, which included a preparatory phase during summer 2017 (from week 0 to week 19) and the 2017-2018 season (ie, regular season and playoffs/playouts from week 20 to week 50). One person from each team's medical staff was responsible for active data collection. Two were sports physical therapists, and 3 were massage therapists. All persons responsible for data collection were in charge of the initial care after an injury. They were present at all games and trainings. They were asked to complete a standardized report form for each traumatic injury occurring during dryland, weight lifting, or on-ice training sessions or games. Each person

responsible for data collection was trained by the primary investigator (R.B.) on how to complete the injury report form correctly before study initiation because injuries in Swiss ice hockey are not documented on a regular basis. The final diagnosis of each reported traumatic injury was made by the team physician. The person responsible for data collection was also asked to gather information on the number of dryland and on-ice training sessions per week. To ensure compliance, this person was asked to send the data collected to the corresponding author (R.B.) on a weekly basis. In the case of incorrect completion of the injury report form or missing data, this person was immediately contacted by the primary investigator for clarification.

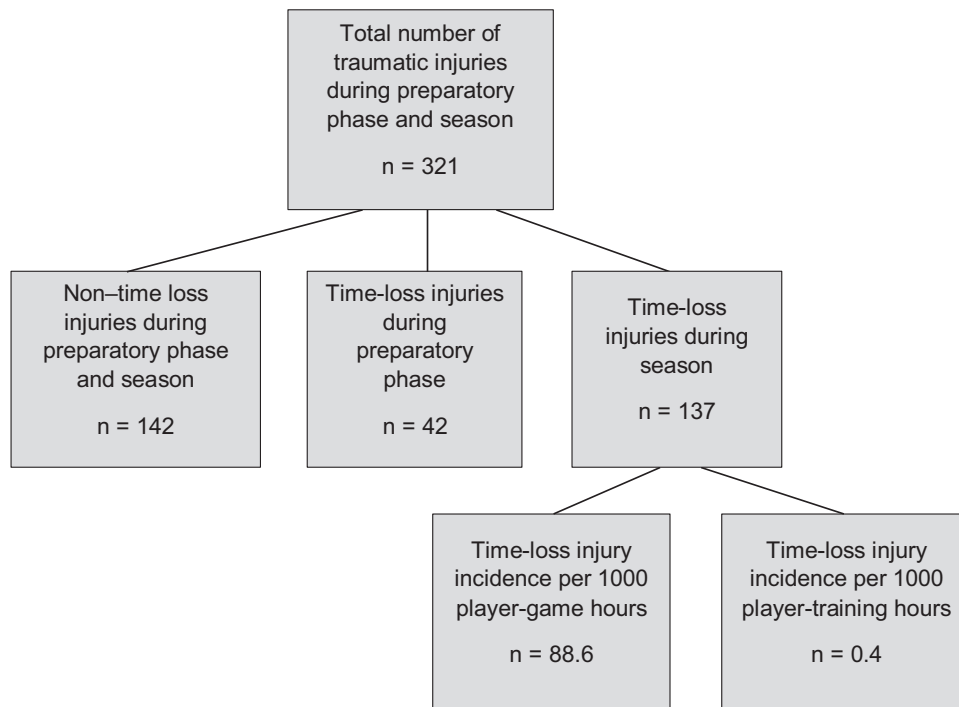
For each player, we extracted the total time on ice during the season from the individual statistics page of the Swiss Ice Hockey Federation website ([www.sihf.ch/de/game-center/national-league/#/mashup/players/playerTimeOnIce/timeOnIce/desc/page/0/2017/2158](http://www.sihf.ch/de/game-center/national-league/#/mashup/players/playerTimeOnIce/timeOnIce/desc/page/0/2017/2158)). All players were asked to complete the OSTRC Overuse Injury Questionnaire biweekly (every second week) during the 1-year study period to collect information regarding overuse injuries.

### Assessment of Traumatic Injuries

We used a standardized ice hockey injury data capture form, which was previously developed and evaluated by Flik et al,<sup>11</sup> to assess traumatic injuries. As noted, the form was completed by the person responsible for data collection for each team. The form comprised 32 questions, the majority of which were multiple choice and focused on determining the following information: individual player's characteristics at the time of injury; whether the injury occurred during a game (home vs away) or a training session and, if so, during on-ice, dryland, or weight lifting sessions; the game period and exact time when the injury occurred; and the player position and playing zone where the injury occurred. The cause of injury was documented, and it was also ascertained if the player was able to continue playing or had to stop. Last, if applicable, the injury was classified according to its grade, the diagnostic procedures, and the treatment(s) undertaken. A time-loss definition of injury, which implied that the player missed 1 or more training sessions or game events because of the injury, was used.<sup>26</sup>

### Assessment of Overuse Injuries

The validated, self-reported OSTRC Overuse Injury Questionnaire was used to assess overuse injuries of different body parts.<sup>6</sup> The questionnaire was handed out to all ice hockey players before and after the first training session of every second week and thereafter collected by the person responsible for data collection for each team. For the non-German speaking players (n = 27), the English version of the questionnaire was used. For the German-speaking players (n = 95), we translated the questionnaire according to the guidelines for cross-cultural adaptation of self-reported measures<sup>1</sup> because only a version of the OSTRC Questionnaire to capture general health problems and illnesses—



**Figure 1.** Overview of the number of traumatic ice hockey injuries.

not targeting specific body parts—has been validated in German.<sup>13</sup> The OSTRC Overuse Injury Questionnaire used in the present study contains 4 multiple-choice questions targeting shoulder, low back, hip/groin, and knee injuries, with questions about (1) the difficulties participating in normal training and competition during the past 2 weeks, (2) the amount of training volume reduction, (3) the extent of performance impairment, and (4) the degree of pain related to ice hockey. The responses to each of the 4 questions were allocated a numerical value between 0 (no problems/limitations) and 25 (maximum problems/limitations) and were subsequently summed to calculate a severity score between 0 and 100 for each body part.<sup>6,18</sup>

### Data Analysis

Descriptive statistics are presented as frequencies and proportions of any recorded traumatic injury. The overall incidence of traumatic injuries was calculated as the number of injuries per 1000 game or training hours during the season.

The prevalence of overuse injuries was calculated as the number of players who reported any overuse problem, identified by a score  $>0$  on any of the 4 questions or substantial overuse problems, divided by the total number of respondents.<sup>6</sup> Substantial overuse problems included only those leading to moderate or severe reductions in training volume or performance or an inability to participate in normal training/competition.<sup>18</sup> The prevalence of overuse injuries was calculated biweekly and for each body part; that is, shoulder, low back, hip/groin, and knee. The cumulative severity score was then calculated for each body part as the sum of the severity scores of the respective body part for all

players over the study period divided by the number of respondents on that 2-week interval.<sup>6</sup> The cumulative severity score was the basis for comparison of the relative effect of overuse problems in each body part.<sup>5,18</sup> For 6 of the 26 biweekly periods (ie, weeks 0, 2, 4, 12, 48, and 50), we received questionnaire data from  $\leq 3$  teams because of holidays or different start periods of the preparatory phase, and therefore the data sets for these time points were not included in the analyses.

## RESULTS

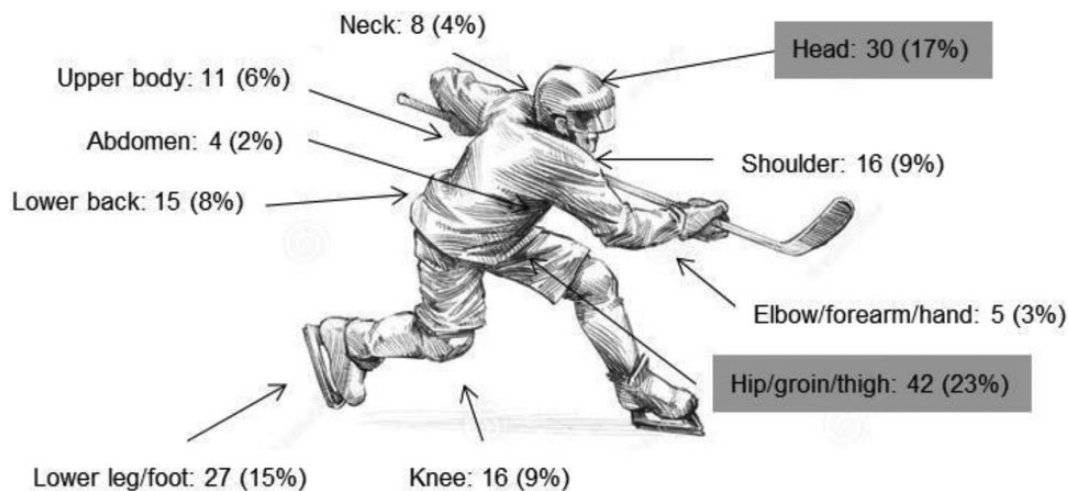
### Participants

The 122 players who participated in this study were from 10 different nations and had a mean age of 26 years. Seventy-seven players had  $>3$  years of experience in the National League.

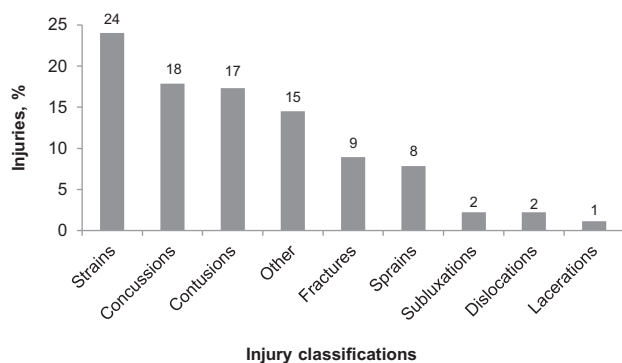
### Traumatic Time-Loss Injuries

The incidence of time-loss injuries per 1000 player-game hours during the season was 88.6, and it was 0.4 per 1000 player-training hours (Figure 1). Team injury incidence ranged between 80 and 96 per 1000 player-game hours and between 0.2 and 0.5 per 1000 player-training hours.

Overall, 23% of injuries were localized to the hip/groin/thigh region; 17%, to the head; and 15%, to the lower leg/foot (Figure 2). Twenty-four percent of injuries were diagnosed as muscle strains; 18%, as concussions; and 17%, as contusions (Figure 3).



**Figure 2.** Time-loss injuries per body region (n = 179).



**Figure 3.** Time-loss injury classifications (n = 179).

### Frequency, Type, and Location of Traumatic Time-Loss and Non-Time-Loss Injuries

Seventy-five percent of all injuries occurred during games. Of the remaining 25% of training-related injuries, 63% occurred on-ice, 30% occurred during dryland, and 7% occurred during weight lifting sessions. On average, a player missed 32 training sessions and 7 games after an injury. Eighteen percent of all injuries were localized to the hip/groin/thigh region; 13%, to the face; and 11%, to the head. Twenty-eight percent of all injuries (ie, time-loss and non-time loss) were diagnosed as contusions, and 21% were diagnosed as muscle strains. The 3 main causes of all traumatic injuries were collisions with the opponent's body (31%), hits by a puck (16%), and collisions with the board (13%). A game-related injury was reported in 23% of the right forwards, 21% of the right defenders, and 20% of the left forwards, followed by 17% of the center players, 15% of the left defenders, and 4% of the goalkeepers. Twenty-seven percent of injuries occurred in the defending zone along the boards, followed by the attacking zone along the boards (20%) and the neutral zone (16%) (Figure 4). Forty-four percent of all injuries were reported during the central part

(minutes 7-13) of the second game period compared with 26% in the first period and 30% in the third period.

### Prevalence of Overuse Injuries

The average response rate of the OSTRC Questionnaire was 83%. The average number of players per team who completed the questionnaire was 21. The yearly prevalence rates of all overuse and substantial overuse injuries were 49% and 13%, respectively. The average prevalence rate for all overuse hip/groin injuries was 16% (Figure 5D). The shoulder, hip/groin, and knee regions alike accounted, on average, for 4% of substantial overuse injuries (Figure 5, B, D, and E). The average prevalence rates of all overuse and substantial overuse injuries during the preparatory phase were 58% and 15% and during the season were 43% and 14%, respectively (Figure 5A).

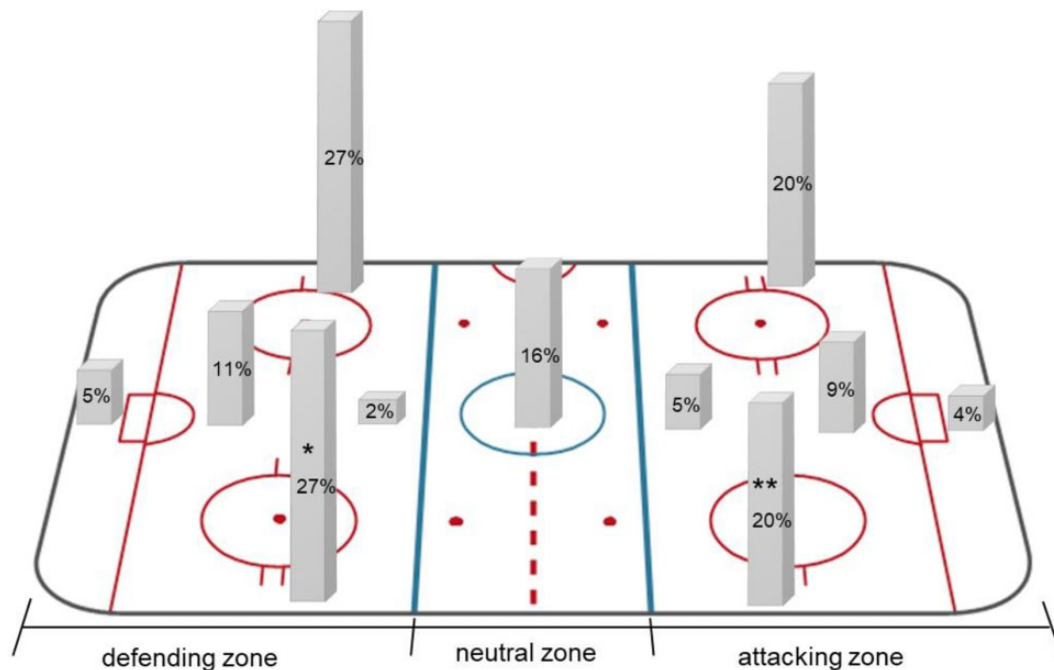
Hip/groin injuries and shoulder injuries showed the highest and lowest cumulative severity scores, respectively (Figure 6).

## DISCUSSION

We investigated the frequency, type, location, and incidence of traumatic injuries as well as the prevalence and relative effect of overuse injuries affecting different body regions in professional male ice hockey players from Switzerland over a competitive season.

### Traumatic Time-Loss Ice Hockey Injury Incidence

The incidence of traumatic time-loss injuries per 1000 player hours during the season was >1.5 times higher in our study compared with National Hockey League (NHL) statistics,<sup>20</sup> even though the European style of play was considered to be less aggressive and physical compared with the American style.<sup>11</sup> Because we collected data over only 1 season, our results cannot be easily compared with those of the prospective study of McKay et al,<sup>20</sup> which



**Figure 4.** Number of time-loss and non-time loss injuries per playing zone ( $n = 256$ ). \*Twenty-seven percent of injuries occurred in the defending zone along the boards on the right or left side. \*\*Twenty percent of injuries occurred in the attacking zone along the boards on the right or left side.

spanned over 6 NHL seasons; they reported a range of traumatic injuries per 1000 player-games of 39 to 67 versus the 80 to 96 in our current study. On the other hand, the incidence of 66 to 83 injuries per 1000 player-game hours reported by a number of earlier studies focused on European ice hockey leagues<sup>19,21-23</sup> was more in line with our range. However, injury definitions vary across the studies, which makes a comparison difficult.

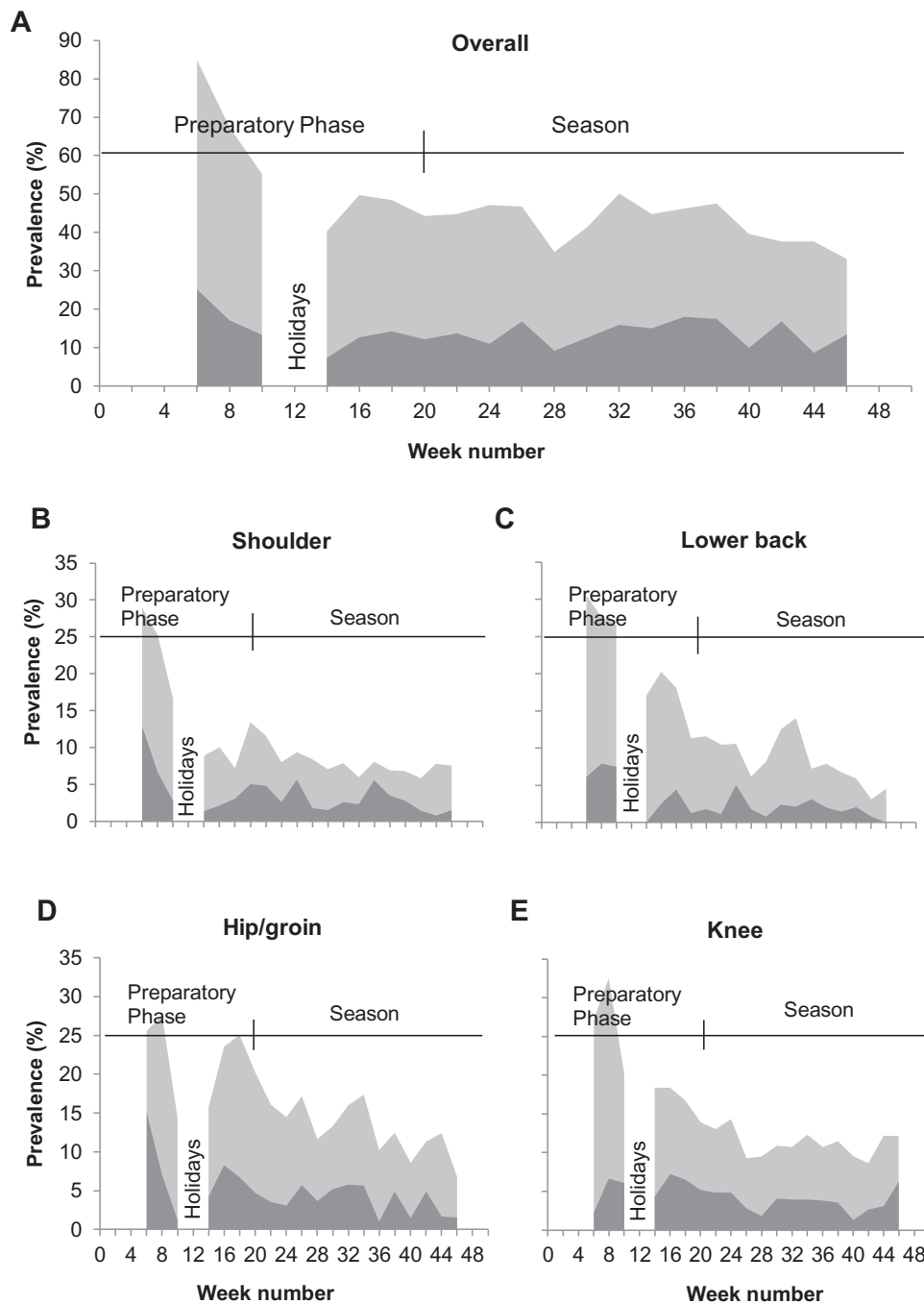
#### Frequency, Type, and Location of Traumatic Time-Loss and Non-Time Loss Injuries

In agreement with other studies,<sup>11,20,27</sup> the incidence of all traumatic injuries of our cohort was higher during games than during training sessions, and the most common injury mechanism was body checking. Most injuries occurred along the boards even though body checking was the more common injury mechanism compared with collision with the boards. This may be explained by the fact that the “event” of players getting checked by an opponent, followed by collision with the board, was not specifically captured by the injury report form. Thus, it was considered as a limitation of the injury report form. We found that injuries were more frequent in the second period, which corresponds to previous observations from 7 World Championship tournaments,<sup>27</sup> followed by the third period. This might be attributed to the fact that the level of fatigue may progressively increase during a game, thus leading to more injuries. Interestingly, a greater number of injuries occurred in the first period of NHL games<sup>20</sup>; McKay and collaborators<sup>20</sup> speculated that, because players were not fatigued, they

had the capacity for greater physical play, which could lead to a higher risk of injuries. Our results also showed that the goalkeepers were at a lower risk of sustaining injuries than were the field players, whereas the risk was highest for the forwards, closely followed by defenders.<sup>19,21,27</sup> There is a notable difference in the physical style of play associated with each of these positions, which can explain the different risk of injuries among goalkeepers, defenders, and forwards.<sup>20</sup>

#### Hip/Groin and Head Injuries as Major Problems in Ice Hockey

Similarly to the NHL study of McKay et al,<sup>20</sup> we found that the most commonly injured lower and upper body regions were the hip/groin/thigh and the head, respectively. Ice hockey players are particularly susceptible to adductor muscle strains,<sup>29</sup> and this was confirmed by our data, as muscle strains in the hip/groin/thigh region were the most common traumatic time-loss injuries. Besides muscle strains, the most common injuries leading to time loss were concussions.<sup>9,17</sup> Ice hockey is a high-impact stop-and-go sport, where body checking is permitted and players are exposed to environmental risk factors such as, ice, boards, sticks, and pucks, thus leading to a high risk of injuries, especially to the head.<sup>17</sup> In 1997, the NHL and NHL Players Association (NHLPA) launched the NHL-NHLPA Concussion Program in order to improve the scientific knowledge about concussion in professional ice hockey players.<sup>2</sup> Hutchison et al<sup>15,16</sup> reported how a systematic video analysis of NHL concussions contributed to

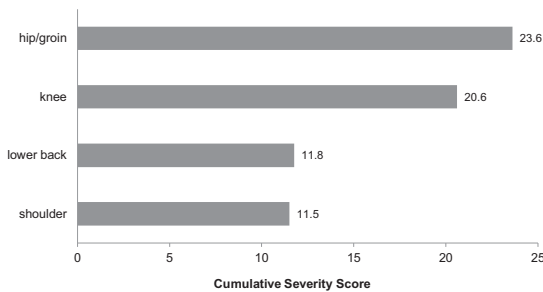


**Figure 5.** Prevalence of all overuse problems (light gray area) and substantial overuse problems (dark gray area) (A) overall and located at the (B) shoulder, (C) low back, (D) hip/groin, and (E) knee.

identifying the injury mechanisms and various factors associated with concussions, therefore helping the development of education, evaluation, management, and prevention strategies. Muscle strains and concussions might be reduced via specific preventive strategies such as, injury prevention training programs, modifications of game rules, and/or implementation of arenas with flexible boards and glass,<sup>27,29</sup> which should definitely require more attention in ice hockey.

#### Overuse Injuries in Ice Hockey

Ice hockey seems to be associated with a high risk of overuse injuries (49%) compared with those in other sports, such as football (13%) and cross-country skiing, floorball, handball, road cycling, and volleyball (39%).<sup>5,18</sup> To our knowledge, this is the first epidemiological study investigating overuse injuries in professional ice hockey players. Based on our results, the hip/groin region, which was



**Figure 6.** Relative effect of overuse injuries affecting the shoulder, low back, hip/groin, and knee, indicated as the cumulative severity score.

previously reported as the most problematic region for ice hockey players,<sup>4,10,25,29,31</sup> showed the highest relative effect of overuse injuries. Clinical entities, such as adductor-related pain,<sup>14</sup> hip-related groin pain,<sup>30</sup> and femoroacetabular impingement syndrome (FAIS),<sup>12</sup> are often used to classify hip/groin pain in ice hockey players. Ice hockey skating patterns (ie, external rotation in hip abduction during the push-off phase and internal rotation in hip flexion during the recovery phase) were previously described to be at-risk positions for FAIS in Peewee ice hockey players and should be taken into consideration in the prevention of overuse injuries of the hip.<sup>25</sup> Furthermore, the imbalance between hip and abdominal muscle strength (ie, strong adductor muscles versus weak lower abdominal muscles) might be an underlying cause of athletic pubalgia.<sup>8</sup> However, a classification, such as a specific diagnosis of hip/groin overuse injuries, using the OSTRC Overuse Injury Questionnaire is not possible because it only captures self-reported overuse problems of different anatomical regions. A recent investigation<sup>31</sup> showed a high prevalence of hip/groin problems in ice hockey players regardless of the playing position, thus indicating that all players might potentially benefit from prevention strategies for overuse injuries.

The highest prevalence of all overuse (85%) and substantial overuse (25%) injuries during the preparatory phase—at the beginning of this study—might be attributed to the fact that players were just starting out the summer training and were not in as good condition as they were later in the season and thus were more prone to injuries. Another reason might be the high training load during the summer months (on average, there were 14 h/wk of dryland training during the preparatory phase vs 3 h/wk during the season) leading to overuse injuries. After the preparatory phase load, there is also the season match load, with often a congested calendar (2-3 games per week), including short recovery times; this, in turn, can lead to a generally high injury rate, as previously seen in professional soccer players.<sup>7</sup>

### Limitations

One of the limitations of this study is the sampling of approximately 50% of invited teams, which might have led

to a potential detection and sampling bias. This limitation can only be addressed by increasing the total number of teams; however, this was not possible because our current study was restricted to ice hockey teams with the ability to understand German or English. One of the major limitations involves the reporting bias of traumatic injuries by the person who was responsible for data collection for each team. However, this was anticipated by the primary investigator training each person using the injury report form before data collection. A comparison among the teams highlighted that some medical staff members were more likely to report minor non-time loss injuries, such as contusions by pucks. For example, in some teams, contusions were consistently treated using an ice pack by the person responsible for data collection, whereas other teams did not treat them and therefore did not report them. The number and type of time-loss injuries among teams were, however, comparable. Another limitation is associated with the OSTRC Overuse Injury Questionnaire, which only focuses on predefined injury regions and does not allow other overuse injuries (eg, FAIS) to be classified. Ideally, each problem reported by an athlete is quickly followed up with a confirmatory medical examination; however, this obviously may increase the logistical difficulty and cost of conducting a study.<sup>6</sup>

### Perspectives

The high prevalence and relative effect of overuse injuries, with hip/groin problems at the top, highlight a significant medical concern in ice hockey athletes that should be addressed in the future. Future research should focus on the development of injury prevention programs, especially for the hip/groin area and head, to decrease the prevalence of injuries. It is of high importance to further develop implementation strategies in order to address injury prevention program adherence in different ice hockey teams.

### CONCLUSION

Muscle strains and concussions were the most frequent time-loss injuries in Swiss professional ice hockey players. The high prevalence and relative effect of overuse injuries, particularly affecting the hip/groin, highlight a significant medical concern in ice hockey athletes that should be carefully addressed in the future.

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