

Incidence, Prevalence, and Severity of and Risk Factors for Hip and Groin Problems in Swedish Male Ice Hockey Players: A 1-Season Prospective Cohort Study

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Context: The epidemiologic focus on time loss may underestimate the true magnitude of hip and groin problems in male ice hockey players.

Objective: To describe the prevalence, incidence, and severity of hip and groin problems (time loss and non–time loss) in Swedish ice hockey players over the course of a season and explore potential preseason risk factors for these conditions.

Design: Prospective 1-season cohort study.

Setting: Professional and semiprofessional Swedish ice hockey players.

Patients or Other Participants: A total of 12 professional and semiprofessional male ice hockey teams were invited to participate. Of those, 9 teams agreed, and 163 players were included in the analyses.

Main Outcome Measure(s): Hip and groin problems in the previous season (time loss, non–time loss), isometric adduction and abduction strength, and 5-second squeeze test results were recorded before the season and served as independent variables in the risk factor analysis. Main outcome measures were cumulative incidence of hip and groin problems, average prevalence, and odds ratios (ORs) for groin problems in season.

Results: Cumulative incidence was 45.4% (95% CI = 37.6%, 53.4%) for all problems and 19% (95% CI = 13.3%, 25.9%) for substantial problems. Average prevalence was 14.1% (95% CI = 10.8%, 17.5%) for all and 5.7% (95% CI = 4.3%, 7.2%) for substantial problems. Among reported problems, 69.2% had a gradual onset, and only 17% led to time loss. Players with non–time-loss problems in the previous season had higher odds for new problems (all: OR = 3.3 [95% CI = 1.7, 6.3]; substantial: OR = 3.6 [95% CI = 1.8, 8.4]). Preseason strength was not significantly associated with the odds for subsequent problems.

Conclusion: Hip and groin problems are common in ice hockey players and may lead to substantial impairments in performance. Only 1 in 5 problems led to time loss, and 7 in 10 had a gradual onset. Non–time-loss problems in the previous season were a significant risk factor for new problems, whereas decreased preseason hip-adduction and -abduction strength was not.

Key Words: epidemiology, injury surveillance, groin pain, hip pain

Key Points

- Over the course of a season, almost half of all ice hockey players experienced hip and groin problems, and more than 4 in 5 of these were non–time-loss problems.
- Players with non–time-loss problems in the previous season had 3.6 times the odds of reporting new, severe hip and groin problems as players without problems in the previous season.
- Extra attention and preventive efforts may be required to keep players with a history of hip and groin problems (both time loss and non–time loss) on the ice and performing.

Ice hockey is often associated with hip and groin problems, and terms such as *hockey groin syndrome*¹ are frequently used in the published literature, clinics, and locker rooms. In collegiate ice hockey, the source of most of our epidemiologic knowledge, the incidence rate of hip and groin problems was 1.3 per 1000 athlete-exposures (AEs),² and those injuries accounted for approximately 1 in 10 of all injuries.³ No other collegiate sport has as high a proportion of hip and groin conditions among all injuries, and only soccer had an even higher incidence rate.⁴

However, the full extent of the problem may be underestimated in the current literature. The authors of epidemiologic studies on hip and groin problems in ice hockey players traditionally recorded only injuries that left players unable to participate in competition or training (time-loss definition of *injury*).^{5,6} Yet that approach neglects a large number of hip and groin problems—those that do not lead to time loss but nevertheless impair sporting performance, affect activities of daily living, and may require treatment.

Similar to other overuse injuries, hip and groin pain typically develops gradually and often becomes a long-standing problem that does not necessarily lead to time loss.⁷ More than 50% of hip and groin injuries in North American college players were reported to be *non-time-loss* problems, defined by a participation restriction of < 24 hours.^{2,7,8} When non-time-loss injuries are defined not only by participation restriction but also by pain and self-reported impairments in performance during participation, their prevalence may be even higher.^{9,10} In a recent study from Sweden, half of all professional ice hockey players reported sustaining non-time-loss hip and groin problems in the preceding season that affected their performance.⁹ Non-time-loss injuries accounted for 82% of all hip and groin problems in ice hockey goalkeepers¹⁰ and even more in sports such as football.¹¹ Players experience considerable impairments in hip-related sporting function, regardless of whether an injury leads to time loss,^{10,11} that should be accounted for in descriptions of their burden. The magnitude and severity of these overuse problems may be best characterized by prospective investigations that consider the magnitude of the problem via prevalence instead of incidence alone and expressing severity according to functional impairment instead of only time loss.¹² Recent researchers¹³ who implemented these recommendations confirmed hip and groin problems as one of the most burdensome overuse conditions for ice hockey players.

Despite the high prevalence and heavy burden of overuse hip and groin problems in ice hockey players, all existing studies^{14,15} of risk factors for these conditions in ice hockey players used a time-loss injury definition. These investigators identified a low level of sport-specific training during the off season, previous groin injury,¹⁴ and reduced adduction strength¹⁵ as possible risk factors for subsequent groin injury. These risk factors for groin injury in ice hockey players are identical to those reported for time-loss groin injuries in athletes in general.¹⁶ How these risk factors are associated with subsequent hip and groin problems, including those not leading to time loss, has not been examined. For non-time-loss problems, it may be appropriate to monitor hip and groin health with the aim of identifying and managing emerging conditions early.¹⁷ A field test that can be used for repeated evaluations of hip and groin health is the 5-second squeeze test,¹⁸ which was shown to indicate self-reported function and hip muscle strength in ice hockey players¹⁹; however, the association between preseason measures and subsequent hip and groin problems in ice hockey players has not yet been explored.

In this study, we aimed to describe the magnitude of hip and groin problems among elite male ice hockey players in terms of prevalence, incidence, and severity over a full competitive season. Furthermore, we aimed to measure the associations between (1) hip and groin problems in the previous season, (2) hip muscle (adduction and abduction) strength, and (3) the 5-second squeeze test results and hip and groin problems during the season.

METHODS

Study Design

In this prospective cohort study, we asked participating ice hockey players to report hip and groin problems on the

Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC-O)²⁰ biweekly during the regular 2017–2018 season. At the beginning of the season, players completed a baseline questionnaire on hip and groin problems in the previous season and performed hip-muscle strength tests (bilateral adduction and abduction) and the 5-second squeeze test. The Ethics Committee at Lund University approved this study (Dnr 2017/483). We provided the results in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (Extension for Sport Injury and Illness Surveillance).²¹

Participants and Recruitment

We invited all professional (Swedish Hockey League, Allsvenska) and semiprofessional (Division 1) male ice hockey teams in the greater Stockholm area to participate. Of the 12 invited teams, 9 agreed to participate. Before the first measurements, all individual players received written information about the study. On the day of the first measurements, they had the chance to ask questions about the study and supplied written informed consent.

Baseline Assessment

Before the 2017–2018 season, we visited each participating team before a training session to collect baseline data. Players completed an electronic questionnaire that asked for demographic information, playing level (league), playing position, years of ice hockey experience, and the occurrence and duration of hip and groin problems during the previous season. Information was collected separately for hip and groin problems that led to an inability to participate in training and matches (*time-loss injuries*) and those that affected self-reported hockey performance without preventing participation (*non-time-loss injuries*).

Subsequently, we conducted a physical test battery consisting of the 5-second squeeze test¹⁸ and bilateral isometric adduction and abduction strength testing. The 5-second squeeze test was performed with the player in a supine position and the assessor's forearm between the player's ankles. The player was asked to produce a 5-second maximal isometric contraction and rate the magnitude of groin pain during the contraction on a numeric pain rating scale from 0 to 10 (0 = *no groin pain*, 10 = *maximal groin pain*). The 5-second squeeze test can indicate hip- and groin-related sporting function and impaired adduction and abduction strength in ice hockey players.¹⁹ Bilateral isometric adduction and abduction strength was measured by a single assessor (T.W.) using a handheld dynamometer (model MicroFET 2; Hoggan Health Industries). Both measures, which have been shown to be reliable,¹⁹ were performed in the 5-second squeeze position. For the abduction measure, a fixation belt held the dynamometer in place on the lower leg at the height it was applied during the adduction measure.

Reporting of Hip and Groin Problems Throughout the Season

Every second week, players retrospectively reported hip and groin problems that occurred during the preceding 14 days on the OSTRC-O. The instrument is a valid method

Question 1

Have you had any difficulties participating in normal training and competition due to hip and groin problems during the past two weeks?

- Full participation without problems
- Full participation but with problems
- Reduced participation due to problems
- Cannot participate due to problems

Question 3

To what extent have hip and groin problems affected your performance during the past two weeks?

- No reduction
- To a minor extent
- To a moderate extent
- To a major extent
- Cannot participate at all

Question 2

To what extent have you reduced your training volume due to hip and groin problems during the past two weeks?

- No reduction
- To a minor extent
- To a moderate extent
- To a major extent
- Cannot participate at all

Question 4

To what extent have you experienced hip and groin pain related to your sport during the past two weeks?

- No pain
- Mild pain
- Moderate pain
- Severe pain

Figure 1. Oslo Sports Trauma Research Center (OSTRC) Overuse Injury Questionnaire for hip and groin problems.

for recording overuse injuries.^{20,22} The OSTRC-O assesses the effect of hip and groin pain on a player's participation, training volume, performance, and pain during ice hockey (Figure 1). When players reported a problem, we also asked them about associated time loss (number of missed matches and games) and the onset (gradual or sudden). When players reported the sudden onset of problems, we asked them to specify whether it happened during training or a match. All players were requested to report exposure to match play and training (number of sessions on ice and off ice). We sent the questionnaire to all players via SMS message (Briteback AB, Norrköping). Messages were sent biweekly on Sundays throughout the regular 2017–2018 season (12 messages between September 2017 and February 2018). Nonresponding players received up to 3 reminders after 1 and 2 days.

Classification of Hip and Groin Problems

We considered any report that included at least 1 of the following answers on the OSTRC-O to represent a hip and groin problem (*all hip and groin problems*):

- Q1. Anything but full participation without hip and groin problems;
2. *Any reduction in training volume*;
3. Any level of affected performance; and
4. *Any hip and groin pain experienced during sport participation*.

We categorized reported conditions as substantial hip and groin problems if players reported any of the following answers on the OSTRC-O:

1. *Moderate or severe reduction in training volume* (Q2);

2. *Moderate or severe affected performance* (Q3);
3. *Inability to participate* (Q1, Q2, or Q3).

If a player missed at least 1 day of ice hockey participation, we considered it to be a *time-loss problem*. We counted multiple sudden or time-loss problems reported by the same individual as separate events if they were separated by at least 2 weeks of full ice hockey participation without symptoms or performance deficits.

Statistical Analysis

We calculated the biweekly prevalence of hip and groin problems (*all* and *substantial*) with corresponding 95% CIs for proportions (p ; symptomatic [Wald] method) based on a normal approximation as $p \pm 1.96 \times (p [1 - p] / n)$. We then determined the average biweekly prevalence with corresponding 95% CIs for the whole season.

We calculated the proportion of players who experienced at least 1 episode of hip and groin problems during the season (all, substantial, and time-loss problems) as well as incidence rates for sudden-onset and time-loss problems in relation to 1000 AEs (number of matches and training sessions) with 95% CIs (normal approximation to the Poisson distribution). Separate logistic regression analyses were performed to explore the odds of experiencing all, substantial, or time-loss problems at some point during the season in relation to preseason factors (time-loss or non-time-loss injury during the previous season, adduction strength, abduction strength, adduction-to-abduction strength ratio, and 5-second squeeze test results). Continuous predictors were categorized into tertiles. Age and years of hockey experience were separately included in the models and evaluated for potential confounding effects

Table 1. Player Characteristics

Characteristic	Mean ± SD
Age, y (n = 158)	22.6 ± 2.3
Height, cm (n = 158)	182.7 ± 5.5
Weight, kg (n = 163)	85 ± 7.1
Years of elite ice hockey	17 ± 3.4
Playing level (n = 159)	n (%)
Swedish Hockey League	14 (8.8)
Hockey Allsvenska Division 1	15 (9.4)
Division 1	130 (81.4)
Playing position (n = 159)	
Goalkeeper	11 (6.9)
Defender	94 (60)
Forward	54 (34)
Hip and groin problems during the previous season (n = 159)	
Non-time loss, No. (%)	66 (41.5)
Symptom duration, wk	2 (1–4) ^a
Time loss, No. (%)	45 (28.3)
Symptom duration, wk	2 (1–4) ^a

^a Median (interquartile range).

according to the change-in-estimate approach.²³ Given that none of the variables resulted in a change in estimate (odds ratio [OR]) of >15%, they were not included in the final analyses.

RESULTS

Study Sample and Response Rate

We invited 12 teams to participate in the study, and 10 teams agreed. At baseline, 212 players underwent testing. One of these 10 teams (18 players) declined prospective follow-up, leaving us with 194 players (17–28 players per team) for prospective injury surveillance. In total, 163 players (84%) provided surveillance data and were included in the final sample. Player characteristics are summarized in Table 1. The baseline questionnaire was completed by all included players, and the average biweekly response rate was 62.7% (minimum = 50.3%, maximum = 85.6%).

Hip and Groin Problems

Over the course of the season, we recorded a total of 182 problem reports (in 74 unique players), of which 73 (in 31 unique players) were classified as substantial hip and groin problems. In total, 45.4% (95% CI = 37.6%, 53.4%) of all players reported at least 1 episode of hip and groin problems (all problems), and 19.0% (95% CI = 13.3%, 25.9%) reported at least 1 episode of substantial problems. On average, 14.1% (95% CI = 10.8%, 17.5%) of all players experienced hip and groin problems (all problems) during any given 14-day interval, and 5.7% (95% CI = 4.3%, 7.2%) experienced substantial hip and groin problems during the regular season (Figure 2).

Time-Loss Problems

Time-loss problems were experienced at least once during the season by 14.7% (n = 24) of players. In total, we recorded 26 separate time-loss problems (in 25 unique players) over the course of the season (incidence rate = 1.3 [95% CI = 0.9, 2.0] per 1000 AEs). Among all reports of hip and groin problems (all problems), 17% led to time loss,

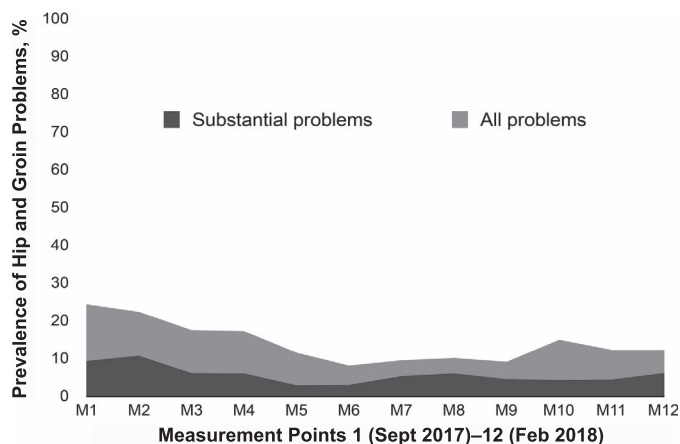


Figure 2. Prevalence of all hip and groin problems (light gray) and substantial hip and groin problems (dark gray) at all 12 surveillance points.

and among all reports of substantial hip and groin problems, 34.2% led to time loss.

Sudden or Gradual Onset

Among all recorded problems, 31% (n = 56) had sudden onset, and 21% (n = 38) of these were classified as separate problems with sudden onset according to our definition (incidence rate = 1.9 [95% CI = 1.4, 2.7] per 1000 AEs). The incidence rate of problems with sudden onset during a match was 5.5 (95% CI = 3.8, 8.8) per 1000 match-exposures and during training, 1.0 (95% CI = 0.06, 1.7) per 1000 training-exposures. Among all recorded problems, 69% had gradual onset. Among all substantial problems, 62% had gradual onset.

Preseason Risk Factors for Hip and Groin Problems

Players who reported a hip and groin problem in the previous season had significantly higher odds of reporting a new one during the season than players without hip and groin problems in the previous season. The odds were 2.6 times higher (95% CI = 1.4, 5.0) for reporting new problems, 4 times higher (95% CI = 1.7, 9.7) for reporting substantial problems, and 3 times higher (95% CI = 1.2, 8.0) for reporting time-loss problems during the season. Non-time-loss conditions in the previous season were associated with the highest odds for new problems. We did not identify any significant associations between preseason hip muscle strength and hip and groin problems during the season (Table 2).

DISCUSSION

In this study, we used a method design to capture the occurrences and consequences of all problems, not just those leading to time loss, to describe the extent to which male professional and semiprofessional ice hockey players sustained hip and groin conditions. Furthermore, we assessed potential risk factors for both time-loss and non-time-loss problems. Our main findings were that almost half of all players reported a hip and groin problem during the season and that 1 in 6 players had problems at any given time during the season. Fewer than 1 in 5 problems led to

Table 2. Analysis of Potential Preseason Risk Factors (N = 163)^a

Risk Factor	All Problems (n = 182)			Substantial Problems (n = 73)			Time-Loss Problems (n = 26)		
	OR	95% CI	P Value	OR	95% CI	P Value	OR	95% CI	P Value
Previous non-time-loss injury? (n = 159)									
No	1/Ref			1/Ref					
Yes (n = 66)	3.3	1.7, 6.3	<.001	3.6	1.8, 8.4	.003	2.3	0.9, 5.7	.077
Previous time-loss injury? (n = 159)									
No	1/Ref			1/Ref					
Yes (n = 45)	0.9	0.5, 1.9	.83	2.3	1.0, 5.3	.047	1.9	0.8, 4.9	.162
Previous time-loss/non-time-loss injury? (n = 159)									
No	1/Ref			1/Ref					
Yes (n = 74)	2.6	1.4, 5.0	≤.001	4.0	1.7, 9.7	≤.001	3.1	1.2, 8.0	.018
5-s Squeeze test (Numeric Pain Rating Scale, 0–10; n = 163)									
0–2 (n = 117)	1/Ref			1/Ref					
3–5 (n = 40)	1.3	0.7, 2.8	.43	2.1	0.9, 4.9	.09	1.84	0.7, 4.8	.211
6–10 (n = 6)	2.7	0.5, 15.2	.27	2.8	0.5, 16.1	.26	3.68	0.6, 22.0	.153
Adduction strength (n = 158)									
T1	0.8	0.4, 1.8	.62	0.8	0.3, 2.2	.64	0.8	0.3, 2.2	.617
T2	0.7	0.3, 1.6	.44	1.1	0.4, 2.9	.81	0.6	0.2, 1.9	.406
T3	1/Ref			1/Ref					
Abduction strength (n = 162)									
T1	0.5	0.3, 1.2	.12	0.5	0.2, 1.3	.14	0.5	0.2, 1.4	.192
T2	1.3	0.6, 2.7	.56	0.7	0.3, 1.8	.48	0.6	0.2, 1.6	.305
T3	1/Ref			1/Ref					
Adduction/abduction ratio									
T1	1.9	0.9, 4.2	.09	1.5	0.6, 3.8	.43	1.2	0.4, 3.6	.750
T2	1.0	0.5, 2.2	1.00	0.9	0.3, 2.5	.79	1.0	0.3, 3.0	1.00
T3	1/Ref			1/Ref					

Abbreviations: OR, odds ratio; Ref, referent; T1, 1st tertile; T2, 2nd tertile; T3, 3rd tertile.

^a Bold indicates statistically significant results.

time loss, and non-time-loss problems in the previous season were a significant risk factor for new substantial problems.

Approximately 14% of ice hockey players had hip and groin problems and approximately 6% had substantial problems at any given time during the season. In a similar investigation¹⁰ of ice hockey goalkeepers, the corresponding prevalences were almost twice as high, indicating that goalkeepers were the most affected players on a hockey team. According to our results, we can expect approximately 11 players per ice hockey team (of 25 players) to experience a hip and groin problem over the course of a season. Therefore, our prospective study results support recent cross-sectional research⁹ that demonstrated a similarly high seasonal prevalence of hip and groin problems in Swedish professional ice hockey players. When we consider only time-loss problems to be recordable events, as is traditional, the number of recorded hip and groin conditions drops dramatically. Data for more than 7000 National Hockey League players over 6 seasons showed an overall incidence rate of 1 per 1000 AEs.⁵ In our study, more than 20 years later, we found an incidence rate of 1.3 time-loss problems per 1000 AEs. However, time-loss events accounted for only 17% of all problems, leaving the majority of hip and groin problems undetected. This result is consistent with previous studies in ice hockey¹⁰ and other sports.^{11,24} Instead of expressing the severity of problems by measuring only the extent of time loss, we also included perceived functional impairment in our definition of a substantial problem.²⁰ At any time during the season, 6% of all players had substantial hip and groin problems, meaning they could not train and play at all or could play only with reduced volume and impaired performance. The fact that

only one-third of all substantial problems led to time loss further highlights the importance of looking beyond that definition of injury when describing the severity of hip and groin problems in ice hockey players.

In line with the existing investigations,^{14,16} we observed that hip and groin problems during the previous season were a risk factor for new hip and groin problems. However, in contrast to earlier authors, we also included the previous season's non-time-loss problems in our risk factor analysis and determined that they were associated with significantly higher odds for both all and substantial groin problems during the season. According to previous researchers,⁹ functional impairments become more severe the longer these hip and groin symptoms persist. Still, more than 4 of 5 players with groin pain in our sample kept playing, possibly putting themselves at risk for more severe problems in the long term. These results emphasize the need to increase our preventive efforts for players with a history of hip and groin conditions, independent of time loss, which may be more important than preseason strength measures. Preseason hip-muscle strength has been associated with in-season groin injuries in 1 study¹⁵ but not in another study.¹⁴ Adduction force was reduced in ice hockey players with ongoing groin symptoms, and the 5-second squeeze test was a potential tool for identifying players with reduced adductor strength and impaired athletic function.^{19,25} We did not find hip muscle strength and pain during the 5-second squeeze test to be significantly associated with increased odds for hip and groin problems. We did note higher odds for problems among players with pain during the 5-second squeeze test, although the increase was not significant. Due to the small number of players with high pain levels during the test and the relatively low

number of problems, the CIs for this part of the analysis were wide and the uncertainty in estimates called for a cautious interpretation. Further work is needed to establish whether the 5-second squeeze test is associated with the risk of future problems in ice hockey players.

Previous injury was consistently the most powerful risk factor for groin injury in sports,¹⁶ and although we would have preferred to have identified more “modifiable” factors, our findings highlight the need to prevent the index injury. In football, groin conditions have been prevented using a single-exercise strengthening program for the adductor muscles.²⁶ The progressive strengthening program in our study was aimed at all players (without identifying individual players deemed at risk for groin problems) and reduced the odds for self-reported groin problems by 41%. Preseason adductor strengthening has also been examined in professional ice hockey players. Instead of aiming the intervention at all players, Tyler et al²⁷ singled out individuals with reduced adductor strength as intervention targets. After the intervention, a significant reduction in adductor strains in comparison with the previous seasons was observed. Whereas preventive efforts should not be focused only on specific groups or individuals but preferably provided to all players, some attention to players considered to be at increased risk may still be warranted. However, our results led to questions about the effectiveness of picking “at-risk players” on the basis of clinical preseason measures such as strength. Instead, it may be more effective to pay attention to players with previous problems and to closely monitor symptoms to identify and manage players who play through groin pain and may incur more severe problems. Players with ongoing problems can be identified and monitored using simple screening tools such as the 5-second squeeze test, which can guide management.¹⁹ Such a secondary preventive approach has been suggested for managing groin pain in football players¹⁷ but needs to be explored prospectively. Primary and secondary prevention efforts could be combined to reduce the burden of hip and groin problems in ice hockey players. The ice hockey season has a long summer break during which adductor strengthening can be implemented for all players to increase load tolerance as is done in football.²⁶ Also, more sport-specific training during the off-season may reduce the risk for new injuries because less sport-specific training during the off-season was a significant risk factor for groin injuries.¹⁴

Certain methodologic factors should be considered when interpreting our findings. About 80% of our sample consisted of semiprofessional hockey players (third tier of the Swedish league), limiting the generalizability of the results to professional hockey players, who made up only 20%. We had preseason data for all players, but on average, 62.7% of them responded to the biweekly problem reports. In comparison with other investigators²² who used the OSTRC-O, our response rate was low, which may have biased the results if players with problems were more prone to report. We collected injury data only during the regular season and hence cannot draw conclusions about the preseason or playoffs. We made that decision in order to address the part of the season in which exposure was similar for all players. The number of substantial hip and groin problems was low, resulting in less precision in the estimated odds ratios, as indicated by the wide CIs. For

logistical reasons, we could not further classify groin problems into adductor-, iliopsoas-, inguinal-, or symphysis-related groin pain.²⁸ Many teams did not have medically trained staff, and geographic distances made it impossible to bring players to the clinic for physical examinations. For the same reasons, we did not attempt to either identify when groin pain may have originated from the hip joint or categorize these cases into femoroacetabular impingement syndrome, acetabular dysplasia, or other nonmorphologic conditions, as was recommended in a recent consensus statement.²⁹ Future investigations are needed to further classify hip and groin pain in ice hockey players.

CONCLUSIONS

Hip and groin problems are common in ice hockey players and can be associated with substantial impairments in performance. Only 1 in 5 problems led to time loss, and 7 of 10 had a gradual onset. Non-time-loss problems in the previous season were a significant risk factor for new problems, whereas decreased preseason hip-adduction and -abduction strength was not. Our findings highlight the importance of detecting and addressing non-time-loss conditions early and increasing our preventive efforts in all players.

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