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Relationship between baseline hip strength and hip and groin injuries in women ice hockey players: a 12-month prospective study

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Abstract

Hip and groin injuries in ice hockey are common problems and has a tendency to have a high recurring rate. Women's ice hockey is lacking on research of the possible reasons behind the problem. The purpose of the study was to find out if baseline hip muscle strength was associated with hip and groin injuries during season and if muscle strength tested in three different timepoints correlate with experienced hip health and function with HAGOS questionnaire in women's ice hockey

Nineteen competitive-level Finnish ice hockey players were followed for 12-month period and tracked all injuries during the time period. Participants were tested in three different timepoints preseason, first part of regular season and second part of regular season including playoffs. Hip muscle strength was manually tested in adduction, abduction, flexion, and extension. HAGOS questionnaire was sent to the participants via Webpropol system in all three timepoints.

Results showed that muscle strength stayed relatively same throughout the season, but HAGOS scores did have a large decline in the third timepoint compared to first two timepoints. Results did not show a correlation between hip muscle strength and HAGOS scores in any of the six subscales and baseline hip muscle strength in any tested planes did not show significant correlation between groups of injured and uninjured players.

Based on the study lower baseline muscle strength is not associated with hip and groin injury in women ice hockey players later in the season or muscle strength tested in different timepoints did not explain the decrease in HAGOS scores.

Keywords/tags (subjects)

ice hockey, hip/groin, injury, muscle strength, women ice hockey

Miscellaneous (Confidential information)

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Introduction

Hip and groin injuries and problems are common in ice hockey as in a variety of sports that include rapid change of direction, acceleration and deceleration and sprinting (Tegner et al., 2019; Dalton et al., 2016). Hip and groin injuries covers approximately 11 % of all injuries in National Collegiate Athletic Association (further referred as NCAA) women's ice hockey (Chandran et al., 2021) and hip and groin injuries have a high incidence in injuries that do not result in time loss which might lead to underreporting of the problem (Dalton et al., 2016). Majority of the hip and groin injuries in NCAA men and women sports are adductor or hip flexor related injuries (Kerbel et al., 2018). Previous research on hip and groin injuries have proposed that adductor muscle strength and adductor-abductor ratio are lower in athletes who are at risk to suffer a hip and groin injury (Esteve et al., 2015; Tyler et al., 2001; Tyler et al. 2002). Additionally, players who have lower adductor strength and lower adductor-abductor ratio also are experiencing more intense pain in adductor muscle testing (Wörner et al., 2019; Thorborg et al., 2010).

Research in women's ice hockey is scarce and are mainly epidemiological studies in NCAA. No studies comparing strength and hip and groin injuries in women's ice hockey were identified prior to this study highlighting the importance of the research in the field. The purpose of this study was to test if baseline hip muscle strength is a risk factor for hip and groin injury in women's ice hockey as it is suggested in studies done with male counterparts and to compare muscle strength with HAGOS questionnaire in three different timepoints throughout the season. Muscle strength and HAGOS questionnaire were carried out in three different timepoints; preseason, first part of the regular season and the second part of regular season and playoffs. Secondary objective was to record all injuries occurring in a 12-month period. Strength values and HAGOS scores can also be used as reference for possible future studies.

1 Overview of ice hockey, physiological profile and injuries in womens ice hockey

Ice hockey is a fast paced, intermittent, contact team sport consisting of a high-intensity skating bouts followed by a passive recovery phase. Ice hockey as a sport requires good overall conditioning in aerobic and anaerobic endurance and power, speed, agility, and full body strength (Stanula et al., 2015). One match without overtime is divided into three periods, each period is 20 minutes. One shift on ice usually is between 40–60 seconds. Players usually accumulate around 16 minutes of overall ice time but there's a lot of variation between players and some might accumulate up to 35 minutes (Cox et al., 1995). There is also a lot of individual variability in the duration of shifts and for example research by Noonan (2010) recorded shift length between 55 and 145 seconds.

Ice hockey is a high-intensity sport that relies heavily on an energy supply from anaerobic metabolism. One shift in duration has a high variability in length so anaerobic endurance and power is important for an ice hockey player to be able to perform with high-intensity interval bouts (Carey et al., 2007). Ransdell et al. (2013) studied off-ice fitness of national level elite female hockey players and found that mean VO2max value was approximately 46 ml/kg/min. VO2max is a common test used by variety of athletes from different sports to determine the athlete's ability to use oxygen during exercise.

Randsell & Murray (2011) tested 1 repetition maximum strength of the players on front squat. Results of the study showed a mean of 88.6 kg. For comparison, college athletes from other sports like basketball had a mean of 81 kg, softball 84 kg, swimming 66 kg and volleyball 84 kg. Another study done by Henriksson et al. (2016) tested 1 RM back squat and in this study the absolute mean of 89.79 kilograms highlighting the importance of lower body absolute strength of ice hockey players.

Upper body strength is also an important attribute of an ice hockey player. Shooting the puck, battling in the corners and body checking requires upper body strength. Upper body strength is commonly tested with horizontal push e.g., bench press exercise or push-ups and vertical pull e.g., pull-ups. Randsell & Murray (2011) found out that mean of pull-up repetitions was 10.1 and 1 RM bench press was 65.3 kg. Another study by Henriksson et al. (2016) had a mean of 47.03 kg 1 RM in bench press.

Besides playing the actual sport of ice hockey, players need to have adequate lower body strength, power, and speed to prosper in their sport. Training of these attributes off-ice also dispose hip and joint region under load and accumulation of total load which could lead to hip and groin injuries and health issues.

Women's ice hockey is a fast-growing sport especially in North America and in Europe but there's also women's hockey programs in Asia, Oceania, Africa and Latin America. International Ice Hockey Federation had in 2018 228,323 registered female players. In Finland, there was 5,906 registered female players. For a comparison, IIHF has 1,555,458 registered male players around the world (IIHF webpage, 2022).

When the women's ice hockey keeps growing in numbers there is also a need for studies to be conducted with women to provide high quality data to players, coaches, and other stakeholders so they can make better decisions how to improve the safety and performance of women hockey players (Randsell & Murray, 2011). Studies done with men might not be applicable directly to women's hockey because the difference in rules and differences in skating mechanics for example (Budarick et al., 2020).

1.1 Injuries in women's ice hockey

Ice hockey is a fast-paced and high intensity sport. Ice hockey is associated with many factors that might expose to an injury. Contact and collisions with other players and surroundings e.g., boards, puck and stick, high-velocity, change of direction in high-velocity and battling on the corners. (Tuominen et al., 2015; Abbott, 2014). Ice hockey is estimated to have high injury rates ranging 5.12 to 6.1 per 1000 athletic exposures in women's ice hockey (Rosene et al., 2017). Studies consistently shows that the injury rates are higher in games than in practice (Chandran et al., 2021; Abbott, 2014).

Rules in women's ice hockey differ from men. In women's ice hockey contact with other players is allowed but body checking is prohibited in all levels of women's hockey. In men bodychecking is also allowed. Body checking is defined as an intentional contact with opponent to remove the player from the control of puck (Tuominen et al., 2015; Abbott, 2014). Additionally, in women's hockey players must wear a full-face mask in addition to protective helmet (IIHF Rule Book, 2022).

Considering the differences in rules and especially the body checking rule might explain the difference of epidemiology in women's ice hockey injuries from men. Overall percentages of injury mechanism as a player contact in men 38,62 % versus women 27,83 % (Boltz et al., 2021; Chandran et al., 2021). Also, lacerations are higher in men 5,68 % versus 1,63 % in women which might be explained with these rule differences.

1.2 Epidemiological injury data collection

Studies done in epidemiology of injuries in women's ice hockey and in sports overall has its challenges because of the differences in definition of injury and athlete exposure. Inconsistency between studies makes it hard to compare the data easily. Accurate and comparable data is important to study for the effectiveness of preventive measures for injuries (Donskov et al., 2019).

Definition of injury has its limitations depending on a need of sport. Clarsen & Bahr (2014) reviewed the strengths and limitations of three different alternatives for injury surveillance and reporting of injuries. These three recordable incidents can be placed in hierarchy based how broad the definition of an injury is. 1) *all complaints*, 2) *medical attention* and 3) *time loss*.

In the category of 1) *all complaints* have the potential to record the highest number of incidents that might affect the athlete's performance. There are limitations to use this as it is prone to bias and differences in the point of view when collecting the data since it is an interpretation of the collector of injuries. On the other hand, this definition might give a good overview of the burden of injuries throughout the season (Clarsen & Bahr, 2014).

Second category 2) *medical attention* refers to a situation that athlete needs medical attention from a healthcare professional for injury. It covers time loss and no time loss injuries, but not issues which do not need medical tension for example delayed onset of muscle soreness. Medical attention has its limitations and risks for systematic bias. In sporting environments athletes have different kind of possibilities to access for medical coverage. Also, the interpretation and qualifications of a medical personnel might affect the reporting of injury. Teams/athletes with less resources for medical accessibility might lead to under reporting on injuries (Clarsen & Bahr, 2014).

For this study the definition on injury was chosen as medical attention category. When player needed medical attention from a healthcare professional the incident was recorded as an injury. In this teams setting healthcare professional was usually the team's physiotherapist or team doctor but, in some cases, players used professionals from outside the team and the data was gathered from medical records for the use of this study.

Third category 3) *time loss* captures injuries that leads to inability of an athlete to fully participate in planned training session or competition. This definition leads to fewest recorded injuries since it does not record injuries that does not prevent the player from training or competition but might hinder the performance. Athletes might continue to participate regardless of the existing injury and leads to under reporting of the burden of injuries (Clarsen & Bahr, 2014).

Consistency and accuracy of data is an important part of epidemiological studies for injury surveillance. Well-designed injury surveillance systems can build insight the nature of common injuries in sports which helps the effort of building different approaches to protect the health of athletes and prevent injuries (Bahr et al., 2020).

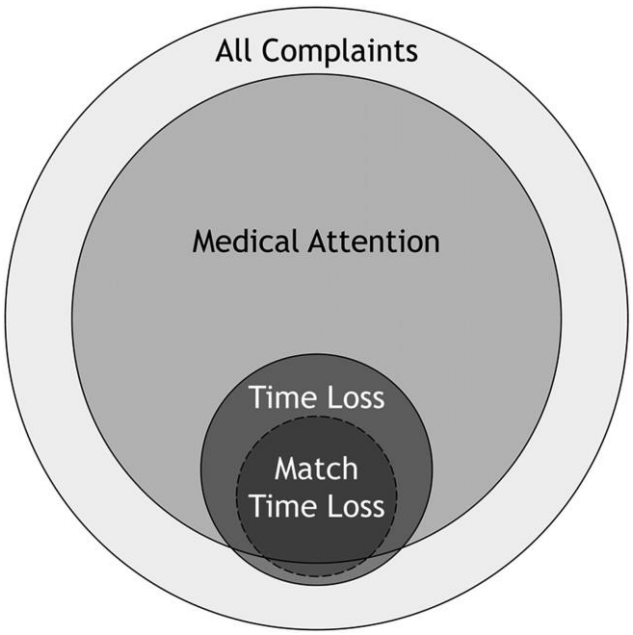

Figure 1 Interactions between definitions of injury. Adopted from Clarsen & Bahr (2014)

1.3 Epidemiology of injuries in women's ice hockey

Epidemiological studies have shown that in women's ice hockey most injured body parts are head and face, shoulder, knee, hand, and wrist. Also, hip and groin and trunk and pelvis has relatively high incidence of injuries. Differences in reporting and defining an injury shows slightly different percentages and body parts that are commonly injured highlighting the importance of unified methods and reporting of injuries. Other studies combine for example hand and wrist and others separate wrist and hand as a site of injury (Chandran et al., 2021; Morrissey et al., 2021; Tuominen et al., 2015). When comparing the injured body part, men had also highest incidence in head and face, shoulder, hand and wrist, knee, and hip/groin injuries but the mechanisms of injuries were higher on player contact compared to women (Boltz et al., 2021; MacCormick et al., 2014).

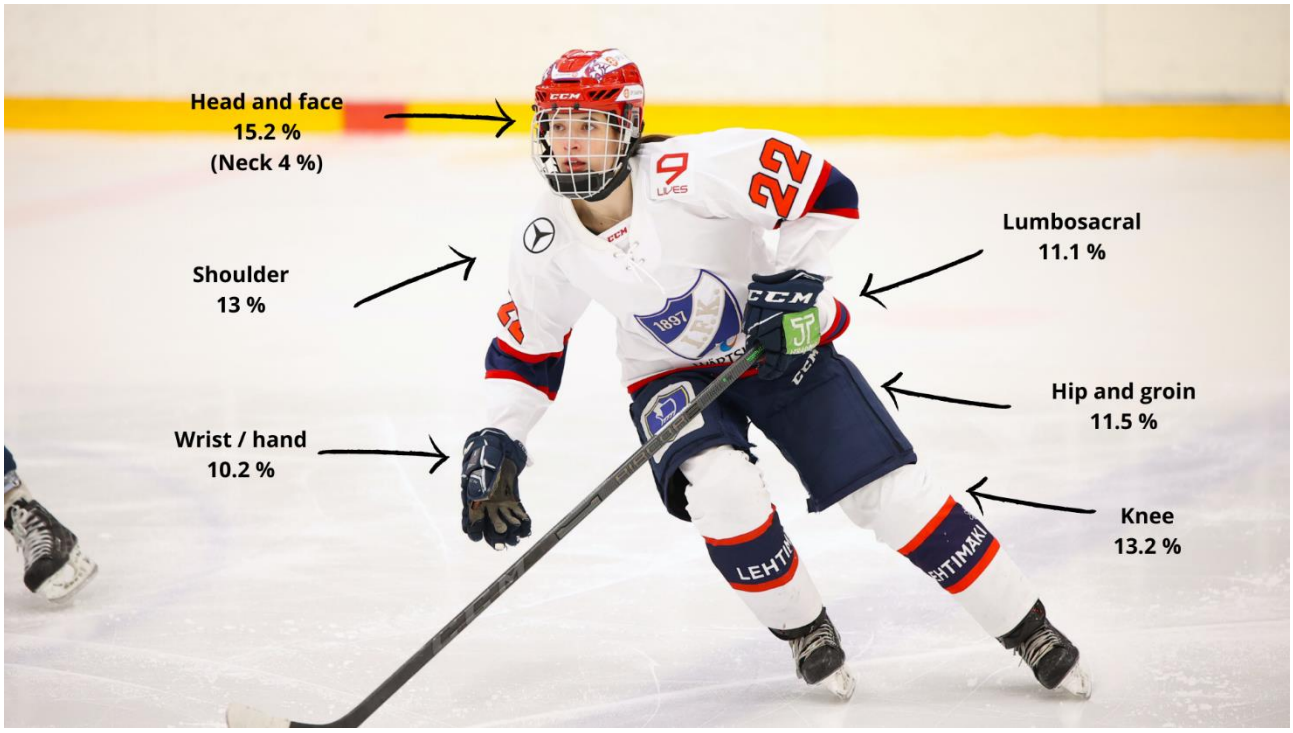

Figure 2 Picture of common injuries in womens ice hockey (Photo: Jukka Ahola)

Mechanism of injury refers to a situation how the injury happened. Most frequent injury mechanism was player contact and apparatus contact, both having a percentage of 27.83 %. Noncontact injuries were counted third with a percentage of 14.02 % and contact with surface had percentage of 12.28 % of all injuries. These mechanisms counted over 80 % of all injuries in NCAA ice hockey athletes (Chandran et al., 2021). Similar results were found in the study of MacCormick et al.

(2014) suggesting that player contact, and apparatus or surface contact was most common injury mechanism.

For diagnosis of injury most of the injuries were contusions (18.91 %), strains (18.70 %) and sprains (15.54 %). These three injuries were not specified in the study of Chandran et al., (2021) as they are distributed to different body parts and tissues. In the same study it was shown that a concussion was reported in 11.85 % of all injuries being the most injured body part with specific diagnosis and same results yielded from a study of MacCormick et al. (2014) with ranging 13.7-18.2 % of all injuries.

1.4 Epidemiological data on injuries per most injured body parts

1.4.1 Head and face injuries

Head and face injuries in women's ice hockey is shown in studies to be most common body part to suffer an injury. Although, in women's ice hockey body checking is prohibited and the most common mechanism for concussion is player contact the rate of concussion is higher than in men in many studies (Abbott, 2014). Especially, mild traumatic brain injuries account for nearly all of the head and face injuries in women's ice hockey. Mild traumatic brain injury (mTBI) is commonly referred as concussion. Concussion is a complex pathophysiological process induced by biomechanical forces. Concussion is commonly caused in ice hockey by direct contact to head, face, or neck but also from a contact to other body parts resulting in an impulsive force transmitted to head (McCrory et al., 2017). Specific diagnosis of head injury was specified as concussion in 77.85 % of the cases which gives Higher rate of injuries happened in competitions than in practice (Chandran et al., 2021).

1.4.2 Knee injuries

Another frequently injured body part in women's ice hockey is the knee. Many studies did not separate the diagnosis of knee injury, but study done by Tuominen et al. (2015) in 8-year study of international women's ice hockey found that knee was the most frequent site for lower body injury and medial collateral ligament (MCL) injury was diagnosis in 37.1 % of the cases. Another common

diagnosis was knee contusion (28.6 %) and anterior cruciate ligament (ACL) injury was specific diagnosis in 11.4 % on knee injuries. Study by Chandran et al. (2021) also showed that the most frequently injured lower extremity injury is knee with 13.15 % of all injuries.

1.4.3 Shoulder and upper extrimity injuries

Overall rate ratio of upper extremity injuries in women's college level ice hockey is 124.61 per 100,00 AE's compared to men 235.97/100,000 AE (Melvin et al., 2018). In NCAA athletes' shoulder and upper extremity injuries from all injuries has percentages in shoulder (12.93 %), arm/elbow (7.76 %), and hand/wrist (10.22 %).

The most common site of injury in upper extremity in women was shoulder (41.9 %), wrist (19.7 %), and hand (19 %). Most common injury type was strain (29.4 %), contusion/hematoma (23.2 %), and subluxation (12.5 %). Specific injury type had the highest percentage in AC sprain (13.8 %), wrist sprain (8.7 %) and hand/finger contusion (8.0 %). Men had significantly higher percentages for AC sprains (29.1 %) which also suggest that allowing body checking these types of injuries occur more often. Injury mechanism in upper extremity injuries is almost entirely from direct contact. Contact with apparatus, player and playing surface covers 81 % of all injuries (Melvin et al., 2018). Similar results were found in the study of Tuominen et al. (2015) with most injured upper extremity diagnosis was AC sprain (50 %) and wrist (18.9 %).

1.4.4 Trunk injuries

Trunk injuries in women's ice hockey in NCAA athletes has a percentage of 11.09 % of all injuries (Chandran et al., 2021) which is similar to the results in study done by MacCormick et al. (2014) showing 10.6 % of all injuries.

According to research (Jenkins et al., 2021) men and women were similarly likely to suffer a lumbar spine injury. The results are based on the data from NCAA injury surveillance from years 2009–2014. Study used the data of three different divisions in collegiate hockey. The rate of lumbar spine injury in women per 10,000 athletic exposures was 3.2 in competition and 4.6 in practice. Most of the injuries were noncontact injuries in women covering 44.8 % on lumbar spine injuries compared to men where most of the injuries were contact injuries covering 43.2 % of injuries. In

both genders time loss from LSI was relatively short. In women 71.6 % and in men 70.2 % were resolved in less than 24 hours and 17.4 % and 23.9 % were resolved in 1–6 days respectively. Injury classification for LSI showed that most of the injuries were strains (30 %) and spasms (19.2 %). Miscellaneous injuries together counted for 45.8 % of all lumbar spine injuries in women consisting of a variety of pathologies in lumbar spine.

1.5 Hip and groin injuries in women's ice hockey

Hip and groin injuries are common injuries in many sports that require repetitive and forceful sprinting, skating, kicking and high-velocity change of direction. Ice hockey is no exception from the demands of sports that predispose to this type of injuries, and which causes repetitive accumulated load and microtrauma to tissues around hip and groin. Hip and groin region is a complex region that is often the center of gravity in sporting movements which makes it vulnerable to injuries (Dalton et al., 2016). Injuries like acute strains in musculotendinous junction of musculature responsible for adduction and hip flexion are common. Also, overuse injuries to insertions of tendons, tendons and bone are reported in hip and groin area in ice hockey (Thorborg et al., 2018).

Another source of hip and groin pain and injuries is femoroacetabular impingement syndrome (FAI). FAI has two main types, cam and pincer pathology, which both affect the biomechanics of the hip joint and surrounding tissues. The precise cause for FAI is unknown but previous research suggests that abnormal biomechanical loading in young athletes with skeletally immature hip leads to bony overgrowth to femoral neck or acetabular rim. Elite women's ice hockey players have higher prevalence of cam morphology compared to non-athletic population which could lead to hip and groin injuries, but it is also important to remember that hips with changes in morphology does not necessarily lead to groin pain (Carter et al., 2021).

Hip and groin injuries contributes to 11.52 % on all injuries in collegiate women ice hockey players in NCAA (Chandran et al., 2021). Hip and groin injuries are shown in studies to have a high incidence in overuse and noncontact injuries with a high recurrence percentage. A study done by Dalton et al. (2016) with collegiate athletes showed that 76.3 % of hip and groin injuries were strains, 58.8 % are noncontact injuries and 18.4 % are overuse injuries. Also, in noncontact injuries 74.6 % did no result to time loss and 23.9 % were recurrent injuries. With overuse injuries 71.4 % did not result in time loss and 42.9 % were recurrent injuries suggesting that the burden of hip and groin

injury is prevalent in women ice hockey players and prevalence might be even higher since majority of the injuries did not result in time loss.

A study done by Wörner et al. (2020) women ice hockey players who experienced hip and groin problems during the previous season reported impairments in all HAGOS subscales in the beginning of new season. Study also showed that 62.3 % af all players had hip and groin problems but only 26.1 % resulted to time loss highlighting the burden of hip and groin problems.

In research by Tegner et al. (2019) with the data over 29 seasons in Swedish Elite League with men studying overuse injuries hip and groin was clearly the most injured body part with overuse injuries. 47.5 % of all index injuries were hip and groin injuries and 62.6 % of recurrent overuse injuries were hip and groin injuries. In the same study the researcher found out that the majority of injuries happened in the preseason and in the start of the season. Same trend regarding to injuries in preseason was found in the study from Jenkins et al. (2021) investigating lumbar spine injuries. Based on the results in these studies it is important to have a 12-month period to capture all injuries during pre-season and in season.

Relationship between hip muscle strength and hip and groin injuries has been studied in ice hockey. Tyler et al. (2001) tested hip adduction, abduction and flexion strength with 47 male NHL players before the seasons 97–98 and 98–99. Study is suggesting that lower adduction strength and adductor-abductor strength ratio could be a risk factor for possible hip and groin injury. Study had limited sample size in hip flexor injuries and did not include analysis in the study. There are also studies in variety of sports that suggest that insufficient adduction strength is a risk factor for hip and groin injury (Esteve et al., 2015).

Based on the previous study Tyler et al. (2002) conducted another study and screened players who had adductor-abductor ratio less than 0.80 were identified at risk for adductor muscle strains and participated in adductor muscle strain injury prevention program. Program consisted of strengthening and sports-specific exercises which players did three sessions in a week for six weeks. The intervention did lower the incidence and absolute number if adductor strains but adductor-abductor ratio was not re-tested leaving it open was it indeed increase of strength that resulted in decrease of injuries.

Regarding of adductor-abductor ratio Olson & Schindler (2022) showed ratios of 1.15 in college aged male ice hockey players and in study done by Wörner et al. (2021) had ratio around 1.4-1.5. Another recent study done by Oliveras et al. (2020) did have ratios closer to 1.0 with Swiss professional ice hockey players. Oliveras et al. study also showed that the presence of pain in testing is associated with lower strength.

Study done by Wörner et al. (2019) used five-second squeeze test for high-level (male) ice hockey players to test for correlation between hip muscle strength and self-reported function. Study did show significant correlation between muscle strength and groin pain suggesting that adduction strength has relationship with hip health and function. A study done by Rodriguez (2020) also suggested that testing adduction-abduction ratio can be beneficial tool to screen players who might have a risk for adductor injury in ice hockey and soccer players.

Hip and groin injuries are common complaint amongst variety of sports. Ice hockey is shown to have high prevalence of hip and groin injuries both men and women. Most of hip and groin injuries are non-contact and overuse injuries which do not lead to time-loss and might not get captured in studies which collects only if player is not able to play and masking the burden of hip and groin problems for players performance. Hip and groin injuries also seem to be longstanding and previous injuries are suggested as a risk factor for future hip and groin issues. Studies conducted on women ice hockey players that studied hip and groin strength and injuries were not identified highlighting the importance of the topic.

2 Objectives of the research and research questions

2.1 Primary objective

Primary objective of this research was to carry out a prospective observational study to investigate the relationship of hip and groin injuries and hip strength in women ice hockey players in Finnish elite-level ice hockey and secondly the study also investigated in three different timepoints if there is a correlation between hip muscle strength and perceived patient-reported outcome of hip and groin health with The Hip and Groin Outcome Score (HAGOS) questionnaire.

2.2 Secondary objectives

Secondary objectives were to test relationship between hip and groin strength and trunk injuries and collecting the injury data throughout the season to represent the epidemiology of injuries during one season in women's ice hockey in Finnish Naisten Liiga.

2.3 Null and alternative hypothesis

Null hypothesis (H_0) = Reduced hip and groin baseline strength is not a risk factor for hip and groin injuries.

Alternative hypothesis (H_a) = Reduced hip and groin baseline strength is a risk factor for hip and groin injuries.

3 Methods of the research

3.1 Study design

Study design is to carry out a prospective observational study to investigate the relationship of hip musculature strength and hip and groin injuries in three different timepoints and the relationship on hip musculature strength and HAGOS questionnaire subscales.

3.2 Subjects

Nineteen women ice hockey players were enrolled in this study from one team. All players of the team were not enrolled because the measurements were done during Olympic year and national team duties and quarantines before camps and Olympics did not allow everyone participate. All subjects played in the Finnish elite-level (Naisten Liiga) women's ice hockey team. Participants were verbally informed about the methods and objectives of the study and possible risks when performing the strength measurements used in the research. Subjects had a possibility to refuse to participate in the study. One of the 19 participants dropped out before third round of measurements because of reasons outside to this study.

3.3 Ethics and data protection

The Ethics committee of the Central Finland Health Care District approved the study (5U/2019). This study is a part of bigger cluster of studies of women's sports researching a variety of topics in field. Participants were given an identification number to secure anonymity throughout the study. All data was handled through the identification number and no real names or other information was able to be connected to data. All of the personnel (student and PI) who are in touch with the data are mandatory to follow the regulations of protection of the data (GDPR). Data was stored in two locations online and external hard drive. JAMK IT (Webfile) system was used as online storage to protect against possible security breach to student's laptop and hard drive was kept in the student's home in locked box. Hard drive was secured with password and password was kept in different location than hard drive.

Data includes sensitive data about human subjects and data will be destroyed after the study is finished accordingly. Original data will not be published at any point of the study.

3.4 Strength testing methods

Strength measurements were conducted at the researchers' clinics in two different facilities located in Helsinki, Finland. All measurements were done by same person in all testing timepoints. Prior to strength testing participants completed a 10-minute warm-up protocol and bodyweight was collected with body scale for later analysis (Amazfit Smart Scale, Zepp North America, Inc.). Strength was assessed with dynamometer that was attached to a fixation belt in all measurements (MicroFET2®, Hogan Health Industries, Inc., UT, USA). More specific protocol for testing is found in appendix 1.

Hip muscle strength was tested isometrically in four different planes of movement, flexion, extension, adduction, and abduction. Participants had four familiarization attempts, with increasing effort, before the attempts that were collected were performed. Three 5-second maximal isometric contractions were performed, and highest value was recorded. If participants experienced severe pain or discomfort during testing or participant had an acute hip and groin injury or other injury preventing to participate in test that particular test was not performed to avoid possible injury. For example, if patient reported pain that is preventing them to do the maximal contraction during testing the test was not performed but, in a situation, where player reported "normal" discomfort e.g., delayed onset muscle soreness tests were performed if player was compliant.

Adduction was tested with assessor's arm placed between the participants ankles 10 centimeters above malleoli with dynamometer in right hand. Abduction was tested in same position, but the dynamometer was attached to fixation belt and placed around participants lower legs, also, 10 centimeters above malleoli. Produced torque was expressed in newton meters and normalized with bodyweight (Nm/kg). The distance was measured between anterior superior sacroiliac spine and the place of dynamometer, 10cm above malleoli. This testing procedure for adduction and abduction was developed by Kristian Thorborg and has shown good reliability in previous studies (Wörner et al., 2019; Thorborg et al., 2009)

Hip flexion strength was measured in seated position in the end of treatment table. Fixation belt was attached to the treatment table and dynamometer placed 5 centimeters above patella. In extension, participant was instructed in prone position on the table and dynamometer was placed 10 centimeters above patella with fixation belt attached to treatment table. Same procedure as done with adduction and abduction; the participant had 4 familiarization attempts before three 5-second maximal isometric contractions which were collected for further analysis. Results were normalized with bodyweight and the distance was measured from the anterior superior iliac spine to placement of dynamometer. This testing procedure was used in the study by Thorborg et al. (2012) with good inter-tester reliability.

3.5 The Copenhagen Hip and Groin Outcome Score (HAGOS) questionnaire

The Copenhagen Hip and Groin Outcome Score questionnaire is a tool designed for young to middle-aged, physically active individuals with groin pain. It consists of six different subscales assessing pain (Pain), symptoms (Symptom), physical function in daily living (ADL), physical function in sport and recreation (Sport / Rec), participation in physical activities (PA) and hip/groin-related quality of life (QoL). It is recommended tool to use when hip and groin related problems is the primary interest of the study (Thorborg et al., 2011). This study was done with athletic young population and primary objective was to study hip and groin injuries.

The HAGOS questionnaire was sent to participants after the strength testing in all three timepoints with Webpropol Survey and Reporting tool via email. There were participants in this study who did not speak Finnish as a native language and in the other hand, some of the participants had limited skills in English. The questionnaire was sent in English and Finnish depending on the language skills of the participant. Two different versions of the same questionnaire were sent to have more reliable data. The Finnish version of HAGOS was adopted from a study done by Paajanen et al. (2019) with the permission of the author. Both versions of the questionnaire were added to Webpropol system by assessor and the data output from answers was added to HAGOS scoring file. HAGOS questionnaires can be found in Appendix 2. (English) and Appendix 3. (Finnish).

3.6 Timepoints of testing

Strength testing and The Copenhagen Hip and Groin Outcome Score- questionnaire was conducted in three different timepoints. 1) *preseason* 2) *first half of regular season* and 3*) second half of regular season including playoffs*.

Preseason phase started in April 2021 and lasted until the end of August 2021. Preseason also consisted of an individual training phase when there were no organized training sessions with the team in the middle of the summer approximately for 4-weeks.

First half of the regular season started at the beginning of September and lasted until the end of December. Most of the practices were organized training sessions, but there was a possibility of doing some of the scheduled sessions individually.

Second half of the regular season and playoffs started at the beginning of January and lasted until the season was over which was at the end of April 2022. During this phase there were changes in regular season schedule due to Winter Olympics in Beijing and some of the games were postponed to later date. All three phases together covered approximately one full year.

In all three testing timepoints strength testing was done before the questionnaire was sent out to the subjects.

3.7 Injury data collection

Epidemiological data in this study was collected by the researcher in this study with the help of other medical/coaching staff in the team. Players either reported the injuries directly to the researcher or to other staff in the team who reported to the researcher the incidents. After the researcher in this study was informed about the injury the researcher contacted the injured player for assessment and classification of injury. In some cases, there was a need for medical attention from the team physician for example if magnetic resonance imaging, radiograph imaging or other treatment that requires physicians' consultation and treatment was needed. Diagnosis and classification of injury from team physician was collected and recorded to the injury surveillance.

The injury definition in this study was considered every incident that needed medical attention either from the team physio or another qualified personnel e.g., team physician. Reporting of medical attention incidents is recommended as it is likely to capture relatively good number of injuries and has the possibility to give a good overview of injuries in chosen timeframe for example season or tournament. Medical attention definition is also recommended when the aim of the surveillance is to allocate medical resources in team setting in future to prevent injuries (Clarsen & Bahr, 2014). Medical attention definition is also used to recorded illness but, in this study, only injuries were recorded. Recording illness throughout the season would have placed even more demands for the medical staff and would possibly compromise the accuracy and completeness of data.

Classifying of the injuries was conducted by recommendation from International Olympic Committee consensus statement for recording and reporting of epidemiological data on injury and illness in sport with the exception that in this study illness was not recorded and focus was on injuries (Bahr et al., 2020).

3.8 Statistical analyses

Anthropometrics descriptives will be presented as means, range and standard deviation. *Strength measurement* descriptives are presented as means, standard deviation. *HAGOS descriptives* will also include range as descriptive statistic. Statistics in injury epidemiology frequencies were analyzed by grouping the injury distribution by event, season phase or severity of injury. Injury epidemiology includes means, standard deviations, and percentages.

Independent samples t-test will be used to test is there a difference in baseline strength levels between groups of injured and uninjured players. Baseline strength and injuries during season was compared in two different injury categories: hip and groin injury and trunk injury. Test variables were hip and groin strength in all four tested strength planes. For the analysis flexion and extension measurements were combined and used as average to make it more compatible with adduction and abduction measurements. In addition, hip adduction-abduction ratio was tested for hip and groin injuries. Trunk injuries category was tested with same variables. For all independents t-tests significance (p) < 0.05 was considered statistically significant.

Bivariate correlation analysis between HAGOS subscale scores and strength measurements in all three timepoints will be conducted for the correlation between variables. Results will be presented as Spearman's correlation coefficient (r) and significance (*p*). Significance < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS, version 28.0 (IBM Corp., Armonk, NY, USA, SPSS Statistics 28.0).

4 Results

Anthropometrcis of the participants is presented in table 2. Measurements were collected in the first testing session by the author. Anthropometric data collected from participants included age, height, body mass and body mass index. Other baseline data consisted of playing position, distance between SIAS (spina iliaca anterior superior) and patella and malleoli. Collected data was later used in analysis.

Table 1 Anthropometrics of subjects

Anthropometric characteristics of subjects n=19

Variable	Mean	Standard deviation	min. - max.
Age (years)	21.16	4.74	16–34
Height (m)	1.67	0.05	1.58–180
Body mass (kg)	68.07	5.93	54.9–75.2
Body mass index (kg m^{-2})	24.25	1.52	21.4–27.1

4.1 Strength measurements in three different timepoints

The strength measures tested in three different timepoints throughout the season did not have a significant change between the three timepoints. Detailed methods for the muscle strength testing are found in Appendix 1. It is notable that subjects participating in this study did not have previous experience in isometric maximal strength testing with this type of protocol. The results of strength measurements are presented in table 3.

Table 2 Hip strength measurements in three different timepoints

Hip strength measurements in three different timepoints

	Timepoint of testing		
	Preseason	Second part of season	Third part of season
Adduction	2.26 (0.36) (n=19)	2.27 (0.28) (n=18)	2.29 (0.28) (n=17)
Abduction	1.83 (0.31) (n=19)	1.79 (0.28) (n=19)	1.77 (0.26) (n=18)
Extension	2.56 (0.46) (n=19)	2.61 (0.37) (n=19)	2.62 (0.40) (n=18)
Flexion	1.52 (0.48) (n=19)	1.66 (0.35) (n=19)	1.72 (0.30) (n=18)

(n= number of tested players in each timepoint) (sd= standard deviation)

Before the third timepoint of testing, one of the participants dropped out from the study. During both, the second and third timepoints of testing, one of the participants had suffered an acute hip and groin injury restricting the participant to safely perform a maximal isometric adduction test.

4.2 Baseline strength measurements and hip and groin injuries

When testing the between-group difference between injured and uninjured players we took mean of hip flexion and hip extension measurements to have more compatible results with adduction and abduction testing method. An independent samples t-test was conducted to measure between group baseline strength measurements of players who suffered a hip and groin injury and players who did not suffer a hip and groin injury during the season. There were no statistically significant differences between the groups of injured and uninjured players. As stated earlier the significance was set at p .05 and all variables exceeded the value. Also, the confidence interval cross zero stating there is no difference between the groups.

In addition, adduction-abduction ratio at baseline was measured and independent t-test was conducted with injured and uninjured groups.

Table 3 Independent samples t-test with strength and injuries between groups HaG

	Hip and groin injury			
Strength test	Injured n = 7	Uninjured n = 12	MD (95% CI)	*p*
Adduction strength	2.244 (0.338)	2.263 (0.393)	-0.019 (-0.395 | 0.357)	0.916
Abduction strength	1.867 (0.243)	1.813 (0.358)	0.054 (-0.270 | 0.377)	0.730
Flexion strength	1.384 (0.340)	1.600 (0.548)	-0.216 (-0.702 | 0.271)	0.363
Extension strength	2.704 (0.481)	2.477 (0.439)	0.227 (-0.228 | 0.682)	0.307
Adduction-abduction ratio	1.210 (0.170)	1.292 (0.320)	-0.082 (-0.359 | 0.195)	0.540

MD = difference in means, (sd= standard deviation)

4.3 Baseline strength measurements and trunk injuries

Independent samples t-test was also conducted with same baseline strength measurements with trunk injuries in injured and uninjured groups. The results show that there was no statistically meaningful difference between the injured and uninjured players with different variables. Statistics are presented in table 5.

Table 4 Independent samples t-test with strength and injuries between groups trunk

	Trunk injury			
Strength test	Injured n = 5	Uninjured n = 14	MD (95% CI)	*p*
Adduction strength	2.148 (0.399)	2.295 (0.399)	-0.147 (-0.552 | 0.258)	0.545
Abduction strength	1.708 (0.411)	1.878 (0.277)	-0.170 (-0.515 | 0.175)	0.313
Flexion strength	1.307 (0.519)	1.597 (0.465)	-0.290 (-0.816 | 0.236)	0.261
Extension strength	2.366 (0.553)	2.630 (0.416)	-0.264 (-0.761 | 0.232)	0.277
Adduction-abduction ratio	1.337 (0.431)	1.234 (0.204)	0.102 (-0.200 | 0.405)	0.485

MD = difference in means, (sd= standard deviation)

4.4 The Copenhagen Hip and Groin Outcome Score in different timepoints

HAGOS scores in three different timepoints were relatively constant in the first two timepoints. In the third timepoint of testing that was performed in the second part of the regular season including playoffs showed a clear decline in HAGOS scores. The HAGOS scores from all timepoints of testing is presented in table 6.

Table 5 HAGOS questionnaire scores in three different timepoints

HAGOS questionnaire scores in three different timepoints

	Timepoint		
Subscale	1st TP	2nd TP	3rd TP
Symptom	81.40 ± 11.76 (60.71–96,43)	79.89 ± 13.11 (50–100)	56.94 ± 15.52 (14.29–71.43)
Pain	95.13 ± 6.37 (77.5–100)	94.34 ± 9.85 (57.5–100)	67.64 ± 10.31 (40–75)
ADL	97.63 ± 4.52 (85–100)	96.32 ± 8.31 (65–100)	72.22 ± 6.0 (55–75)
Sport / Rec	89.14 ± 8.80 (71.88–100)	92.43 ± 11.80 (56.25–100)	67.19 ± 10.73 (34.38–75)
PA	98.02 ± 4.86 (87.5–100)	94.74 ± 8.66 (75–100)	67.36 ± 12.96 (37.5–75)
QoL	94.47 ± 5.99 (85–100)	93.16 ± 10.03 (60–100)	66.67 ± 13.39 (25–75)

ADL = Physical funtion in daily living, Sport / rec = Physical function in Sport and Recreation, PA = Participation in Physical Activities, QoL = Hip and Groin related quality of life.
Data reported as the mean ± SD (min-max)

The results are showing that the hip and groin health was significantly lower in the end of the season than in the beginning and in the middle of the season. Difference between timepoints 1 and 2 and 1 and 3 is presented in a boxplot below (Figure 2).

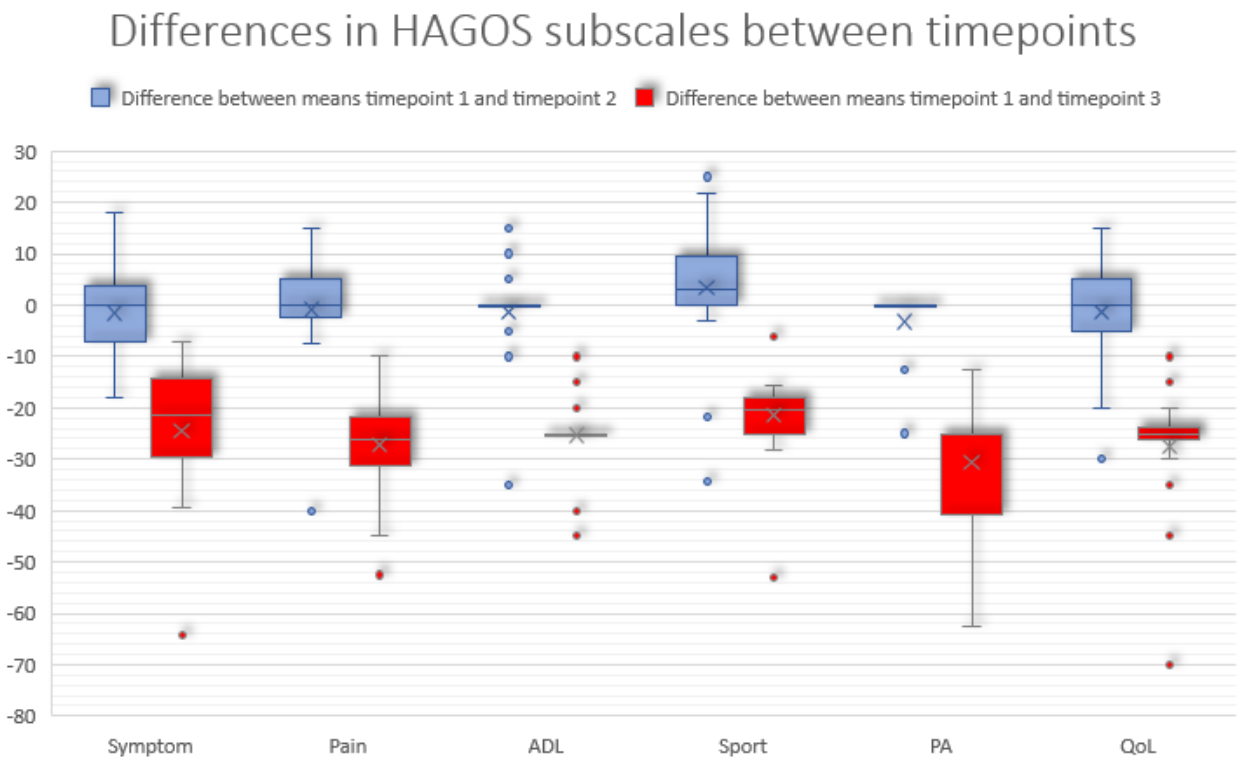

Figure 3 Differences between HAGOS subscales between timepoints

Correlation (r) and significance (p) between hip muscle strength and HAGOS scores in all six subscales did show only low or very low correlation in any testing timepoints. Correlations varied from negative and positive correlation, but all tests showed low or very low correlation. Also, significance was low throughout the tested variables in all three timepoints.

4.5 Epidemiology of injuries in Finnish Naisten Liiga team season 21-22

4.5.1 Distribution of injuries by event - competition

In competition (game) injuries were generally acute sudden onset injuries. Acute injuries counted 81.2 % of all injuries in competition and repetitive gradual onset injuries counted 18.8 % of injuries. Most common mechanism of injury was direct contact with more than half of the injuries

(56.2 %) and in-direct contacts covered 25 % of injuries. Rest (18.8 %) of injuries were noncontact injuries.

Region of injuries in competition was distributed evenly (25 %) for four different regions head and neck, upper limb, trunk, and lower limb. More specific distribution of injuries per body part was head (25 %), lumbosacral (25 %), wrist (25 %), knee (18.8 %) and thigh (6.3%).

Most frequently injured tissue was ligament / joint capsule (31.3 %), nervous (25 %), non-specific (18.8 %), bone (12.5 %). For specific pathology of injury in competition was joint sprains (31.3 %), brain / spinal cord (25 %), injury without tissue type specified (18.8 %) and muscle injuries, bone contusions, bone stress injuries and cartilage injuries counted the rest 25.2 % of injuries.

4.5.2 Distribution of injuries by event - practice

In practice, that covered practice on-ice and off-ice the onset of injuries was distributed by repetitive gradual onset injuries (63.9 %) and acute sudden onset (36.1 %) and almost all injuries (91.7 %) were non-contact injuries. During practice there were no direct contact injuries and in-direct contact injuries covered 8.3 % of all injuries happened during practice.

Most injured body region was lower limb (63.9 %), trunk (25 %), upper limb (8.3 %) and head and neck (2.8 %). For body parts the distribution was hip and groin (25 %), lumbosacral (25 %), knee (13.9 %), lower leg (11.1 %), thigh (8.3 %) and the rest (16.8 %) were divided to foot, wrist, elbow, and head.

During practice sessions the most injured tissue was muscle / tendon (58.3 %) and non-specific (25 %). Rest (16.7 %) was divided to bone, ligament / joint capsule, nervous and superficial / skin tissues. Most common pathology for injury was tendinopathy (27.8 %), injury without tissue type specified (25 %), muscle injury (22.2 %) and muscle compartment syndrome (8.3 %). The rest 14 % included joints sprains, bones stress injury, brain / spinal cord injury and laceration.

4.5.3 Injury type, season phase, time loss and severity of injuries

Injury type was during competition generally an index injury meaning that player had suffered specific injury for first time (68.8 %) or a recurrent injury (25 %). In practice injuries were also mainly index injuries (50%), recurrent injuries (27.8 %) or exacerbation injuries (16.7 %). When comparing the injuries in the phases of season 40.4 % of all injuries happened during the preseason and 32.7 % in the first half of regular season. In the second half consisting of the playoffs 26.9 % of all injuries recorded. Time loss injuries distribution by event is presented in pie charts below in Figure 4 and severity of time loss injuries in Table 8.

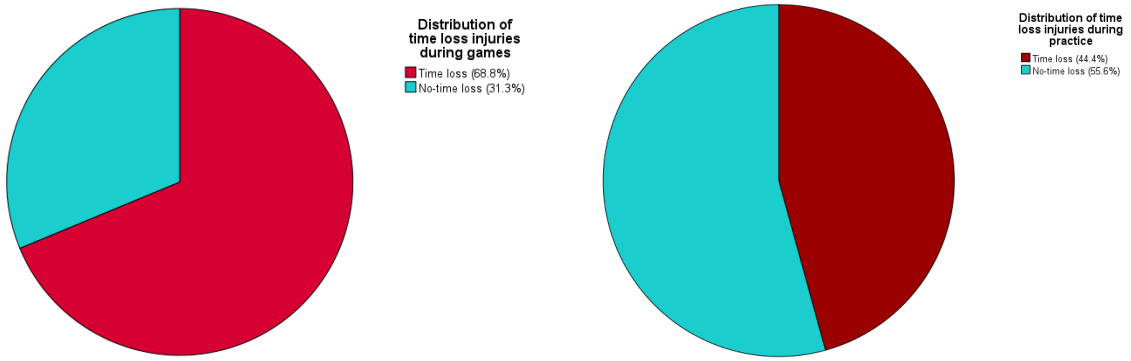

Figure 4 Distribution of timeloss injuries in games and practises

In this research season was divided in three different timeframes. 1) *preseason*, 2) *first half of regular season* and 3) *second half of regular season and playoffs.*

Preseason started in middle of April 2021 and lasted until the end of August. Preseason consisted supervised training consisting of ice and off-ice training with individual training phase during the summer. *First half of regular season* started in the beginning of September consisting of ice, off-ice and competition and lasted until the end of December and *second part of regular season and playoffs* consisted of on-ice, off-ice and competition and lasted until the end of season which was late April 2022. It should be noted that year 2022 was a year for Winter Olympics in Beijing which resulted in break of regular season games in February 2022. Distribution of injuries in three phases is shown in Table 7. Injuries are divided only in two categories *trunk and lower body injuries* and *upper body injuries.*

Table 6 Distribution of injuries in three different timeframes during season

Distribution of injuries in three different timeframes during season

Injury type	Season phase		
	n Preseason	n 1st half of reg. season	n 2nd half + playoffs
Lower body or trunk injury	20 (38.5 %)	13 (25 %)	9 (17.3 %)
Upper body injury	1 (1.9 %)	4 (7.7 %)	5 (9.6 %)
Total percentage of injuries	40.4 %	32.7 %	26.9 %

Table 7 Distribution of timel oss injuries with severity of injury

Distribution of time loss injuries with severity of injury

Mechanism of injury	Severity of injury		
	Mild (1-7d) n=9	Moderate (8-21d) n=15	Severe (<21d) n=3
Direct contact	0	4	1
In-direct contact	2	2	2
Noncontact	7	9	0
Total percentage of injuries, x = mean timeloss in days	33.3 % $\bar{x}$ = 5.67 d	55.6 % $\bar{x}$ = 14.33 d	11.1 % $\bar{x}$ = 38.67 d

Injuries are a substantial problem in many sports and especially in fast paced contact sport like in ice hockey. Many of the injuries do not require absence from sport, but more severe injuries could result in long periods of restriction of participation in sport. Depending on the duration of time loss in sports, severity of the injury can be categorized. Commonly used categories for severity of injury regarding time loss is a) mild (1-7 days), b) moderate (8-21 days) and c) severe (more than 21 days). In this study, time loss was calculated as days when player was unable to fully participate in planned training session.

In this study athletic exposure was not recorded because of the lack of resources collecting the data and the findings in this study are absolute number of injuries and percentages of injuries. Also, specific diagnosis was recorded by the researcher but, in this report, specific diagnoses are not presented for the anonymity of the athletes.

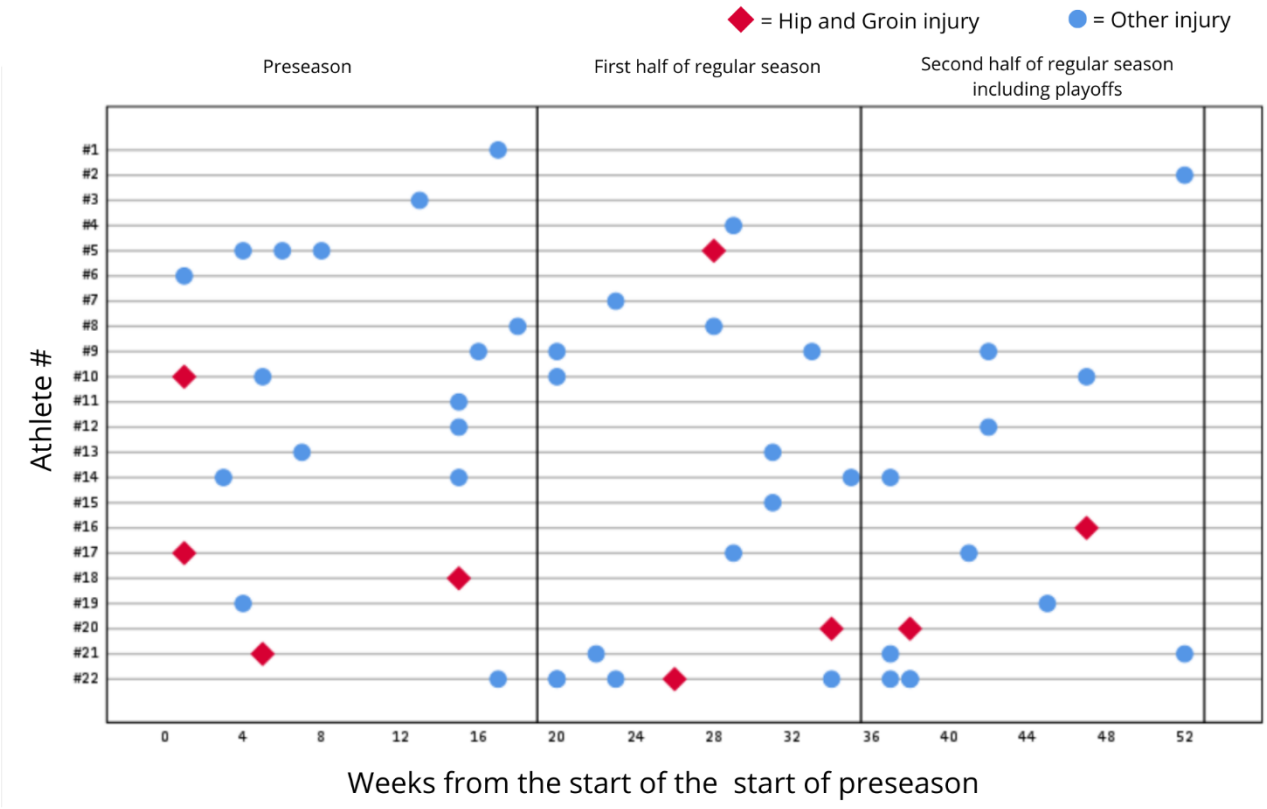

Figure 5 Distribution of injuries during the 12-month period

In figure 5 is presented distribution of the injuries by individual athlete throughout the season in a scatterplot. Table only shows players who did suffer an injury or multiple injuries. Scatterplot is showing 50 individual injuries (total of 52 injuries occurred during season) because graph stacks injuries really close each other for individual participant.

4.6 Discussion

Findings in this study are suggesting that baseline lower hip strength tested isometrically in four different planes of movement or hip adduction-abduction ratio is not an applicable assessment to predict a hip and groin injury later in the season. On the same note hip strength did not show an association between strength and HAGOS questionnaire in any of the three different timepoints. There are no prior studies in women's ice hockey to compare results of this study so further studies are needed to be able to have stronger conclusions about association of strength and injuries and HAGOS questionnaire. This study did show that all six subscales had significantly lower scores in the third timepoint of testing suggesting that hip and groin health declines closer to the end of the season. This study also showed that most of the hip and groin issues does not result in time loss but rather decline in player hip and groin health during season. HAGOS questionnaire could be a great tool to capture health problems in women's ice hockey players to figure out which individuals are having issues and help health professionals to act accordingly.

Relationship between strength and hip and groin injuries

Previous studies are suggesting that hip and groin strength, especially adductor strength and adductor-abductor ratio less than 0.8 might be risk factor for hip and groin injury in ice hockey. We also used adduction-abduction ratio in the study to look for possible relationship with injuries. The mean ratio in this study was 1.26 which is a similar finding done with men in a recent study done by Olson & Schindler (2022) and study done by Wörner et al. (2021) suggesting that notable differences is not seen between sexes in add-abd ratio. The results in this study are suggesting that hip and groin strength nor the adduction-abductor ratio tested in the beginning of the season in women ice hockey players does not show an association for hip and groin injury during season. Neither variable did not have a statistically meaningful finding. The protocol for testing the muscle strength was chosen based on the studies by Wörner et al. 2019; Thorborg et al. 2012 and Thorborg et al. 2009 for good inter-tester reliability and for the convenience of testing procedure. As shown in appendix 1. adduction and abduction were tested bilaterally and if the testing would have been done unilaterally the results of the study might have had different outcome regarding the relationship between muscle strength and hip and groin injuries. Also, in ice hockey, the adductors are exposed to high eccentric loads especially in high velocities. It could be that testing the eccentric strength could be better way to test strength of hockey players (Chang et al., 2009).

Women also present lower abduction range of motion and lower knee flexion from stance phase to push of compared to men. The difference in skating mechanics might not predispose adductors as high eccentric loads as men (Budarick et al., 2020).

Many of the players reported that they did not have much history of doing maximal isometric muscle testing with the chosen procedure and the testing itself felt somewhat “awkward”. During the 12-month period in the later testing sessions we observed that many of the players felt more comfortable of doing the testing since the procedure was more familiar. It might affect to the results at some level since the players are able to do a maximal isometric contraction when feeling more comfortable. It is also important to be noted that the participants were not professional ice hockey players in the sense of professionalism meaning that playing ice hockey is their main source of income, so the timing of the testing was impossible to be controlled the way that the players were as fresh as possible during sessions. As stated in the methods section, the produced torque was expressed in newton meters and normalized with bodyweight (Nm/kg). When using a body weight as variable throughout the season the fluctuation of body weight in a year or even weekly could yield different results compared if absolute muscle strength would have been used. A study done by Delisle-Houde et al. (2019) showed that female collegiate ice hockey players fat mass and fat percentage did have significant fluctuations, but lean mass did not.

As to my knowledge, prior studies that have researched women ice hockey players hip and groin injuries and tested hip muscle strength have not been conducted. Most of the studies found are epidemiological studies so we could not compare strength measurements with women ice hockey players highlighting the importance of the study and research in the field with women athletes in ice hockey and in general.

Lastly, even this study is suggesting that hip strength does not have a relationship with hip and groin injuries there is compelling evidence done with men in several sports that are suggesting it is a possible risk factor for especially adductor injuries. This study only had 19 participants so strong conclusions can not to be drawn and future studies with larger sample size would be interesting to see if there is a relationship. We did not take into consideration other factors such as previous hip

and groin injury, early sports specialization and lower extremity neuromuscular control and alignment which also has been found have some influence (Esteve et al., 2015; Sheppard et al., 2020; Wörner et al., 2020).

Relationship between strength and HAGOS

We used HAGOS questionnaire to track participants hip and groin health in six different subscales in three different timepoints – beginning of the season, middle of the season and the end of the season. It was interesting to see that in first two timepoints there was no significant change in scores in any of subscales but the difference between first and third and second and third scores in all six subscales decreased drastically showing the decline in hip and groin health and function. A study done by Wörner et al. (2021) followed male ice hockey players over one season and used HAGOS questionnaire in three different timepoint. Their results did not show significant change in any of the subscales throughout the season which differs clearly in our findings with women. In the study of Wörner et al. (2021) the adduction and abduction strength testing were done with same procedure as in our study and no significant changes happened throughout the season likewise our study.

As seen in the results the muscle strength does not explain the decrease in HAGOS scores as the strength levels stay relatively same throughout the year. A recent study (Baida et al., 2021) used intersegmental rehabilitation approach for athletic groin pain (AGP) and their study is suggesting that only 11 % on improvement in HAGOS scores is explained with muscle strength. These findings support the conclusion in this study that strength as independent variable should not be used as only measurement to screen possible risk factors for hip and groin injury and health and is contributing only partly to hip and groin health. Other reasons for possible drop in scores could be hypothesized that this season was considerably longer than a normal season because of the Olympics. Usually, season ends in March but this year it lasted until the end of April which could accumulate load that is causing more hip and groin issues for the players. Also, as the end of the season some of the players accumulate more total load through increased playing minutes and there are more games with insufficient recovery period eg., back-to-back games. Players also

might be underreporting injuries to the staff to avoid possible sidelining from important games, and they do not want to appear burden to the team (Roderick et al., 2000; Roderick, 2006). At the time of study, the COVID-19 pandemic was still relevant which also brings a mental stress and disruptions in many aspects of normal life. A study done by Facer-Childs et al. (2021) showed that during COVID-19 pandemic athletes reported disruptions in social life, physical activity, mood, sleeping patterns, mental health, nutrition, and family life. All these variables might have an effect for the HAGOS questionnaire results.

As summary, the results in this study regarding HAGOS questionnaire scores and strength suggest that other factors than strength could be more important or at least should be taken better into consideration to promote women ice hockey players hip and groin health. It is recommended to research this topic with larger sample size to see if results are reproduced or are the findings in this study coincidental.

Injuries in Finnish Naisten Liiga. The results in injury surveillance did follow same trends as in many other studies done with women's ice hockey. Mostly frequent body parts that were injured were head, hip and groin, lumbosacral, wrist and knee. The results also showed similar trend on onset and mechanism of injury depending on the event showing that sudden onset and direct contact injuries are more common in games and repetitive gradual onset and noncontact injuries are more common in practice.

This study used medical attention as definition of an injury which means that it does not capture the whole burden of injuries throughout the season. Several other studies (Chandran et al., 2021; Tuominen et al., 2015; Kerbel et al., 2018) have reported also minor injuries such as contusions in their studies. This study did not record contusions (e.g., bruises from contact or hit by a puck) since many of the players do not see them as injuries which leads to underreporting. Other reasons for players to underreport injuries might be willingness to play in forthcoming games, fear of losing spot in roster or they don't want to appear as a burden for the team (Roderick et al., 2000; Roderick, 2006).

As seen in the epidemiological results in this study most of the injuries (73,1 %) were reported in the first two phases of the season. This could also suggest that when the season was closer to

playoffs and most important games players might underreport injuries in fear of missing games. Another reason for missing an injury in this study might be demands of collecting the data. Injury data was collected manually by the physiotherapist and some of the injuries are reported briefly by the players and might get lost in the hectic environment in training facilities (Kerr et al., 2014).

Strengths and limitations of the study

This study only included nineteen participants from single team. Study was also conducted during a season when season before and season during the study had different schedule compared to normal seasons schedule because of the COVID pandemic and the Olympics. For stronger conclusions larger group of participants and during normal scheduling would give more robust results. During the skating phases a lot of loading happens unilaterally. Adduction and abduction testing for hip strength could be more precise and applicable done unilaterally compared to methods in this study. Also, in this study injuries were represented as overall hip and groin injury, not specified which leg. Testing individual strength and then comparing possible injury could yield different results.

HAGOS questionnaire has shown good reliability in previous studies and did show that women ice hockey players had large decline in hip and groin health in the third timepoint of the season. Especially using the HAGOS questionnaire with larger sample size would be interesting research to investigate hip and groin health throughout the season.

This study did give reasonably good overall picture of the injuries that happen in women's ice hockey in Naisten Liiga. The results were in line with previous studies. Especially the incidence of concussion injuries in women's ice hockey is high even the body checking rule differs from men. High quality studies and resources should be aimed to make ice hockey safer for women.

4.7 Conclusions

Muscle strength testing alone does not seem to predict a hip and groin injury in women's ice hockey and is time consuming way of assessing players. Other assessments for example passive

range of motion testing and 5-second-squeeze test might be more convenient in team sport environment to screen players that might be in risk for hip and groin injuries or already have issues in hip and groin region.

Hip and groin overall health on the other hand seemed to drastically decrease at the end of the season when using a HAGOS questionnaire which could not be explained with changes in strength levels. HAGOS questionnaire could be one of the interventions to screen players hip health regularly. To our acknowledge this is the first study where the relationship between hip strength and hip and groin injuries was researched in women's elite-level ice hockey. More research on the topic is needed for the possibility to compare results and to build ice hockey safer for women all around the world. In this study concussions were most common specific injury and also future research should look for ways to avoid concussions in women's ice hockey.

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Appendices

Appendix 1. Muscle strength testing protocol

Testing

The testing protocol includes four different measurements of strength. Adduction strength, abduction strength, hip flexion strength and hip extension strength. All the tests are done with maximal voluntary contraction against fixation belt that is attached to the floor/treatment table or assessor's hand. In the test there is no movement on the joint, but the objective is to produce as much force as possible in a 5 second period. In between every attempt there is a minimum of 30 seconds resting period.

It should be noted to the participants that when performing a maximal voluntary contraction test there is a possibility of musculoskeletal injury when performing this kind of a muscle testing. There is a warm-up session before testing and two sub-maximal and two maximal contractions to familiarize the participant for the movement. The testing protocol is introduced more closely later. If the participant is not able to perform the test because its causing severe discomfort or pain, the testing procedure is stopped to avoid injuries.

The data that is collected in this protocol are strength measurements, distance from anterior superior iliac spine and measurement device and participants' weight. Data is collected by the assessor and a possible assistant and is stored safely electronically and analogically. The data is never admitted to third party without a participant consent. The collected data is used in further analysis to try to find possible correlation between strength levels of the athlete and possible injuries in hip and groin area during the season.

Covid safety protocol

When arriving to a testing site the participant was guided to the sanitary facilities to wash hands and given hand sanitizer. All the personnel in testing site are mandatory to wear a facemask the whole time during the testing event. If participant, assessor, or the assistant has been in a contact

with covid positive person, has even minor symptoms of covid or has been assigned to a quarantine it is forbidden to enter the site and in the testing event.

Between every participant the measurement device, treatment table and utilities e.g., stationary bike is disinfected with a proper disinfectant. Testing is carried in two different testing sites and same precautions are done in both places. The timing of testing is planned so there will be as few other persons in the site as possible.

Distance markings for the calculating torque

Assessor and the assistant marks spots with a marker pen to participants lower limb on supine position on the treatment table. Marked spots are 5 cm above the superior apex on patella on both legs, 10 cm above malleolus medialis and 10 cm above malleolus lateralis on both legs. Then the distance from superior anterior iliac spine is measured to the marked spots to use in further analysis and to right placement of the measuring device.

Warm-up

Prior to the actual testing there is a 10-minute warm-up phase to avoid injuries and to prepare the participant to the test.

Warm-up includes:

a) 5-minutes of stationary bike. To achieve moderate-hard intensity, participants are introduced to Borg's rating of perceived exertion and are advised to stay between 12-16.
b) 10 repetitions of glute bridge exercise and 8 repetitions of stationary lunges for each leg. No recovery period between these too exercises.
c) 20 second recovery period
d) 10 repetitions of glute bridge exercise and 8 repetitions of stationary lunges for each leg. No recovery period between these too exercises.

Rating	Descriptor
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Adduction strength test (Test 1.)

In the first test the participant is instructed to supine position on the treatment table. Assessor places his/her hand between the ankles of the participant 10 cm above medial malleoli with the measurement device in his/her right palm at the earlier marked spot.

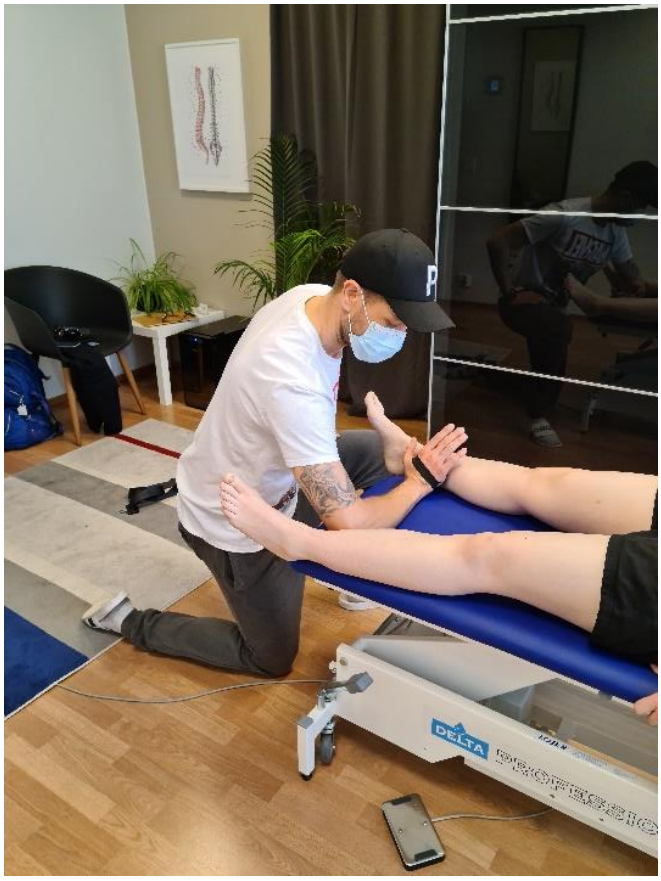
The participant is instructed to hold from both sides of the table with his/her hands to have more stability during the testing. Before the actual testing attempts the participant does two sub-maximal contractions and two maximal contractions to familiarize herself to the testing procedure. First sub-maximal contraction is instructed to do 50 % of the participants maximal contraction and the second 80 % of maximal contraction followed by two maximal contractions. After familiarization attempts there is 30 second recovery period. If in these sub-maximal or maximal attempts, the participant is feeling discomfort or pain the testing procedure is stopped.

After the familiarization phase the recorded maximal voluntary contraction attempts are done. One attempts duration is five seconds. The participant is verbally cued with words “go ahead, push push push, and relax”. Participant has three maximal contractions and between every contraction there is a minimum of 30 second recovery period. The highest value of those three contractions is

collected and used in further analysis. If the last contraction produces the highest value there will be another MVC until no further increase will be produced. Maximum amount of attempts is six, even if the sixth result is highest.

Step by step instructions:

a) Instruct the participant to supine position on the treatment table
b) Assessor places his/her hand between the participants ankles approximately 10 cm above medial malleoli where the markings are.
c) Assessor measures the width of legs to equal the amount of abduction in the test 2.
d) Participant is instructed to hold from both sides of the table to have more stability
e) Participant is guided to have first familiarization attempt with 50 % subjective maximal contraction against the assessors hand. Assessor confirms that there was no pain or discomfort during the attempt.
f) 10 second recovery period
g) Participant is guided to have a second familiarization contraction at 80 % of subjective maximal contraction against assessors hand. Assessor confirms that there was no pain or discomfort during the attempt.
h) 10 second recovery period
i) Participant is guided to do first maximal familiarization attempt
j) 10 second recovery period
k) Participant is guided to do second maximal familiarization attempt
l) 30 second recovery period
m) The first maximal voluntary contraction. The participant is verbally qued to ”go ahead, push push push push, and relax”. One contraction duration is five seconds. Assessor confirms that there is no pain or discomfort during the attempt.
n) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
o) 30 second recovery period
p) The second maximal voluntary contraction with same protocol than in the first one.
q) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
r) 30 second recovery period
s) The third maximal voluntary contraction with same protocol than the first and the second.
t) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
u) 30 second recovery period
v) If the last MVC results to highest value, then another MVC is carried out as long as the value does not increase anymore (maximum six attempts)



Abduction strength test (Test 2.)

In the second test the participant is instructed to supine position on the treatment table. The fixation belt is located to the same distance from the anterior superior iliac spine than it was in the adduction test and the measurement device is placed between the fixation belt and lateral part of right ankle. The amount of abduction on the hip is what produces from the assessors' hand between the legs as in the adduction test.

The participant is instructed to hold from both sides of the table with his/her hands to have more stability during the testing. Before the actual testing attempts the participant does two sub-maximal contractions to familiarize herself to the testing procedure. First sub-maximal contraction is instructed to do 50 % of the participants maximal contraction and the second 80 % of maximal contraction followed by two maximal familiarization contractions. After familiarization attempts

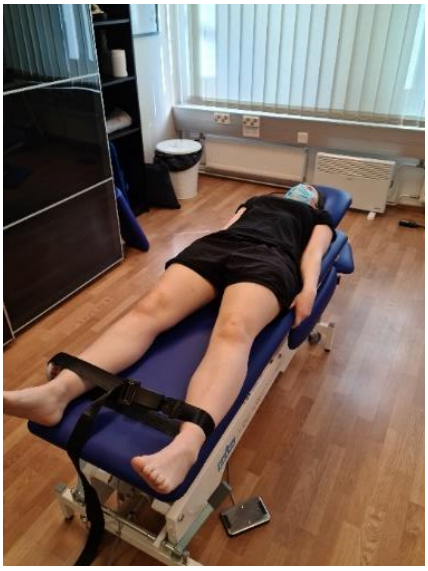
there is 30 second recovery period. If in these sub-maximal attempts, the participant is feeling discomfort or pain the testing procedure is stopped.

After the familiarization phase the recorded maximal voluntary contraction attempts are done. One attempt duration is five seconds. The participant is verbally cued with words “go ahead, push push push, and relax”. Participant has three maximal contractions and between every contraction there is a 30 second recovery period. The highest value of those three contractions is collected and used in further analysis. If the last contraction produces the highest value there will be another MVC until no further increase will be produced. Maximum amount of attempts is six, even if the sixth attempt is the highest.

Step by step instructions:

a) Instruct the participant to supine position on the treatment table
b) Assessor places measurement device approximately 10 cm above lateral malleolus on the lateral side of right leg where are the markings.
c) The fixation belt is set around both legs and the device with the length that hip abduction is equal to the first test.
d) Participant is instructed to hold from both sides of the table to have more stability
e) Participant is guided to have first familiarization attempt with 50 % subjective maximal contraction against the fixation belt. Assessor confirms that there was no pain or discomfort during the attempt.
f) 10 second recovery period
g) Participant is guided to have a second familiarization contraction at 70 % of subjective maximal contraction against assessors hand. Assessor confirms that there was no pain or discomfort during the attempt.
h) 10 second recovery period
i) Participant is guided to do first maximal familiarization attempt
j) 10 second recovery period
k) Participant is guided to do second maximal familiarization attempt
l) 30 second recovery period
m) The first maximal voluntary contraction. The participant is verbally qued to ”go ahead, push push push push, and relax”. One contraction duration is five seconds. Assessor confirms that there is no pain or discomfort during the attempt.
n) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
o) 30 second recovery period
p) The second maximal voluntary contraction with same protocol than in the first one.
q) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
r) 30 second recovery period
s) The third maximal voluntary contraction with same protocol than the first and the second.

t) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
u) 30 second recovery period
v) If the last MVC results to highest value, then another MVC is carried out as long as the value does not increase anymore (maximum six attempts)



Hip flexion strength test (Test 3.)

In the third test the participant is instructed to a seated position in the edge of the treatment table. Participant is sitting back in neutral position and hip and knee in 90 degrees flexion. The participant is allowed to stabilize themselves by placing both hands on the sides of the treatment table. During the maximal contractions accessory movement from other body parts is forbidden and the attempt is disqualified if such appears. The measurement device is located 5 cm above patella with fixation belt around the device. Fixation belt is attached to the treatment table as shown in picture.

Before the actual testing attempts the participant does two sub-maximal contractions to familiarize herself to the testing procedure. First sub-maximal contraction is instructed to do 50 % of the participants maximal contraction and the second 80 % of maximal contraction followed by two maximal familiarization attempts. After familiarization attempts there is 30 second recovery period. If in these sub-maximal attempts, the participant is feeling discomfort or pain the testing procedure is stopped.

After the familiarization phase the actual maximal voluntary contraction attempts are done. One attempt duration is five seconds. The participant is verbally cued with words “go ahead, push push push, and relax”. Participant has three maximal contractions and between every contraction there is a 30 second recovery period. The highest value of those three contractions is collected and used in further analysis. If the last contraction produces the highest value there will be another MVC until no further increase will be produced. Maximum amount of attempts is six, even if the sixth attempt is the highest.

Step by step instructions:

a) Place the measurement device above the patella on the spot where the markings were made in part 3.
b) Instruct the participant to seated position on the end of the treatment table
c) Participant is instructed to sit in a neutral position with hip and knee in 90 degrees flexion
d) Assessor places measurement device 5 cm above knee cap on the thigh on the spot where the distance was measured.
e) The fixation belt is attached to the treatment table and over the measurement device on participants thigh
f) Participant is instructed to hold from both sides of the table to have more stability
g) Participant is guided to have first familiarization attempt with 50 % subjective maximal contraction against the fixation belt. Assessor confirms that there was no pain or discomfort during the attempt.
h) 10 second recovery period
i) Participant is guided to have a second familiarization contraction at 70 % of subjective maximal contraction against assessors hand. Assessor confirms that there was no pain or discomfort during the attempt.
j) 10 second recovery period
k) Participant is guided to do first maximal familiarization attempt
l) 10 second recovery period
m) Participant is guided to do second maximal familiarization attempt
n) 30 second recovery period
o) The first maximal voluntary contraction. The participant is verbally qued to ”go ahead, push push push push, and relax”. One contraction duration is five seconds. Assessor confirms that there is no pain or discomfort during the attempt.
p) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
q) 30 second recovery period
r) The second maximal voluntary contraction with same protocol than in the first one.
s) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
t) 30 second recovery period
u) The third maximal voluntary contraction with same protocol than the first and the second.

v) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
w) 30 second recovery period
x) If the last MVC results to highest value, then another MVC is carried out as long as the value does not increase anymore (maximum six attempts)

Hip extension strength test (Test 4.)

In the fourth test the participant is instructed in prone position. Measurement device is placed 10 cm above malleoli in the posterior part of lower leg with the fixation belt over the device. Other end of the fixation belt is attached to the treatment table. The participants knee has to be on the table and 1/3 of the shin length is outside of the table. Participants hip is in neutral position and the knee is allowed to be in slight flexion. The participant is allowed to hold both sides of the table

with her/his hands to have more stability but accessory movement from other bodyparts is forbidden.

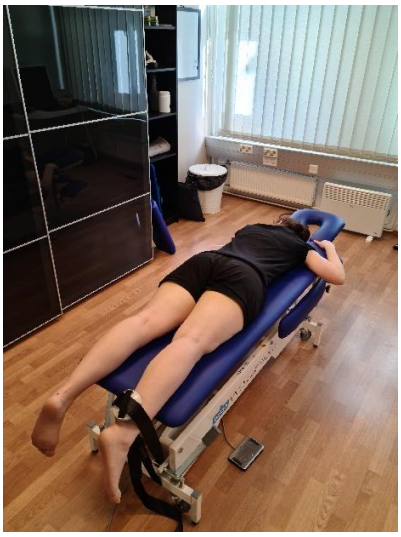
Before the actual testing attempts the participant does two sub-maximal contractions to familiarize herself to the testing procedure. First sub-maximal contraction is instructed to do 50 % of the participants maximal contraction and the second 80 % of maximal contraction followed by two maximal familiarization contractions. After familiarization attempts there is 30 second recovery period. If in these sub-maximal attempts, the participant is feeling discomfort or pain the testing procedure is stopped.

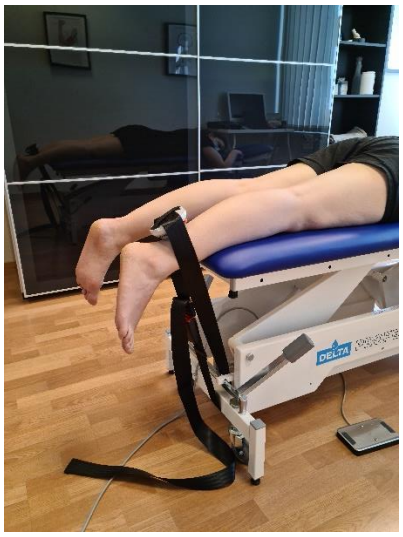
After the familiarization phase the actual maximal voluntary contraction attempts are done. One attempt duration is five seconds. The participant is verbally cued with words “go ahead, push push push, and relax”. Participant has three maximal contractions and between every contraction there is a 30 second recovery period. The highest value of those three contractions is collected and used in further analysis. If the last contraction produces the highest value there will be another MVC until no further increase will be produced. Maximum amount is six, even if the sixth attempt is the highest.

Step by step instructions:

a) Instruct the participant to prone position on the treatment table
b) Participant is instructed to have knee on the table, but half of the shin outside at the end of the table
c) Hip is in neutral and knee is allowed to be in slight flexion, but no movement of knee flexion is allowed when taking the measures
d) Assessor places measurement device approximately 10 cm above malleoli on the posterior part of lower leg where the markings were made earlier.
e) The fixation belt is attached to the treatment table and over the measurement device on participants leg
f) Participant is instructed to hold from both sides of the table to have more stability
g) Participant is guided to have first familiarization attempt with 50 % subjective maximal contraction against the fixation belt. Assessor confirms that there was no pain or discomfort during the attempt.
h) 10 second recovery period
i) Participant is guided to have a second familiarization contraction at 80 % of subjective maximal contraction against assessors hand. Assessor confirms that there was no pain or discomfort during the attempt.
j) 10 second recovery period

k) Participant is guided to do first maximal familiarization attempt
l) 10 second recovery period
m) Participant is guided to do second maximal familiarization attempt
n) 30 second recovery period
o) The first maximal voluntary contraction. The participant is verbally qued to ”go ahead, push push push push, and relax”. One contraction duration is five seconds. Assessor confirms that there is no pain or discomfort during the attempt.
p) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
q) 30 second recovery period
r) The second maximal voluntary contraction with same protocol than in the first one.
s) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
t) 30 second recovery period
u) The third maximal voluntary contraction with same protocol than the first and the second.
v) The value is collected by the assessor and written down by the assistant. The assessor double checks the value from the assistant.
w) 30 second recovery period
x) If the last MVC results to highest value, then another MVC is carried out as long as the value does not increase anymore (maximum six attempts)





Cool down

After the testing there is short cool down. Cool down is done with the stationary bike at light intensity from the Borg scale 6–11.

Appendix 2. The Copenhagen Hip and Groin Outcome Score (HAGOS) (Eng)

The Copenhagen Hip And Groin Outcome Score (HAGOS). English version LK 1.0. HAGOS Questionnaire concerning hip and/or groin problems

Today's date: _____/_____/_____ Date of birth: _____/_____/_____

Name: _____

INSTRUCTIONS: This questionnaire asks for your view about your hip and/or groin problem. The questions should be answered considering your hip and/or groin function during the past week. This information will help us keep track of how you feel, and how well you are able to do your usual activities.

Answer every question by ticking the appropriate box. Tick only one box for each question. If a question does not pertain to you or you have not experienced it in the past week please make your “best guess” as to which response would be the most accurate.

Symptoms

These questions should be answered considering your hip and/or groin symptoms and difficulties during the past week.

S1 Do you feel discomfort in your hip and/or groin?

Never Rarely Sometimes Often Always

S2 Do you hear clicking or any other type of noise from your hip and/or groin?

Never Rarely Sometimes Often All the time

S3 Do you have difficulties stretching your legs far out to the side?

None Mild Moderate Severe Extreme

S4 Do you have difficulties taking full strides when you walk?

None Mild Moderate Severe Extreme

S5 Do you experience sudden twinging/stabbing sensations in your hip and/or groin?

Never Rarely Sometimes Often All the time

Stiffness

The following questions concern the amount of stiffness you have experienced during the past week in your hip and/or groin. Stiffness is a sensation of restriction or slowness in the ease with which you move your hip and/or groin.

S6 How severe is your hip and/or groin stiffness after first awakening in the morning?

None Mild Moderate Severe Extreme

S7 How severe is your hip and/or groin stiffness after sitting, lying or resting later in the day?

None Mild Moderate Severe Extreme

Pain

P1 How often is your hip and/or groin painful?

Never Monthly Weekly Daily Always

P2 How often do you have pain in areas other than your hip and/or groin that you think may be related to your hip and/or groin problem?

Never Monthly Weekly Daily Always

The following questions concern the amount of pain you have experienced during the past week in your hip and/or groin. What amount of hip and/or groin pain have you experienced during the following activities?

P3 Straightening your hip fully

None Mild Moderate Severe Extreme

P4 Bending your hip fully

None Mild Moderate Severe Extreme

P5 Walking up or down stairs

None Mild Moderate Severe Extreme

P6 At night while in bed (pain that disturbs your sleep)

None Mild Moderate Severe Extreme

P7 Sitting or lying

None Mild Moderate Severe Extreme

The following questions concern the amount of pain you have experienced during the past week in your hip and/or groin. What amount of hip and/or groin pain have you experienced during the following activities?

P8 Standing upright

None Mild Moderate Severe Extreme

P9 Walking on a hard surface (asphalt, concrete, etc.)

None Mild Moderate Severe Extreme

P10 Walking on an uneven surface

None Mild Moderate Severe Extreme

Physical function, daily living

The following questions concern your physical function. For each of the following activities please indicate the degree of difficulty you have experienced in the past week due to your hip and/or groin problem.

A1 Walking up stairs

None Mild Moderate Severe Extreme

A2 Bending down, e.g. to pick something up from the floor

None Mild Moderate Severe Extreme

A3 Getting in/out of car

None Mild Moderate Severe Extreme

A4 Lying in bed (turning over or maintaining the same hip position for a long time)

None Mild Moderate Severe Extreme

A5 Heavy domestic duties (scrubbing floors, vacuuming, moving heavy boxes etc)

None Mild Moderate Severe Extreme

Function, sports and recreational activities

The following questions concern your physical function when participating in higher-level activities. Answer every question by ticking the appropriate box. If a question does not pertain to you or you have not experienced it in the past week please make your "best guess" as to which response would be the most accurate. The questions should be answered considering what degree of difficulty you have experienced during the following activities in the past week due to problems with your hip and/or groin.

SP1 Squatting

None Mild Moderate Severe Extreme

SP2 Running

None Mild Moderate Severe Extreme

SP3 Twisting/pivoting on a weight bearing leg

None Mild Moderate Severe Extreme

SP4 Walking on an uneven surface

None Mild Moderate Severe Extreme

SP5 Running as fast as you can

None Mild Moderate Severe Extreme

SP6 Bringing the leg forcefully forward and/or out to the side, such as in kicking, skating etc.

None Mild Moderate Severe Extreme

SP7 Sudden explosive movements that involve quick footwork, such as accelerations, decelerations, change of directions etc.

None Mild Moderate Severe Extreme

SP8 Situations where the leg is stretched into an outer position (such as when the leg is placed as far away from the body as possible)

None Mild Moderate Severe Extreme

Participation in physical activities

The following questions are about your ability to participate in your preferred physical activities. Physical activities include sporting activities as well as all other forms of activity where you become slightly out of breath. When you answer these questions consider to what degree your ability to participate in physical activities during the past week has been affected by your hip and/or groin problem.

PA1 Are you able to participate in your preferred physical activities for as long as you would like?

Always Often Sometimes Rarely Never

PA2 Are you able to participate in your preferred physical activities at your normal performance level?

Always Often Sometimes Rarely Never

Quality of Life

Q1 How often are you aware of your hip and/or groin problem?

Never Monthly Weekly Daily Constantly

Q2 Have you modified your lifestyle to avoid activities potentially damaging to your hip and/or groin?

Not at all Mildly Moderately Severely Totally

Q3 In general, how much difficulty do you have with your hip and/or groin?

None Mild Moderate Severe Extreme

Q4 Does your hip and/or groin problem affect your mood in a negative way?

Not at all Rarely Sometimes Often All the time

Q5 Do you feel restricted due to your hip and/or groin problem?

Not at all Rarely Sometimes Often All the time

Thank you very much for completing all the questions in this questionnaire.

Appendix 3. The Copenhagen Hip and Groin Outcome Score (HAGOS) (Fin)

NIVUS- JA LONKKAKIPU KYSELYKAAVAKE (HAGOS)

Päivämäärä: _____/_____/_____ Syntymäaika : _____/_____/_____

Nimi: _____

TÄYTTÖOHJEET: Tämä kyselykaavake mittaa lonkan ja nivusalueen kipuja ja oireita. Kysymyksillä tarkoitetaan viime viikon (viimeisen seitsemän päivän) aikana esiintyneitä lonkka- ja nivusalueen oireita. Kysymykset mittaavat vain nivusalueen ja lonkan kuntoa ja oireistoa.

Valitse jokaisesta kysymyksestä yksi vaihtoehto. Valitse vaihtoehto, joka vastaa parhaiten oiretta- tai sitä lähinnä oleva tilanne. Jos et ole tehnyt kyseistä aktiviteettia tai liikettä valitse vaihtoehto, jonka uskoisit olevan lähinnä tilannettasi

Oireet

Vastaa näihin kysymyksiin edellisen viikon (viimeisen seitsemän päivän) aikana kokemasi lonkka- ja nivusoireiden mukaan.

S1 Tunnetko nivusalueella ja/tai lonkassa mitään kipuja tai epämukavuuden tunnetta?

Ei koskaan Harvoin Joskus Usein Aina

S2 Kuuluuko lonkasta tai nivusalueelta napsahduksia tai muita ääniä?

Ei koskaan Harvoin Joskus Usein Jatkuvasti

S3 Onko sinulla vaikeuksia loitontaa jalkoja keskilinjasta ulospäin?

Ei Lievästi Keskivaikeaa Vaikeaa Äärimmäisen vaikeaa

S4 Koetko vaikeuksia ottaa harppauksia/pitkiä askeleita, kun kävelet?

Ei Lievästi Keskivaikeaa Vaikeaa Äärimmäisen vaikeaa

S5 Tunnetko lonkan tai nivusen alueella äkillistä pistävää tai puukkomaista kipua?

Ei koskaan Harvoin Joskus Usein Jatkuvasti

Jäykkyys

Seuraavat kysymykset koskevat lonkan/nivusalueen jäykkyyttä viimeisen viikon aikana. Jäykkyyden tunteella tarkoitetaan liikerajoittuneisuuden ja jähmeyden tunnetta lonkassa tai nivusessa.

S6 Kuinka vaikea on lonkan ja/tai nivusen jäykkyys, kun aamulla heräät?

Ei lainkaan Lievästi Keskivaikea Vaikea Äärimmäisen vaikea

S7 Kuinka vaikea on lonkan ja/tai nivusen jäykkyys myöhemmin päivällä, kun lähdet liikkeelle istuma- tai makuuasennosta?

Ei lainkaan Lievästi Keskivaikea Vaikea Äärimmäisen vaikea

Kipu

P1 Kuinka usein lonkka ja/tai nivunen on kipeä?

Ei koskaan Kerran kuussa Viikottain Päivittäin Kipu on jatkuvaa

P2 Kuinka usein sinulla on muissa kehon alueissa kipua, jonka uskot johtuvan lonkan ja/tai nivusalueen vaivasta?

Ei koskaan Kerran kuussa Viikottain Päivittäin Jatkuvasti

Seuraavat kysymykset koskevat kokemaasi kivun määrää viimeisen viikon aikana lonkassa ja/tai nivusalueella seuraavien liikesarjojen yhteydessä.

P3 Kun suoristat lonkkanivelen kokonaan eli koukusta suoraksi (ekstensio)?

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P4 Kun koukistat lonkan täysin (fleksio, polven vienti kohti rintaa)

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P5 Portaita kävellessä joko ylös tai alas

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P6 Lepokipua yöllä (kipua, joka häiritsee untasi)?

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P7 Istuessa tuolilla tai maatessa

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P8 Pystysuorassa seistessä

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P9 Kävellessä kovalla alustalla (esim. asfaltti tai sementti)

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

P10 Kävellessä epätasaisella alustalla (esimerkiksi metsässä)

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

Toimintakyky, päivittäiset askareet

Seuraavat kysymykset koskevat lonkan ja/tai nivusalueen vaivan aiheuttamaa vaikeutta päivittäisissä askareissa viimeisen viikon aikana.

A1 Portaita ylös kävellessä

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia Äärimmäisen paljon vaikeuksia

A2 Kun taivutat lantiota alaspäin esimerkiksi, kun poimit lattialta tavaroita

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

A3 Menet autoon tai nouset autosta

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

A4 Makaat sängyssä (kun käännät kylkeä tai kun makaat pitkään samassa asennossa)

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

A5 Raskaissa kotiaskareissa (lattianpesu, imurointi, nostelet huonekaluja etc)

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

Liikunta, urheilu ja harrastukset

Seuraavat kysymykset koskevat urheilussa tai kovassa liikuntaharrastuksessa kokemaasi vaikeuden astetta seuraavissa aktiviteeteissa. Jos et ole tehnyt kyseisiä aktiviteetteja viimeisen viikon aikana, valitse se vaihtoehto, jonka uskoisit olevan tilannettasi kuvaavin vaihtoehto.

SP1 Kyykkyyn meneminen

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP2 Juokseminen

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP3 Tukijalan kierto tai vääntöliikkeissä

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP4 Epätasaisella alustalla käveleminen

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP5 Juokseminen maksimaalisella nopeudella

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP6 Voimakas potkuliike ja/tai luistelu

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP7 Äkilliset/räjähtävät liikkeet, jotka sisältävät nopeaa jalkatyötä, kiihdytyksiä, jarrutuksia tai suunnanmuutoksia

Ei vaikeuksia Hieman vaikeuksia Kohtalaisesti vaikeuksia Paljon vaikeuksia
Äärimmäisen paljon vaikeuksia

SP8 Tilanteet, joissa jalka on venyttyneenä kauas kehon keskipisteestä (esim. poikittaisspagaatti)

Ei kipua Lievä kipu Keskivaikea kipu Vaikea kipu Erittäin vaikea kipu

Harrastukset ja fyysinen aktiviteetti

Seuraavat kysymykset koskevat osallistumistasi harrastuksiin, liikuntaan tai muuhun vastaavaan fyysiseen aktiviteettiin viimeisen viikon aikana.

PA1 Pystytkö osallistumaan haluamaasi urheiluun, liikuntaan tai fyysiseen aktiviteettiin niin pitkään kuin haluaisit?

Aina Usein Joskus Harvoin En koskaan

PA2 Pystytkö osallistumaan haluamaasi urheiluun, liikuntaan tai fyysiseen aktiviteettiin normaalin suorituskykysi tasolla?

Aina Usein Joskus Harvoin En koskaan

Elämän laatu

Seuraavat kysymykset koskevat elämän laatua.

Q1 Kuinka usein koet lonkka- ja/tai nivusongelmasi?

En koskaan Kuukausittain Joka viikko Joka päivä Aina

Q2 Oletko joutunut muuttamaan elintapojasi välttääksesi aktiviteetteja, jotka mahdollisesti vaurioittaisivat lonkkaasi ja/tai nivusaluettasi?

En ollenkaan Vähän Kohtuullisen paljon Hyvin paljon Kokonaan

Q3 Yleisesti, kuinka paljon vaikeuksia/ongelmia sinulla on lonkan tai nivusen vaivan vuoksi?

Ei yhtään Vähän Kohtuullisen paljon Hyvin paljon Erittäin paljon

Q4 Vaikuttaako lonkan ja/tai nivusen ongelmat negatiivisesti mielialaasi?

Ei yhtään Harvoin Joskus Usein Aina

Q5 Koetko elämäsi olevan rajoittunutta lonkan ja/tai nivusen ongelmien vuoksi?

En yhtään Harvoin Joskus Usein Aina