



UNIVERSITAT DE VIC
UNIVERSITAT CENTRAL
DE CATALUNYA

FEBRER 2023

Epidemiologia lesional en l'hoquei patins

Bernat de Pablo Marquez

Martí Casals

Gil Rodas





TESI DOCTORAL

EPIDEMIOLOGIA LESIONAL EN L'HOQUEI PATINS

BERNAT DE PABLO MARQUEZ

Tesi per obtenir el títol de Doctor de la Universitat de Vic - Universitat
Central de Catalunya en el programa de doctorat de Medicina
i Ciències Biomèdiques

Directors:

DR. MARTÍ CASALS TOQUERO

DR. GIL RODAS FONT

2023

«És millor prevenir que curar»

D. Erasmus 1466-1536

AGRAÏMENTS

Als meus pares, Conxita i Santi , i a la meva germana Anna, pilars incontestables.

A la Mireia, amb qui aconseguim a través de l'amor, el diàleg, el treball en equip i un bon somriure, mantenir dret aquest castell de cartes en el qual vivim.

A l'Arnau, l'Ot i en Roger, l'origen i final de qualsevol cosa.

A en Josep Salvador, el meu mentor en el món de la medicina esportiva, qui em va posar en contacte amb l'hoquei patins.

A en Toni Arevalo i la Marta Serra, per despertar-me l'esperit crític i l'interès per la investigació.

Als meus tutors, en Martí Casals i en Gil Rodas, que han posat totes les eines perquè aquesta tesi tirés endavant.

Als coautors dels articles, Javi Peña, Dani Moreno, Xavier Yanguas, David Dominguez, Dai Sugimoto, Marcos Quintana i Isaac Subirana per la seva inestimable ajuda.

Al doctor Ramon Canal i al Futbol Club Barcelona, per donar-me l'empenta per arrencar aquest apassionat projecte.

A la *Real Federación Española de Patinaje*, amb en Carmelo Paniagua i en Xavi Moyano al capdavant, per haver-me permès gaudir de l'hoquei patins en el seu més alt nivell.

A tots els jugadors i tècnics amb qui he tingut l'oportunitat de treballar i sobretot als fisioterapeutes, figures clau en la cura dels esportistes.

LLISTAT DE PUBLICACIONS

Entre els estudis presentats en l'apartat de publicacions, els articles científics acceptats en accés obert es mostren en format original, mentre que els acceptats en accés limitat es mostren en el format de la versió acceptada (amb l'objectiu de respectar els drets editorials de la pròpia revista). Per últim, els articles que actualment estan en revisió es presenten en format de l'última versió tal com s'envien a la revista.

Estudi I: de Pablo B, Peña J, Moreno D, Rodas G, Casals M. Injury incidence and patterns in rink hockey: a systematic review. *Apunts Sports Medicine*. 2022; 57 (214): 1-12.
doi: 10.1016/j.apunsm.2022.100380
SJR 2021 0,37. Quartil 3.

Estudi II: de Pablo B, Trabal G, Yanguas J, Dominguez D, Rodas G, Casals M. Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo. *Arch Med Dep*. 2022; 39(6): 190-196.
doi: 10.18176/archmeddeporte.00112
SJR 2021 0,16. Quartil 4.

Estudi III: de Pablo B, Subirana I, Quintana M, Rodas G, Casals M. Time-loss injuries among male and female Spanish rink hockey players. 2023. En revisió a la revista *International Journal of Sports Medicine*.

Estudi IV: de Pablo B, Sugimoto D, Arboix-Alio J, Rodas G, Casals M. Analysis of injuries during the 2019 Rink Hockey World Championship, *Phys Sportsmed*. 2022 Oct 3;1-7;
doi: 10.1080/00913847.2022.2129502
SJR 2021 0,6. Quartil 2. Factor d'impacte 2,36

LLISTAT D'ABREVIATURES

AE	Athlete Exposure
CI	Confidence Interval
CIR	Cumulative Incidence Ratio
EH	Exposure hours
et al.	et alia
FIFA	Fédération Internationale Football Association
GE	Game Exposure
GIR	Game Injury Incidence Rate
h	Hours
HP	Hockey patines
IC	Intervalo de confianza
IOC	International Olympic Committee
IR	Injury incidence rate
IP	Injury incidence proportion
kg	Kilogram
km	Kilometer
RFEP	Real Federación Española de Patinaje
MA	Medical Attention
m	Meter
NR	Non-reported
ORCID	Orchard Sports Injury Classification System
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RD	Risk difference
RH	Rink Hockey
RTP	Return-to-play
SD	Standard deviation
SF	Senior Female
SM	Senior Male
SP	Senior Players
TAE	Total Athletic Exposure
TE	Training Exposure
TIR	Training injury incidence rate
TLI	Time-loss injury
TRIPP	Translating Research into Injury Prevention Practice framework
UEFA	Union of European Football Associations
U19M	Under-19 male
YP	Youth players

LLISTAT DE FIGURES

Figura 1: Posició de jugadors i porters en l'hoquei patins durant un partit.	25
Figura 2: Seqüència de prevenció de lesions	28
Figura 3: Adaptació de la seqüència de prevenció TRIPP proposada per Caroline Finch.....	29
Figura 4: Imatge que representa, segons Caroline Bolling, la importància del context en el disseny de la seqüència de prevenció de lesions.....	30
Figura 5: Esquema dels articles que constitueixen la tesi «Epidemiologia lesional de l'hoquei patins».....	35
Figura 6: Proteccions i posició de genoll a terra adoptada pels porters de hoquei patins.....	101

LLISTAT DE TAULES

Taula 1: Definicions per a la classificació de les lesions utilitzades en els estudis de la tesi.....	31
--	----

NOTA ACLARIDORA

Per llegir aquesta tesi doctoral s'ha de tenir present que en els casos en què es fa referència al gènere masculí s'ha d'interpretar, a no ser que s'indiqui expressament el contrari, com una condició compartida en ambdós sexes, ja que queda clar que resultaria molt dispendiós i bastant fatigant pel lector si s'haguessin comprès totes les situacions possibles que poden aparèixer en fer referència directa tant al gènere femení com masculí. Per això, les paraules «el», «al», «a ell», etc. s'han utilitzat indistintament per influir tan el gènere masculí com el femení, sense distinció de sexe.

ÍNDIX GENERAL

Llistat de publicacions	7
Llistat d'abreviatures	9
Llistat de taules i figures	11
Resum	17
Resumen	19
Abstract.....	21
CAPÍTOL 1: Introducció	25
1.1. L'hoquei patins	25
1.2. L'epidemiologia lesional	27
1.3. Epidemiologia lesional i en l'hoquei patins.....	33
1.4. Hipòtesi i objectius	34
1.5. Estructura de la tesi	34
CAPÍTOL 2: Estudi I	39
Injury incidence and patterns in rink hockey: a systematic review	
CAPÍTOL 3: Estudi II	55
Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo	
CAPÍTOL 4: Estudi III.....	65
Time-loss injuries among female and male Spanish rink hockey players	
CAPÍTOL 5: Estudi IV.....	85
Analysis of injuries during the 2019 Rink Hockey World Championship	
CAPÍTOL 6: Conclusions, limitacions i futures línies de recerca	95
Referències bibliogràfiques	107
Annexos.....	117

RESUM

La present tesi doctoral estudia les lesions en esportistes d'elit d'hoquei patins, a partir d'una revisió sistemàtica de la bibliografia científica existent i estudis observacionals sobre les mostres de jugadors i jugadores més grans analitzades fins al moment. A diferència d'altres esports, on l'estudi de les lesions ha esdevingut un procés clau per treballar en la seva prevenció, en l'hoquei patins hi ha una manca d'investigacions d'aquest tipus.

La tesi s'ha basat en 4 estudis que s'han acabat traduïnt en publicacions científiques. El primer estudi consisteix en una revisió sistemàtica seguint la metodologia PRISMA per avaluar la bibliografia existent sobre lesions en esportistes d'hoquei patins. Els resultats obtinguts van mostrar poca bibliografia disponible, amb estudis amb mostres petites i metodologies heterogènies. El segon i el tercer estudis es van realitzar en esportistes de les màximes competicions espanyoles d'hoquei patins durant una temporada completa i el quart estudi es va realitzar en seleccions nacionals de 3 països durant la consecució d'un Campionat del Món. Cal destacar que aquests estudis són els primers en incloure esportistes femenines d'elit de hoquei patins i els primers en diferenciar les lesions per posició de joc .

Les lesions musculotendinoses han estat les més freqüents en els campionats nacionals espanyols amb una proporció d'incidència de 32,8 lesions/100 esportistes/temporada (IC 95% 25,2 - 42,5) i 24,2 (IC 95% 19,1-29,1), les temporades 2019/20 i 2020/21 respectivament. La regió de la cuixa, principalment als músculs adductors, ha sigut la zona més freqüentment lesionada. Aquesta troballa és especialment rellevant en comparació amb altres esports, on no es descriu tanta lesionabilitat a la musculatura adductora. Això es pot explicar per la biomecànica específica de l'hoquei patins i ha de permetre posar el focus en la prevenció d'aquest tipus de lesions.

Les lesions traumàtiques també han sigut freqüents, especialment en el Campionat del Món, on els traumatismes a la regió craniofacial van ser

les lesions més freqüentment descrites. Els traumatismes craniofacials han demostrat ser una causa freqüent de lesions i les seves conseqüències han estat motiu de debat en les categories inferiors de l'hoquei, on s'ha proposat la obligatorietat del casc protector. Vistos els resultats obtinguts caldria valorar l'aplicabilitat d'aquesta eina preventiva en els esportistes d'elit.

Les esportistes femenines han presentat patrons lesionals lleument diferents als esportistes masculins, tot i que tan les mesures absolutes com relatives de les proporcions d'incidència no semblen indicar que siguin significatives a nivell estadístic. Pel que fa a la posició de joc, s'ha comprovat que la proporció incidència lesional és superior en jugadors de pista que en porters, desmentint el mite que la posició de porter és la més perillosa de l'hoquei patins.

Els resultats de la present tesi aporten primeres evidències que l'hoquei patins té uns patrons lesionals específics i diferencials d'altres esports. Aquest resultat permeten focalitzar estratègies preventives dirigides a jugadors d'elit per posició, categoria i gènere amb l'objectiu de minimitzar les lesions i optimitzar el rendiment esportiu.

RESUMEN

La presente tesis doctoral estudia las lesiones en deportistas de elite de hockey patines, a partir de una revisión sistemática de la bibliografía científica existente y estudios observacionales sobre las muestras de jugadores y jugadoras más grandes analizadas hasta el momento. A diferencia de otros deportes, donde el estudio de lesiones se ha convertido en un proceso clave para trabajar en la prevención, en el hockey patines hay una falta de investigaciones de este tipo.

La tesis se ha basado en cuatro estudios que se han traducido en publicaciones científicas. El primer estudio consiste en una revisión sistemática siguiendo la metodología PRISMA para evaluar la bibliografía existente sobre las lesiones en deportistas de hockey patines. Los resultados obtenidos han mostrado poca bibliografía disponible, con estudios de muestras pequeñas y metodologías heterogéneas. El segundo y tercer estudio se realizaron en deportistas de las máximas competiciones españolas de hockey patines durante una temporada completa y el cuarto estudio se realizó en selecciones nacionales de tres países durante la consecución de un Campeonato del Mundo. Cabe destacar que estos estudios son los primeros en incluir deportistas femeninas de elite de hockey patines y el primero en diferenciar las lesiones por posición de juego.

Las lesiones musculotendinosas han sido las más frecuentes en campeonatos nacionales españoles con una proporción de incidencia de 32,8 lesiones/100 deportistas/temporada (IC 95% 25,2-42,5) y 24,2 (IC 95% 19,1-29,1), las temporadas 2019/20 y 2020/21 respectivamente. La región del muslo, concretamente los músculos aductores, han sido la zona más frecuentemente lesionada. Este hallazgo es especialmente relevante comparado con otros deportes, donde no se describe tanta lesionabilidad en la musculatura aductora. Ello se puede explicar por la biomecánica

específica del hockey patines, y debe permitir poner el foco en la prevención de este tipo de lesiones.

Las lesiones traumáticas también han resultado frecuentes, especialmente en el Campeonato del Mundo, donde los traumatismos en la región craneofacial fueron las más frecuentemente descritas. Los traumatismos craneofaciales han demostrado ser una causa frecuente de lesiones y sus consecuencias han sido motivo de debate en las categorías inferiores del hockey patines, donde se ha propuesto la obligatoriedad del casco protector. Vistos los resultados obtenidos, cabría valorar la aplicabilidad de esta herramienta preventiva en deportistas de elite.

Las deportistas femeninas han presentado patrones lesionales levemente diferentes a los deportistas masculinos, aunque ni las medidas absolutas ni relativas de las proporciones de incidencia parecen indicar que sean significativas a nivel estadístico. En lo que respecta a la posición de juego, se ha comprobado que la proporción de incidencia lesional es superior en jugadores de pista que en porteros, desmintiendo el mito que la posición de portero es la más peligrosa del hockey patines.

Los resultados de la presente tesis aportan primeras evidencias que el hockey patines tiene un patrón lesional específico y diferencial de otros deportes. Estos resultados permiten focalizar estrategias preventivas dirigidas a deportistas de elite según la posición, la categoría y el género, con el objetivo de minimizar las lesiones y optimizar el rendimiento deportivo.

ABSTRACT

This thesis aims to study the injuries in rink hockey elite players, for that we conducted a systematic review of available scientific literature and observational studies including the biggest samples analyzed up until the current era.

In contrast with other sports, where injury surveillance has become a key element in prevention, rink hockey lacks this kind of investigation.

The thesis is based in four studies that became scientific publications. The first study consists in a systematic review, following the PRISMA methodology, that evaluated the existing bibliography about rink hockey injuries. This review showed a lack of available studies, only finding studies including small samples and heterogenic methodologies. The second and third studies were conducted in the Spanish national league during a whole season and the fourth study analyzed three national teams during a World Cup Championship. It must be highlighted that these studies are the first ones to include female elite rink hockey athletes and the first ones to analyze injuries according to the playing position.

Muscle and tendon injuries were the most frequently reported in Spanish national competitions, with an incidence proportion of 32.8/100 athletes/season (IC 95 25.2-42.5) and 24.2 (IC 95% 19.1-29.1) during seasons 2019/20 and 2020/21, respectively. The thigh area, specifically the adductor muscles, was the most frequently injured. This finding can be explained by the specific biomechanics of rink hockey, and should set a starting point for injury prevention programs.

Traumatic injuries have also been frequently reported, especially during the World Cup Championship, where the craniofacial injuries were the most frequently described. Craniofacial injuries have proven to be a frequent cause of lesion and their consequences have been debated in young athletes'

categories of rink hockey, where the use of a helmet has been proposed as a mandatory measure. Following the studies' results, this preventive tool should also be considered in elite athletes.

Female athletes have presented slightly different injury patterns when compared with male athletes, however neither absolute or relative incidence proportions seem to indicate statistic significance. Regarding the playing position, it has been proven that injury incidence proportion is higher in field players than in goalkeepers, refuting the myth that the goalkeeper position is the most dangerous in rink hockey.

This thesis provides first evidence that rink hockey has a specific injury pattern, different from other sports. These results allow to put the focus on preventive strategies in elite rink hockey players according to their playing position, category and gender, with the final goal of reducing injuries and improve athletes' performance.

CAPÍTOL 1
INTRODUCCIÓ

INTRODUCCIÓ

1.1. L'HOQUEI PATINS

L'any 1991 Joan Antoni Samaranch, president del Comitè Olímpic Internacional, va definir l'hoquei patins com un esport que barreja espontaneïtat, rapidesa, esperit col·lectiu, domini de la tècnica individual i plantejament tàctic. Samaranch feia referència a un esport que havia practicat de jove, en el context de la presentació de l'esport com a modalitat d'exhibició durant els Jocs Olímpics de Barcelona de 1992 (1).

L'hoquei patins és una disciplina del patinatge amb origen a Anglaterra a l'any 1885 (2). En l'hoquei patins s'enfronten dos equips amb 5 jugadors (4 jugadors de pista i un porter). Els jugadors es desplacen amb patins de dos parells de rodes paral·leles i propulsen una bola rodona i sòlida amb un pal de fusta (*stick*) (**Figura 1**). L'objectiu del joc és introduir la bola en la porteria rival (3).



Figura 1: Posició de jugadors i porters en l'hoquei patins durant un partit. Font: Luis Velasco

Es tracta d'un esport practicat principalment en països Europeus (per exemple Itàlia, Portugal, França, Espanya, Alemanya o Suïssa) i d'Amèrica Llatina (per exemple Argentina, Xile, Colòmbia o Brasil). En el nostre entorn, Catalunya és un dels bressols de l'hoquei al nostre país i a Europa, tenint poblacions com Vic, Igualada, Reus, Sant Hipòlit de Voltregà i Sant Sadurní d'Anoia on aquest esport té una gran història i tradició.

La Federació Catalana de Patinatge, fundada l'any 1930, gestiona el número més alt de llicències (10.000 federats per temporada) de hoquei patins a Espanya (4) i els equips catalans han sigut dominadors de l'esport tant a l'àmbit nacional com a competicions continentals i intercontinentals. Igualment, la selecció espanyola d'hoquei patins és la més guardonada a nivell internacional, amb 17 campionats del món masculins i 7 campionats del món femenins (5). En els últims anys, els equips capdavanters de les lligues espanyola i portuguesa s'han professionalitzat cada cop més, integrant en les seves estructures a professionals associats amb la salut i el rendiment (metges, fisioterapeutes, preparadors físics, nutricionistes i psicòlegs).

L'hoquei patins és considera un esport de contacte, dinàmic i ràpid, amb canvis constants de velocitat i direcció. Els jugadors han de desenvolupar habilitats coordinatives i motrius específiques de l'esport, per tal d'optimitzar el seu rendiment (6). L'execució tècnicotàctica d'aquest esport es realitza a una alta intensitat i requereix una gran precisió per tal que l'equip pugui executar de manera eficient les accions conjuntes de defensa, atac i contraatac a gran velocitat (7).

Al ser un esport que es practica a gran velocitat (fins a 8,3 m/s, molt superior a la d'altres esports *indoor* com futbol sala, bàsquet o handbol (8)) el risc de col·lisió entre els esportistes és elevada. Això, juntament amb la utilització d'un stick de fusta i una bola rodona i sòlida que es pot desplaçar fins a 115 km/h (9) fa que el risc de traumatisme en l'esport sigui elevat (10). Tots aquests factors poden fer pensar que l'hoquei patins té un patró lesional específic.

1.2. L'EPIDEMIOLOGIA LESIONAL

L'epidemiologia és la ciència que estudia la distribució, freqüència i factors etiològics i determinants de salut com malalties o lesions en la població (11). Al llarg de la història ha esdevingut una peça angular en el desenvolupament científic, mèdic i inclús social, principalment pel paper que ha tingut en les grans pandèmies mundials (com per exemple el còlera, la verola, o més recentment el virus SARS-COV2). Tot i així, l'epidemiologia es pot aplicar en molts altres àmbits de la medicina, i també té un paper molt important des de fa anys en la identificació de lesions en els esportistes (12).

Les lesions han demostrat ser un problema important en el món de l'esport, no només per l'efecte sobre el rendiment i la salut dels esportistes (12) sinó també per la influència negativa que poden tenir sobre els resultats esportius dels equips i inclús sobre els ingressos econòmics dels clubs professionals (13-15).

Constatant la magnitud del problema en l'àmbit de l'esport, el Comitè Olímpic Internacional va implementar un programa per fomentar la creació d'estratègies per prevenir lesions amb l'objectiu de fomentar un esport més segur (16).

L'any 1992, van Mechelen *et al.* (17) van descriure per primera vegada un cicle o la «seqüència de prevenció», constituïda per quatre passos que pretenen disminuir de forma efectiva les lesions esportives (**Figura 2**).

El primer pas de la seqüència consisteix en determinar la magnitud del problema, mitjançant mesures de freqüència i de severitat de les lesions. En el segon pas cal identificar els factors de risc, possibles causes i mecanisme de les lesions. El tercer pas consisteix en introduir mesures de prevenció basades en els factors etiològics i mecanismes detectats en el segon pas. Finalment, el quart pas consisteix en valorar l'efectivitat de les mesures implementades, idealment mitjançant assaigs clínics randomitzats (17).

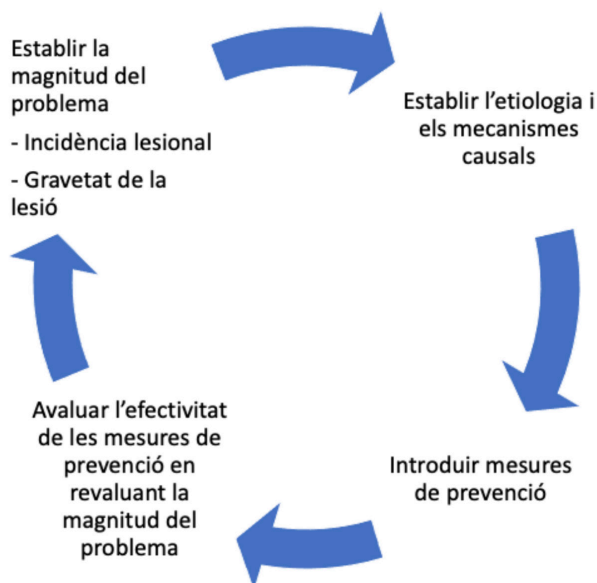


Figura 2: Seqüència de prevenció de lesions. Imatge adaptada de Van Mechelen *et al.*

La tesi de van Mechelen ha estat renovada i reformulada gràcies a les noves aportacions de Caroline Finch (18) amb la seva proposta de la metodologia TRIPP (*Translating Research into Injury Prevention Practice framework*), (**Figura 3**). Els treballs de Finch contextualitzen la proposta de van Mechelen en una aplicació més real en esportistes, tenint en compte que l'origen multifactorial de les lesions dificulta la identificació del factors de risc i la recerca d'estratègies de prevenció. L'estudi de Finch (18) recomana dur a terme treballs més acurats i tenint en compte equips multidisciplinars per tal d'abordar el problema de la salut dels esportistes(20).

Passos	TRIPP	<i>Passos van Mechelen</i>
1	Vigilància lesional	<i>Establir les dimensions del problema</i>
2	Establir la etiologia i mecanismes de lesió	<i>Establir l'etiologia i els mecanismes de lesió</i>
3	Desenvolupar mesures preventives	<i>Introduir mesures preventives</i>
4	Condicions ideals / avaluació científica	<i>Establir la efectivitat repetint el punt 1</i>
5	Descriure la intervenció per informar les estratègies d'implementació	
6	Avaluar l'efectivitat de les mesures preventives en el context d'implementació	

Figura 3: Adaptació de la seqüència de prevenció TRIPP proposada per Caroline Finch. Adaptació pròpia.

Les diferents mesures epidemiològiques i tècniques estadístiques també poden dificultar les comparacions entre els estudis, pel que s'han intentat crear guies per homogeneïtzar aquestes metodologies (19) permetent comparar els resultats entre esportistes d'una mateixa disciplina com amb altres disciplines. Una de les propostes de Finch (18) és també dur a terme vigilàncies epidemiològiques el més generalitzades possible, és a dir, tenir en compte la validesa externa i per exemple, no només realitzar estudis descriptius d'un equip d'una lliga durant una sola temporada si fos possible, que és el model més utilitzat en els estudis publicats durant les últimes dècades en el camp de la medicina esportiva.

Al treball de Van Mechelen i Finch s'hi van afegir l'any 2018 les aportacions de Caroline Bolling *et al.* (20), que van mostrar la importància del context, ja sigui de l'esportista i/o el seu entorn (Figura 4) en l'estudi de les lesions. Aquest context pot ajudar i es pot donar més criteri als treballs amb visió més quantitativa de Van Mechelen i Finch.

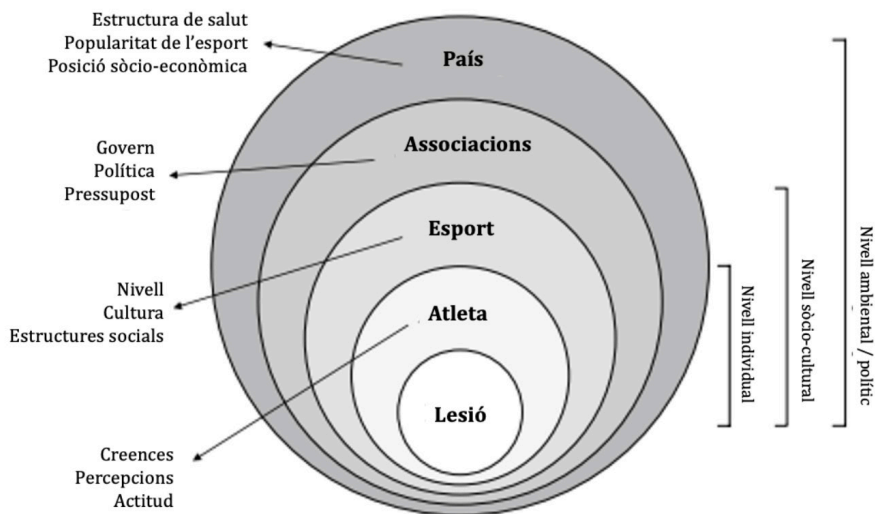


Figura 4: Imatge que representa, segons Caroline Bolling, la importància del context en el disseny de la seqüència de prevenció de lesions. Traduïda al català de l'original.

Definició de les lesions

En els estudis epidemiològics realitzats en el món de l'esport durant les últimes dècades s'han fet servir diferents definicions del concepte de la lesió. En alguns estudis es definien com aquelles condicions declarades per les companyies asseguradores (21), en altres es basava en la necessitat de primers auxilis o assistència mèdica (22). Aquesta heterogeneïtat en la definició dificultava la comparació entre registres.

Així doncs, l'any 2009, la «*Fédération Internationale de Football Association*» (FIFA) va crear un document de consens per tal de definir de forma clara i homogènia les definicions, mètodes de recollida i anàlisi de dades (19). En aquest document es defineix lesió com a «tota molèstia física que apareix durant la pràctica esportiva i que precisa d'atenció mèdica». Aquelles lesions que condicionen la pèrdua d'una sessió d'entrenament o de partit es consideraran «*time-loss injuries*» (lesions amb baixa esportiva) i aquelles que precisen atenció mèdica però sense baixa esportiva es consideraran «*medical attention injuries*» (19).

Classificació de les lesions

A la **Taula 1** s'exposen els termes que s'han utilitzat durant la tesi per a la classificació i estudi de les lesions.

Taula 1: Definicions per a la classificació de les lesions utilitzades en els estudis de la tesi

Terme en Català	Terme en Anglès	Definició
Lesió amb baixa esportiva	<i>Time-loss injury</i>	Qualsevol dolència física que limita la participació en la següent sessió d'entrenament/partit (19)
Lesió amb atenció mèdica	<i>Medical attention injury</i>	Qualsevol dolència física que requereix de l'atenció de l'equip mèdic, sense limitar la participació en entrenaments/partits (19)
Temps de baixa	<i>Return-to-play</i>	El temps (dies) que transcorren des de la lesió fins a la reincorporació a un entrenament complet o un partit (23)
Severitat	<i>Severity</i>	Es defineix a partir del return-to-play. Així, les lesions es classifiquen en lleus (1-7 dies), moderades (8 a 28 dies) i greus (>28 dies) (17)
Re-lesió	<i>Re-injury</i>	Lesió del mateix tipus i a la mateixa localització que apareix dins dels dos mesos posteriors a l'últim dia de rehabilitació (17)
Mecanisme causal	<i>Mechanism</i>	Es classifica en mecanisme causal com: lesió aguda/traumàtica o lesió per sobreús (causades per microtraumatismes repetits, sense un mecanisme causal clar i definit) (17)
Aparició	<i>Onset</i>	L'aparició es classifica en aguda o progressiva (17)

Mesures de freqüència

Les mesures de freqüència més conegudes són la prevalença i la incidència. La interpretació d'aquestes mesures són importants també per conèixer i definir les estratègies a seguir.

La prevalença és la mesura de freqüència que defineix el percentatge d'una població que pateix una malaltia/lesió en un moment determinat. La incidència en canvi és la mesura de freqüència que defineix el número de nous casos d'una malaltia/lesió durant el període d'estudi (24).

Al mateix temps, hi ha dues maneres de calcular la incidència:

- Proporció d'incidència o incidència acumulada: Número de noves lesions/número d'esportistes a risc a l'inici de l'estudi.
- Taxa d'incidència o densitat d'incidència. Número de noves lesions/suma de persones-temps-seguiment (per exemple hores d'entrenaments i/o partits). Es sol presentar en el format número de lesions/1000 hores d'exposició.

En el món de l'esport la taxa d'incidència és la mesura de freqüència més utilitzada, doncs permet conèixer exactament el temps que l'esportista ha estat realitzant l'activitat en estudis longitudinals o de seguiment i per tant exposat als potencials factors de risc.

En alguns estudis la nomenclatura d'incidència lesional es fa servir indistintament segons el denominador utilitzat, fet que pot dur a confusió si es volen comparar estudis. És important que les publicacions científiques que reportin la incidència lesional siguin clares a l'hora de definir quina mesura de freqüència s'utilitza, per exemple si es tracta d'una taxa o proporció d'incidència (25).

En resum, l'epidemiologia és una ciència que permet mostrar un mapa fotogràfic de la descripció de les patologies, concretament les lesions en el món de l'esport. La utilització d'una metodologia estandarditzada i ben definida ens ha de permetre comparar els resultats obtinguts amb altres mostres i, així, extreure'n conclusions vàlides.

1.3. EPIDEMIOLOGIA LESIONAL I HOQUEI PATINS

Pel que fa a la recerca científica, l'hoquei patins ha estat un camp abandonat fins a principis del segle XXI. Es van realitzar alguns estudis l'any 1992, en motiu de la inclusió de la disciplina com a esport olímpic (10,26) però després la producció científica va disminuir dràsticament, per tornar a repuntar amb força a partir del 2010. En els darrers anys grups d'investigació catalans i portuguesos han reprès la investigació en hoquei patins, principalment pel que fa a l'anàlisi de rendiment (7,8,27,28), *game analysis* (1,29-32) i antropometria (33-36).

L'anàlisi de l'epidemiologia lesional, com veurem en els propers capítols, ha estat escassa. Això contrasta amb els protocols de vigilància epidemiològica ben establerts en múltiples esports, on s'han implementat de forma rutinària en competicions nacionals i internacionals d'esports d'equip (futbol, basquet, handbol, rugbi) des de fa més de dues dècades, (14,23,37-40). Darrerament, també els esports individuals com l'atletisme o el tennis estan implementant programes de vigilància epidemiològica (41)(42). Dins dels esports més semblants a l'hoquei patins destaca l'hoquei gel, amb un entorn molt professionalitzat, que si que ha introduït programes de vigilància de lesions (43,44) i programes de prevenció de les mateixes, com per exemple el programes de prevenció de commoció cerebral en un esport on les lesions per traumatisme són molt habituals (45)

Els estudis publicats en hoquei patins, fins al moment de la publicació d'aquesta tesi (any 2023), són bàsicament estudis de casos o descriptius amb mostres petites i heterogènies (46,47), dificultant l'aplicació de les recomanacions de van Mechelen (17), Bolling (20), Finch (18) i el COI (16) en quan a vigilància epidemiològica i descripció de les lesions. Cap dels estudis publicats fins al moment ha presentat resultats sobre incidència lesional, no han diferenciat les lesions per posicions de joc ni han reportat lesions en esportistes femenines per conèixer per primera vegada el patró lesional d'aquest esport.

Tal com indiquen els estudis de Van Mechelen (17) i Finch (18), el primer pas per desenvolupar una estratègia de prevenció efectiva ha de ser descriure les característiques de les lesions en els esportistes, seguint de la forma el més escrupolosa possible els consensos internacionals (20).

1.4. HIPÒTESI I OBJECTIUS

Hipòtesi

- a) L'hoquei patins té un perfil lesional específic, amb característiques úniques i diferencials respecte altres esports d'equip.
- b) Les lesions de l'hoquei patins tenen un patró específic quan són estudiades per categoria, per gènere, per tipus de competició (nacional / internacional), per posició de joc o per moment (entrenament/partit).

Objectius

- a) Dur a terme una revisió sistemàtica seguint la metodologia PRISMA per estudiar la literatura científica disponible d'epidemiologia lesional en l'hoquei patins.
- b) Descriure la freqüència de les lesions en esportistes d'hoquei patins en diferents lligues nacionals i internacionals, per tal de definir un punt de partida per l'establiment de protocols preventius de lesions en l'hoquei patins.
- c) Descriure i comparar les característiques de les lesions a nivell epidemiològic segons categoria, gènere, nivell competitiu, posició de joc i moment.

1.5. ESTRUCTURA DE LA TESI

Per tal d'assolir aquests objectius la tesi es basarà en 4 estudis (**Figura 5**):

- Estudi I: Revisió sistemàtica, seguint la metodologia PRISMA (48), per tal de conèixer totes les publicacions realitzades fins al moment sobre les lesions en hoquei patins. La metodologia PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) és una eina que ajuda als investigadors a realitzar revisions sistemàtiques i meta-anàlisis, assegurant una descripció completa i transparent de la informació obtinguda (49).

- Estudi II: Estudi descriptiu sobre les lesions en la temporada 2019/20 de l'OK Lliga, màxima competició espanyola d'hoquei patins. La mostra inclou alguns dels equips de la lliga tant masculina com femenina. Aquest estudi inclou per primera vegada esportistes de diversos equips d'una màxima competició nacional. S'inclouen per primera vegada equips femenins d'àmbit nacional.
- Estudi III: Estudi descriptiu sobre les lesions en la temporada 2020/21 de l'OK Lliga, màxima competició espanyola d'hoquei patins i de l'OK Lliga plata, segona divisió masculina. S'estudien les lesions de la mostra més gran descrita fins al moment d'esportistes d'hoquei patins. Es descriu la proporció d'incidència i també mesures absolutes i relatives de risc de lesions, comparant per gènere i posició de joc
- Estudi IV: Estudi descriptiu sobre les lesions registrades durant el Campionat del Món d'Hoquei patins celebrat a Barcelona l'any 2019, amb els esportistes sènior masculí, sènior femení i sub19 masculí de les tres principals seleccions (Espanya, Portugal i Argentina). Es descriuen les característiques lesionals d'una competició internacional amb participants de diferents països. Igualment, es descriu per primera vegada les taxes d'incidència lesional (número de lesions per cada 1000 hores d'exposició) tant en els entrenaments com en els partits. S'inclouen per primera vegada també esportistes internacionals femenines.

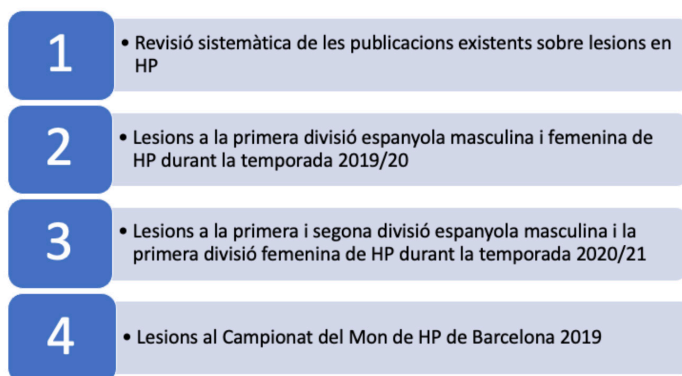


Figura 5: Esquema dels articles que constitueixen la tesi «Epidemiologia lesional de l'hoquei patins».

CAPÍTOL 2

ESTUDI I

INJURY INCIDENCE AND PATTERNS IN RINK HOCKEY: A SYSTEMATIC REVIEW

**Bernat de Pablo
Javier Peña
Daniel Moreno
Gil Rodas
Martí Casals**

Títol: Injury incidence and patterns in rink hockey: A systematic review

Paraules clau: Injury surveillance, injury prevention, roller hockey, epidemiology, team sports

Referència bibliogràfica: de Pablo B, Peña J, Moreno D, Rodas G, Casals M. Injury incidence and patterns in rink hockey: A systematic review. *Apunts Sports Medicine*. 2022; 57(214): 1-12

doi: <https://doi.org/10.1016/j.apunsm.2022.100380>

A les següents pàgines s'inclou la revisió sistemàtica de la bibliografia existent, seguint la metodologia PRISMA, sobre les lesions en l'hoquei patins.



REVIEW

Injury incidence and patterns in rink hockey: A systematic review



Bernat De Pablo^{a,b,c,*}, Javier Peña^{d,e}, Daniel Moreno^e, Gil Rodas^{c,f}, Martí Casals^{c,d,e,g}

^a Hospital Universitari Mutua Terrassa, Barcelona 08221, Spain

^b Doctoral program in Medicine and Biomedical Sciences, University of Vic - Central University of Catalonia (UVic-UCC), Barcelona 08500, Spain

^c Medical Department, Futbol Club Barcelona, Barça Innovation Hub, C/ Sant Pere n° 1 08173, Sant Cugat del Vallés, Barcelona 08028, Spain

^d Sport and Physical Activity Studies Centre (CEEAF), University of Vic - Central University of Catalonia, Vic, Barcelona 08500, Spain

^e Sport Performance Analysis Research Group (SPARG), University of Vic - Central University of Catalonia, Vic, Barcelona 08500, Spain

^f Sports Medicine Unit, Hospital Clinic & Hospital Sant Joan de Déu, Barcelona 08950, Spain

^g Faculty of Medicine, University of Vic - Central University of Catalonia (UVic-UCC), Barcelona 08500, Spain

Received 11 February 2022; accepted 1 March 2022

Available online xxx

KEYWORD

Injury surveillance;
Injury prevention;
Roller hockey;
Epidemiology;
Team sports

Abstract This systematic review aims to analyze studies on the extent of injuries in rink hockey athletes. Quality of the reported information was also analyzed. A literature search was performed from January 1992 until August 2020 using the main databases. The search terms were: “rink hockey” or the synonym “roller hockey” and “injur*”.

A total of 11 studies were considered eligible and included. Of these, nine were cross-sectional or descriptive. All samples were non-random, and only one study used a standardized consensus classification of injuries.

Muscle strains were the most frequent injuries and lower limbs the most affected body regions. Moreover, overuse was the most common cause, and injury severity was primarily moderate. Injury burden was not reported, and the incidence rate ranged from 3.23–9.7 injuries/1000 h.

We conclude that the quality of the reports has room for improvement in terms of study design, outcome, epidemiology measures, and investigation of injury characteristics.

© 2022 The Author(s). Published by Elsevier España, S.L.U. on behalf of FUTBOL CLUB BARCELONA and CONSELL CATALÀ DE L'ESPORT. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Rink hockey (RH), also known as roller hockey, quad hockey, or hardball hockey, is an international team sport played for the first time in England in the late 19th Century.

* Corresponding author at: Medical Department, Futbol Club Barcelona, Barça Innovation Hub, C/ Sant Pere n° 1 08173, Sant Cugat del Vallés, Barcelona 08028, Spain.

E-mail address: bernatdepablo@gmail.com (B. De Pablo).

Spain, Italy, Portugal, and Argentina are the countries with a higher number of RH licenses, and their national teams gather the majority of international trophies. The most mediatic moment for this sport was in 1992 when RH was included in the Barcelona Summer Olympic Games as a demonstration sport.

RH is a collective sport, played on four-wheeled quad roller skates with a wooden stick used as an extension of the arm to propel a round hardball.¹ The game is played by two teams of five players (four outfield players and one goalkeeper). It is considered dynamic, with repeated intermittent bouts of high intensity skating.² Therefore, players need to develop many sport-specific skills, such as coordination, endurance, power, and speed, to optimize their match performance.³

RH is a contact sport, with potential collision elements, either static (fences, goals) or dynamic (hockey sticks and ball).⁴ Nevertheless, the use of protective equipment, such as helmets or mouthguards, is not mandatory nor frequent (unlike in other similar sports, such as ice hockey and inline hockey).

Over recent decades, knowledge about the epidemiology of injuries has become one of the main trends in sports medicine to decrease injury risk through specific prevention strategies. Indeed, injury studies have been carried out in sports such as soccer,⁵ basketball,^{6,7} and ice hockey.^{8,9}

As a sport with important similarities to RH (contact, speed, use of skates and stick), ice hockey can be used as a reference point for the investigation. Many studies focusing on ice hockey injury surveillance have been released in recent years, including male, female, and youth athletes.^{10,12} Furthermore, studies on the application of injury prevention programs have been carried out.¹⁰

This systematic review aims to identify and describe the study design, outcome, objective, population, injury epidemiology measures, and characteristics (type, body region, mechanism, and severity) of injuries sustained in RH athletes while analyzing the quality of the reported information.

Methods

Sources of information

A computer-based literature search was conducted within electronic databases from 1990 to August 2020 (the lower limit was set in 1990 because of an increase in the scientific literature in that period due to the inclusion of male RH as a demonstration sport in the 1992 Olympic Games).

The consulted databases were PubMed, Web of Science, SportDiscus, Google Scholar, Scielo, and Semantic Scholar, according to the recommendations from the preferred reporting items for systematic and integrative reviews and meta-analysis statement (PRISMA).¹¹

Search strategy

The search terms were: (rink-hockey OR roller hockey OR quad hockey) AND (injury OR injuries OR pathology) that were included in the title, abstract, or keywords of a paper.

Selection of the studies included in the review

To increase research accuracy, two authors (BDM and MCT) separately screened citations and abstracts to identify the publications relevance for inclusion. Only studies focused on injuries of RH were included.

Afterwards, full texts were obtained to ascertain whether the publications satisfied the inclusion criteria. Besides, the reference sections of the selected articles were searched to identify other relevant papers.

Data were collected and stored in a database and checked by both authors in order to find possible discrepancies that were solved by consensus after reviewing the conflictive articles again.

Inclusion criteria

Any research item about rink hockey injuries was included. Articles in English, Spanish, Portuguese, and Italian were accepted. PhD dissertations, final projects for master's and bachelor's degrees were incorporated.

Exclusion criteria

Manuscripts about other team sports with a formal structure similar to RH were not considered (e.g., inline hockey, also referred to in the literature as roller hockey).

Case reports, abstracts, congress posters, and communications in conferences or workshops were excluded.

Selection process

Fig. 1 uses the PRISMA flowchart to summarize all stages of the process for selecting the papers to review.¹²

The first identification phase revealed 78 research items through database searching and one from another source (directly from the author).

Fifty-four duplicated items were eliminated in the screening phase.

The remaining 25 were then screened for relevance based on their title and full text.

Fourteen items were excluded according to the following criteria: other sports ($n = 9$), case reports ($n = 3$), congress posters ($n = 2$).

Finally, 11 items were included in the review.

Statistical analysis

We performed a descriptive study of some variables analyzed in the different studies, computing absolute and relative frequencies for categorical variables and central tendency and statistical dispersion measures for continuous variables. All analyzes were performed with the R statistical package (The R Foundation for Statistical Computing), version 3.3.3.

Results

Study design, primary outcome, and objectives

The 11 reviewed items comprised nine cross-sectional or descriptive studies^{15–18,21–24} and two experts' opinions.^{17,18}

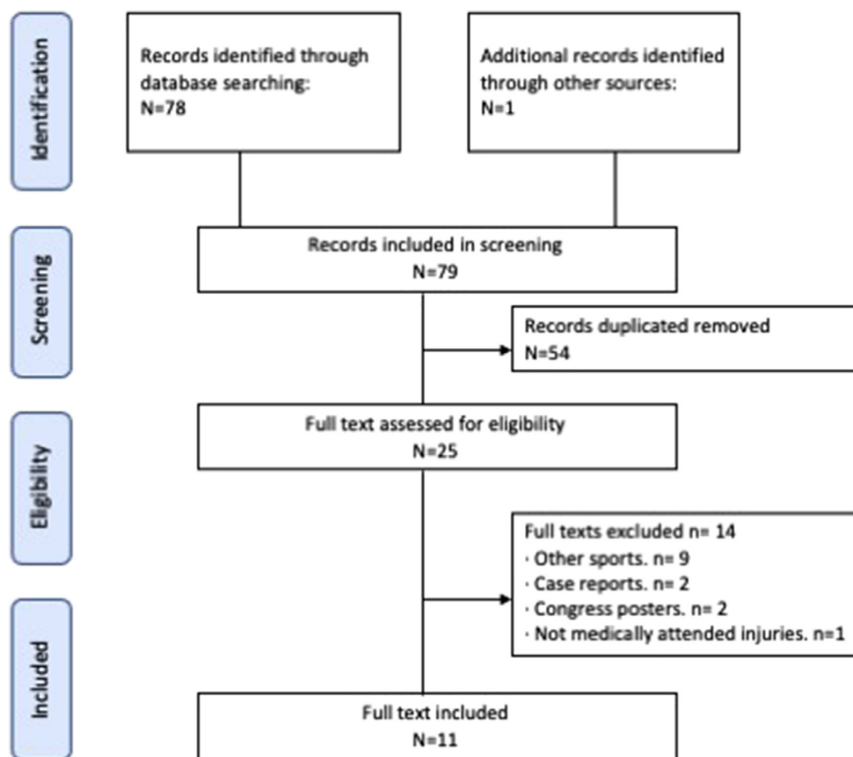


Fig. 1. Flow chart of the selection of articles to review.

Following the description of the study design, the evidence level¹⁹ was evaluated as III in nine items (81.8%)^{13,14,16,20–24} and V in two (18.2%).^{17,18}

Nine studies were specific about RH (13–18,21–23), while two studies included RH among other sports or injury evaluation reporting as the primary objective.^{20,24} Four studies were conducted in Portugal,^{14,15,21,22} four in Spain,^{17,20,23,24} one in Italy,¹⁸ one in Argentina,¹³ and one in Germany.¹⁶

The primary outcome was described as injury patterns in five of the 11 studies (45.4%);^{17,18,20,22,23} injury patterns and incidence in two (18.2%)^{14,16}; injury incidence in one (9.1%);²¹ and specific incidence of tendinopathy and craniofacial injuries in the last three studies (27.3%).^{13,15,24}

The objective was defined as descriptive in seven of the 11 studies (63.6%),^{14–16,20,22–24} analytical in two (18.2%),^{17,18} non-reported in one (9.1%),²¹ and unclear in one (9.1%).¹³

All the information in this subsection is summarized in Table 1.

Population and collection, number, and definition of injuries

Eight of the 11 studies (72.7%) stated their sample size, ranging from 22 to 289 athletes, with a median of 85.5 (Q1 = 28.2; Q3 = 120.5). All samples were reported as non-randomized.

Five studies (45.4%) prospectively collected injuries through predetermined templates reported by coaches/physical trainers/physiotherapists ($n = 4$) or by medical staff ($n = 1$). Three studies (27.2%) used retrospective questionnaires answered by the athletes, two (18.2%) were experts' opinion, and one (9.1%) was based on a retrospective review of medical records.

Seven of the 11 studies (63.6%) reported the number of injuries, ranging from 13 to 2947, with a median of 81 (Q1 = 61; Q3 = 86.5). Five (45.4%) did not report the injury classification and three (27.3%) used as an injury definition the Junge's formula.²⁵ Finally, three studies (27.3%) focused on specific injuries (two in craniofacial injuries and one in tendon injuries), and only one (9.1%) used a standardized by consensus injury classification (OSIICS).²⁶

Table 1 summarizes all the data reported above.

Epidemiological measures of occurrence

Seven of the 11 studies (63.6%) reported measures of occurrence, such as: incidence rate ($n = 4$), proportion ($n = 1$), and prevalence ($n = 2$). In two studies, measures were unclear (Table 1).

None used association measures, and only one calculated the confidence intervals.

Table 1 Characteristics of the studies included in the systematic review.

First author, year Country (Reference)	Study design (evidence level)	Main outcome measured	Objective	Sample size	Num of injuries	Injury definition	Injury data collection	Occurrence measures	Association measures	CI provided
Pons, 1991 Spain ¹⁷ Egocheaga, 2004 Spain ²⁰	Experts' opinion (V) Descriptive (III)	Injury patterns Injury patterns	Analytical Descriptive	NR N = 22 male professional SP	NR 48	NR NR	NR Prospective study during two seasons. Injured players visited in a Sport Medicine Unit.	NR Incidence rate	NR NR	NR NR
Marques, 2007 Portugal ²¹	Descriptive (III)	Injury incidence	NR	N = 30 male international YP Mean age: 15.2 ± 0.44	13	Fuller et al. 2006 ¹⁴	Prospective study for 8 months. Injuries recorded by coaches in a pre-designed template.	Incidence rate	NR	NR
Pelaez, 2008 Argentina ¹³	Cross-sectional (III)	Craniofacial injuries (any head/neck damaged tissue during a RH game)	Unclear	All players participating in 119 games	85	Craniofacial injuries (any head/neck damaged tissue during a RH game)	Prospective study for 18 months. All games in 2 clubs. Injuries recorded by coaches in a pre-designed template.	Incidence rate? Unclear	NR	NR
Gonçalves, 2008 Portugal ¹⁴	Descriptive (III)	Injury incidence Injury patterns	Descriptive	N = 63 male YP 32 international YP Mean age 14.9 ± 0.6 31 Regional YP Mean age 15.4 ± 0.4	81 28 injuries (international) 53 injuries (regional)	Fuller et al. 2006 ¹⁴	Prospective study for 8 months. Injuries recorded by coaches in a pre-designed template.	Incidence rate	NR	NR
Pereira, 2013 Portugal ²²	Descriptive (III)	Injury patterns	Descriptive	N = 289 225 male SP 64 male YP Mean age: 24.3 ± 5.5	NR	NR	Retrospective questionnaire about injuries during the last season.	Incidence prevalence	NR	Yes
Durigon, 2014 Italy ¹⁸ Reverter, 2018 Spain ²³	Experts' opinion (V) Descriptive (III)	Injury patterns Injury patterns	Analytical Descriptive	N = 23 male SP 10 Professional team 13 Amateurs Mean age: 30.48 ± 7.98 years	NR 88 48 amateur team 40 professional team	NR Fuller et al. 2006 ¹⁴	Prospective study for 2 seasons. Injuries recorded by coaches in a pre-designed template.	NR Incidence proportion? Unclear	NR NR	NR Yes
Lopes, 2019 Portugal ¹⁵	Cross sectional (III)	Orofacial injuries	Descriptive	117 YP (116 male, 1 female) Mean age 15.3 years.	NR	Orofacial injuries	Retrospective questionnaire about mouth/tooth injuries during the whole career	Incidence prevalence	NR	NR
Florit, 2019 Spain ²⁴	Descriptive (III)	Tendinopathy incidence	Descriptive	8 seasons. N = 131 RH players Mean age 29.5 ± 6.7 years.	74 47 professional team 27 YP	Tendon injuries according OSIICS classification ¹⁵	Retrospective revision of clinical history in a multisport elite club.	Incidence proportion	NR	Yes

Table 1 (Continued)

First author, year Country (Reference)	Study design (evidence level)	Main outcome measured	Objective	Sample size	Num of injuries	Injury definition	Injury data collection	Occurrence measures	Association measures	CI provided
Husen, 2020 Germany ⁶	Cross sectional (III)	Injury patterns injury inci- dence	Descriptive	108 (69 male, 39 female), 65% German 1st division	2947	NR	Retrospective ques- tionnaire about inju- ries during the whole career.	Incidence rate	NR	NR

NR: Non-reported; RH: Rink Hockey; SP: Senior Players; YP: Youth Players

Measures of injury incidence

Two of the 11 studies^{14,21} presented the injury incidence rate calculated following standardized formulas.²⁵ Both studies were conducted among Portuguese youth players. The total rate was 3.23²¹–9.7¹⁴/1000 exposure hours (EH). The match rate was 17.5¹⁴–36.7²¹(21)/1000 EH, and the training rate was 1.77²¹–7.5¹⁴/1000 EH.

Other studies presented injury incidence rates using non-standardized formulas. In Egocheaga’s study²⁰ the rate was 7.1 injuries/500 EH, and the formula was not specified.

The Husen study reported 9.4 ± 12.3 injuries/1000 AE (9.8 ± 11.1/1000 AE in men and 8.9 ± 14.3/1000 h AE in women).¹⁶ In Husen’s study, the AE was defined as the “number of athletes participating in a game or practice regardless of duration or type of exposure”.

In Florit’s study,²⁴ the injury incidence proportion of tendinopathy was 64.4 and 19.6 injuries/100 athletes/season, respectively, for professional RH players and youth RH players.

In the specific studies about orofacial injuries, 45/117 (25.4%) of the interviewed players reported at least one orofacial trauma during their career(15) and the incidence rate of craniofacial injuries in Pelaez’s study was reported as 85 injuries/100 match hours.¹³

Although two studies reported an injury incidence rate or proportion during matches and training sessions,^{16,23} none of them calculated the athletic exposure. The Reverter study²³ reported 88 injuries; 26.1% (n = 23) occurred during training sessions and 73.9% (n = 65) during matches. In the Husen study,¹⁶ the athletes reported in the injury surveillance questionnaire that 53.3% of their injuries occurred during practice and 46.7% during matches, but these observations were not confirmed or registered by any medical staff.

None of the studies calculated the injury burden. Table 2 summarizes injury incidence.

Injury characteristics

Type of injuries

Muscle strain was the most frequent injury in two of the studies in Spanish RH players,^{20,23} followed by tendon/ligament injuries in Egocheaga’s study²⁰ and by fractures in Reverter’s study.²³

In young Portuguese athletes, articular injuries were the most frequent, followed by muscle/tendon injuries.¹⁴

In the Pelaez study, 10% of the reported craniofacial injuries were fractures.¹³

The type of injuries reported in the reviewed research is shown in Table 3.

Body region affected

The lower limbs were the body regions with the highest proportion of injuries, followed by the upper limbs and head and neck. Trunk and back injuries were only reported in one study.

No detail about the specific regions (thigh, calf, shoulder, forearm) or affected muscles, tendons, or ligaments were reported, except for the Florit study.²⁴ In this latter study, the most frequent tendinopathy in professional and young RH players involved the adductor muscles, followed by the

Table 2 Injury incidence in RH studies.

First author, year Country (Reference)	Population	Total incidence	Training incidence	Match incidence	Incidence formula	Injury burden
Pons, 1991 Spain ¹⁷	NR	NR	NR	NR	NR	NR
Egocheaga, 2004 Spain ²⁰	Professional	7.1 injuries / 500 h	NR	NR	NR	NR
Marques, 2007 Portugal ²¹	International YP	3.23 injuries / 1000 h	1.77 / 1000 h	18.45 / 1000 h	Junge et al. 2006 ¹⁴	NR
Pelaez, 2008 Argentina ¹³	NR	NR	NR	85 / 100 h	Craniofacial injuries / 100 match hours*	NR
Gonçalves, 2008 Portugal ¹⁴	International YP	4.9 injuries / 1000 h	3.7 / 1000 h	17.5 / 1000 h	Junge et al. 2006 ¹⁴	NR
Pereira, 2013 Portugal ²²	Regional YP Senior & YP	9.7 injuries / 1000 h NR	7.5 / 1000 h NR	36.7 / 1000 h NR	NR	NR
Durigon, 2014 Italy ¹⁸	NR	NR	NR	NR	NR	NR
Reverter, 2018 Spain ²³	Professional & amateur senior players	NR	NR	NR	Junge et al. 2006 ¹⁴	NR
Lopes, 2019 Portugal ¹⁵	YP	NR	NR	NR	NR	NR
Florit, 2019 Spain ²⁴	Professional YP	64.4** 19.6**	NR	NR	Injuries / 100 players / season	NR
Husen, 2020 Germany ¹⁶	Men Women	9.8 ± 11.1/1000 AE 8.9 ± 14.3/1000 AE	NR	NR	AE definition = n of athletes participating in a game or practice regardless of duration or type of exposure.	NR

*Craniofacial injuries: any damage in head/neck tissues.

**Tendinopathy injuries.

AE: Athlete Exposure, YP: Youth Players, NR: Non-Reported

Table 3 Injury characteristics in RH studies.

First author, year Country (Reference)	Population	Total injuries	Type of injury	Mechanism of injury
Pons, 1991 Spain ¹⁷	NR	NR	NR	NR
Egocheaga, 2004 Spain ²⁰	Professional SP	48	Muscle injuries <i>n</i> = 21 (43.7%), tendon/ligament injuries <i>n</i> = 13 (27.1%), bone injuries <i>n</i> = 5 (10.4%), others <i>n</i> = 9 (18.8%).	9 (18.8%) direct trauma, 22 (45.8%), overuse (including muscle injury), 17 (35.4%) acute injury.
Marques, 2007 Portugal ²¹	International YP	13	NR	NR
Pelaez, 2008 Argentina ¹³	NR	85	Fractures <i>n</i> = 8 (9.4%).	39% contact with stick, 24% elbow, 21% ball, 5% skate, 4% hand, 4% fences, 3% others
Gonçalves, 2008 Portugal ¹⁴	International YP Regional YP	28 53	Joint injuries <i>n</i> = 36 (44.4%), muscle/tendon injuries <i>n</i> = 25 (30.9%), contusions <i>n</i> = 17 (21%), fractures <i>n</i> = 3 (3.7%).	
Pereira, 2013 Portugal ²²	SP and YP	NR	NR	242 (45.1%) acute, 294 (54.9%) overuse.
Durigon, 2014 Italy ¹⁸	NR	NR	NR	NR
Reverter, 2018 Spain ²³	Professional SP Amateur SP	40 48	Muscle injuries <i>n</i> = 22 (25%), fracture <i>n</i> = 20 (22.7%), wound <i>n</i> = 16 (18.2%), sprain <i>n</i> = 6 (6.8%), contusion <i>n</i> = 6 (6.8%), dislocation <i>n</i> = 4 (4.5%), concussion <i>n</i> = 4 (4.5%), others <i>n</i> = 10 (1.4%)	Professional SP: <i>n</i> = 16 (40%) traumatic, <i>n</i> = 24 (60%) overuse Amateur SP: <i>n</i> = 32 (66.7%) traumatic, <i>n</i> = 16 (33.3%) overuse
Lopes, 2019 Portugal ¹⁵	YP	NR	NR	71.9% impact with equipment, 28.1% impact with other athletes.
Florit, 2019 Spain ²⁴	Professional SP Regional YP	47 27	Senior: Adductor tendinopathy <i>n</i> = 8 (17%), hamstring <i>n</i> = 5 (10.6%), shoulder <i>n</i> = 3 (6.4%) YP: Adductor tendinopathy <i>n</i> = 5 (18.5%), shoulder <i>n</i> = 3 (11.1%), hamstring <i>n</i> = 1 (3.7%).	NR
Husen, 2020 Germany ¹⁶	Men and women RH players	2947	Abrasion (23.4%), wrist contusion (7.9%), thigh muscle strain (6.2%), knee contusion (5.4%), cervical muscle strain (5.1%).	NR

NR: Non-Reported; SP: Senior Players; YP: Youth Players.

hamstring in professional players and shoulder tendinopathy in young players.

Two studies presented specific data about craniofacial injuries. Lopes study reported orofacial injuries in 117 Portuguese youth players; 38.5% of the subjects referred an RH-related orofacial trauma. Only four out of the 45 affected

athletes (8.9%) were using a mouthguard at the moment of the accident.¹⁵ Pelaez study reported craniofacial injuries during 119 games of the Argentinean League: in 54 games (45.4%), at least one craniofacial injury was reported. The facial area was the most commonly affected (lips 37%, nose 21%, orbit 21%, chin 11%).¹³

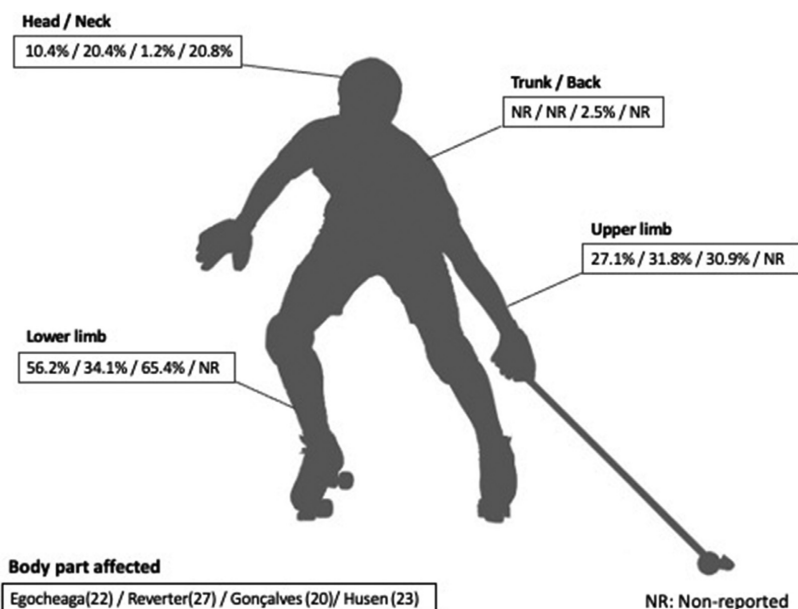


Fig. 2. Most affected body regions reported in RH injury research.

In Husen's study,¹⁶ the knee was the location most likely to cause time-loss injuries (38.5%), followed by foot (14.5%) and hand (13.7%).

The most frequent injured body regions are shown in Fig. 2.

Mechanism of injury

Four studies reported the mechanism of injury. Overuse was the most frequent mechanism of injury in Egocheaga's study²⁰ (20) (45.8%), followed by an acute presentation (35.4%).

In Reverter's study,²³ the leading cause of injury was contact with the stick (22.7%), whereas 13.6% of injuries occurred with no contact. On the contrary, in the German questionnaire,¹⁶ the primary causes of reported injuries were ball contact among men (35.7%) and collisions among women (32.1%).

In Pelaez's study,¹³ craniofacial injuries were caused by contusion with a stick (39%), other players' elbow (24%), ball (21%) or skate (5%). Finally, in Lopes' study (25), most of the impacts were with mobile equipment (71.9%), other athletes (28.1%)

The reported mechanisms of injury are shown in Table 3.

Injury severity

The Husen questionnaire¹⁶ detected a median time loss due to injuries of 0.9 ± 1.4 weeks per player per season and 12.7 ± 20.3 weeks per player career.

In Pereira's questionnaire,²² athletes reported that ankle/feet injuries caused an average time-loss of 13.7 ± 24.2 days, followed by knee injuries (11.1 ± 24.3 days) and groin/hip injuries (10.1 ± 29.9 days).

Pelaez's study¹³ showed that 3% of the 85 craniofacial injuries led to a loss of consciousness, and 16% required a transfer to the hospital, with 9.4% causing fractures.

In the Florit study,²⁴ 64% of the tendinopathies reported did not cause the players to miss practices or matches.

Moderate injuries (7–28 days) were the most frequent in the three studies, following the Junge classification about severity.²⁷ The injury severity is summarized in Table 4.

Experts' opinions

Two articles with experts' opinions on RH hockey were found. The first article¹⁷ was released during the 1992 Olympic Games. The Medical Staff of the Spanish National Team stated that the most frequent injuries were strains in adductor muscles, overuse injuries in anterior tibial muscles, ankle sprains, and wrist injuries in RH players; and knee articulation injuries (the meniscus tear being the most frequent) and hamstring strains in goalkeepers. The quality score of the study was 19% (Table 1).

The Medical Staff of the Italian National Team¹⁸ also released an article in 2014 describing muscle strains in the adductor area and articular injuries in the ankle and knee as the most frequent injuries in RH. Moreover, lower back pain and shoulder tendinopathy were the most frequent overuse injuries. Finally, this study concurred with the Spanish article that the most frequent injury in goalkeepers was the knee articulation injury (meniscus).

Neither studies presented epidemiological data to support these arguments. The quality score of the study was 12,5% (Table 1).

Table 4 Injury severity in RH studies.

First author, year Country (Reference)	Population	Total injuries	Time loss (days) average \pm SD (range)	Mild (1–7 days)	Moderate (7–28 days)	Severe (>28 days)
Pons, 1991 Spain ¹⁷	NR	NR	NR	NR	NR	NR
Egocheaga, 2004 Spain ²⁰	Professional SP	48	NR	NR	NR	NR
Marques, 2007 Portugal ²¹	International YP	13	4.63 \pm 9.43 (1–33)	5 (38.5%)	7 (53.8%)	1 (7.7%)
Pelaez, 2008 Argentina ¹³	NR	85	NR	NR	NR	NR
Gonçalves, 2008 Portugal ¹⁴	International YP	28	31.1 \pm 35.2 (1–115)	11 (39.3%)	13 (46.4%)	4 (14.3%)
Pereira, 2013 Portugal ²²	Regional YP SP & YP	53 NR	38.9 \pm 27.2 (4-79) Ankle/feet injuries 13.8 \pm 24.2	28 (52.8%) NR	22 (41.5%) NR	3 (5.7%) NR
			Knee injuries 11.1 \pm 24.3 Groin/hip injuries 10.1 \pm 29.9			
Durigon, 2014 Italy ¹⁸	NR	NR	NR	NR	NR	NR
Reverter, 2018 Spain ²³	Professional SP	40	NR	6 (15%)	26 (65%)	8 (20%)
Lopes, 2019 Portugal ¹⁵	Amateur SP	48	NR	8 (16.7%)	18 (37.5%)	22 (45.8%)
Florit, 2019 Spain ²⁴	YP Professional SP Regional YP	NR 47 27	NR NR NR	NR NR NR	NR NR NR	NR NR NR
Husen, 2020 Germany ¹⁶	Men and women RH players	2947	0.9 \pm 1.4 weeks per player per season 12.7 \pm 20.3 weeks per player career.	NR	NR	NR

SD: Standard Deviation; SP: Senior Players NR: Non-Reported; YP: Youth Players.

Discussion

Despite a growing scientific interest in RH over the last few years (several studies on physical performance^{2,28,29} or match analysis^{30,31} have been carried out), there are few studies regarding injury profiles or surveillance. Moreover, the articles found in our research had high methodological heterogeneity and small samples. To our knowledge, this is the first systematic review that summarizes the injury profiles of RH players. Our analysis may set a starting point in the study of RH injuries, allowing us to assess real problems and tailor specific prevention programs.^{32,33}

Study design, primary outcome, and objectives

Even though most of the analyzed research is descriptive, design and objective are not reported in five of the 11 studies. According to Nielsen et al.³⁴ failure to be clear about goals may lead to inappropriate, misleading, and flawed conclusions in sports injury research. Therefore, we must encourage that in future research about RH, an optimal study design description must be stated.

Furthermore, none of the included studies presented a high level of evidence, and there were no randomized cohort studies or case-control studies.

Population and definition, collection, and number of injuries

The majority of analyzed studies included male professional RH players. Male youth players were also involved in several reports.^{14,15,21,22,24} On the contrary, female athletes were only incorporated in one study.¹⁶ Moreover, the sample size was generally small and comprehended heterogeneous age groups.

The injuries classified by player position were unavailable in epidemiological studies (despite the goalkeepers' specific injuries mentioned in two experts' opinion articles). Only three studies used standardized injury definition, and data collection sources were heterogeneous (conducted by athletic therapists, athletic trainers, physicians using injury registry databases). Also, all the included articles except for one did not use injury classification tools such as OSICS,³⁵ and this may cause a lack of homogeneity in the categorization of injuries. Thus, better consistency and homogenization in the definitions and methodologies may help compare data across studies.²⁶

Finally, more exhaustive studies, including all ages and female athletes, should be performed to obtain better information about RH's actual injury patterns.

Epidemiological measures of occurrence

Standard measures used to describe the frequency of injury are incidence proportion and incidence rate.³⁶ In a sport-injury context, the numerator is generally the number of injuries or number of injured athletes, while the denominator is often the total number of athletic exposures or hours played during the follow-up period.³⁷

In our systematic review, only two studies used standardized formulas to report injury incidence.^{14,21} That can be a limitation for further investigations because equivalent formulas allow a comparison between populations and data.

The results obtained in the studies involving Portuguese international youth players showed an overall injury rate between 3.23²¹–9.7¹⁴/1000 exposure hours (EH). The match injury incidence ranged from 17.5¹⁴–36.7²¹/1000 EH and the training incidence from 1.77²¹ to 7.5¹⁴/1000 EH. The results can be compared with professional sports, such as ice hockey (15.6/1000 h overall incidence),³⁸ futsal (6.8/1000 h overall incidence, and 44.9/1000 h match incidence);³⁹ handball (6.5/1000 h overall incidence, and 22.2/1000 h match incidence).⁷ Nevertheless, we should consider that there might be differences between senior players and youth players, so the comparison of the results should be made with caution. In a study conducted on American basketball youth players, the overall incidence was 1.94/1000 EH, and the match incidence was 3.27/1000 EH.⁷

As shown, results from other sports demonstrated that injury incidence during matches is higher than during training because of several factors (e.g., the higher physical and physiological demands required in matches compared to training sessions).⁴⁰

Further research must be carried out to confirm this trend in RH with studies on senior players, including female athletes. The final goal will be to implement injury prevention programs.

Despite injury incidence is widely used, injury burden has now been suggested as the most accurate measure to evaluate the impact of injuries in athletes.²⁶ The injury burden should consider the injury and the exposure and time-loss in the equation.⁴¹ Nevertheless, none of the evaluated research in our review calculated the injury burden.

Characteristics of injury (type, body region, mechanism, and severity)

Muscle injuries seem to be the most frequent injury in RH players. None of the studies described the affected muscle groups. Joint injuries seem to be frequent in youth players.²⁰ Nevertheless, only in one study, the injuries were surveilled by medical staff.²⁰

Lower limbs were the most affected body regions, and moderate injuries (7-28 days) were the most frequent.

High prevalence of head injuries

Specific studies have been carried out about injuries in the craniofacial area in RH players since these types of injuries have become a reason of relevant concern in all sports in the last decade.^{42,43} At the moment, no helmet nor mouthguard is mandatory for RH players, although some countries, such as Italy, recommend the use of a helmet in youth players. The Spanish RH Federation (*Real Federación Española de Patinaje*) has presented the project to implement a protective helmet in different categories over the 2021–2022 season.⁴⁴ This implementation is supported by Lopes²² and Pelaez²³ studies concluding that more effective protection gear must be considered for all players to prevent craniofacial injuries. Also, data from other sports support this implementation. Indeed, a helmet is mandatory in ice hockey, where the head is the most reported injured body area.^{45,46} In inline hockey, the helmet is also mandatory, and the reported head injuries are lower.⁴⁷

Groin pain

We found two articles about groin pain in RH players.^{48,49} We excluded them from this systemic review because they did not investigate the epidemiology of RH injuries. Besides, none of them sustained any epidemiological data about groin pain in RH players to justify an investigation about this matter. We think that it is relevant to mention these studies because in a field that is hardly explored, such as RH injuries, the existence of two articles focused on a specific injury reveals a concern.

Limitations

In addition to the limitations of the included studies, there were also limitations in the review process. The search strategy was deliberately broad to identify all original RH-related studies, including reference searches and knowledge from authors with extensive RH research backgrounds. However, it is still possible that large studies reporting on other sports or injuries could have reported on RH within a subgroup analysis.⁵⁰

Despite all limitations, our study sets a starting point in the injury surveillance in RH players, willing to understand the physical implications of this sport better.

Conclusions

Our systematic review revealed that research on RH injuries is sparse and presents high methodological heterogeneity. The studies present relevant methodological issues that do not draw valid comparisons and evaluations to reach conclusions or patterns.

According to the studies included in this review, the most frequent injury was muscle strain; the most frequent mechanism was acute; the most affected body regions were the lower limbs, and the severity was mainly moderate (7–28 days of return-to-play).

Head and neck injuries are reported as a concerning issue, suggesting that further investigations on the effect of appropriate protective equipment are needed.

According to this systematic review, the quality of the reports on injury surveillance has room for improvement. Finally, more research on injury incidence and burden should be performed to implement specific prevention programs and adopt the best countermeasures.

Funding

MC acknowledges the financial support from the Ministry of Science and Innovation and the Ministry of Universities of the Government of Spain (Ref: PID2019-104830RB-I00/AEI DOI: 10.13039/501100011033).

Conflicts of interest

The authors declare that they have no competing financial interests or personal relationships that could have influenced the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.apunsm.2022.100380.

References

1. Moreno D. Anàlisi dels gols en hoquei patins a les lligues espanyola, italiana i portuguesa. Doctoral thesis. Universitat de Barcelona [Barcelona]; 2019.
2. Fernández D, Varo F, Carmona G, Reche X. Quantification of external load of elite rink hockey players in official matches. *J Sports Med Phys Fitness*. 2020;60(12):1520–5.
3. Yagüe P, del Valle M, Egocheaga J, Linnamo V, Fernández A. The competitive demands of elite male rink hockey. *Biol Sport*. 2013;30(3):195–9.
4. Gonçalves L, Clemente FM, Silva B, Mendes B, Lima R, Bezerra P, et al. Variations of season workload and well-being status among professional roller-hockey players: Full season analysis. *Physiol Behav*. 2020;215:112785.
5. Ekstrand J, Hägglund M, Waldén M. Epidemiology of muscle injuries in professional football (soccer). *Am J Sports Med*. 2011;39(6):1226–32.
6. Drakos MC, Domb B, Starkey C, Callahan L, Allen AA. Injury in the national basketball association: a 17 year-overview. *Sports Health*. 2010;2(4):284–90.
7. Borowski LA, Yard EE, Fields SK, Comstock RD. The epidemiology of US high school basketball injuries, 2005–2007. *Am J Sports Med*. 2008;36(12):2328–35.
8. Tuominen M, Stuart MJ, Aubry M, Kannus P, Parkkari J. Injuries in men's international ice hockey: a 7-year study of the International Ice Hockey Federation Adult World Championship Tournaments and Olympic Winter games. *Br J Sports Med*. 2015;49(1):30–6.
9. Nordstrøm A, Bahr R, Talsnes O, Clarsen B. Prevalence and burden of health problems in male elite ice hockey players: a prospective study in the Norwegian professional league. *Orthop J Sports Med*. 2020;8(2):2325967120902407.
10. Popkin C, Schulz B, Park C, Bottiglieri T, Lynch TS. Evaluation, management and prevention of lower extremity youth ice hockey injuries. *Open Access J Sports Med*. 2016;21(7):167–76.
11. Selcuk AA. A guide for systematic reviews: PRISMA. *Turk Arch Otorhinolaryngol*. 2019;57(1):57–8.
12. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg*. 2009;6(7):e1000097.
13. Pelaez EG, Dascenzi PF, Savastano LE, Cremaschi FE. Lesiones craneofaciales producidas en hockey sobre patines. *Rev Arget Neurocir*. 2008;22(4):181–5.
14. Gonçalves BF. Lesões desportivas em Jovens Hoquistas do Escalão Etário 14–16 Anos. Coimbra: Universidade de Coimbra; 2008.
15. Lopes L, Santos M. Mouthguard and orofacial traumatismo in young roller hockey practicers. *Glob J Med Res*. 2013;19(5):5–11.
16. Husen M, Burgsmüller L, Burggraf M, Jäger M, Dudda M, Kauther M. Injuries and overuse syndromes in rink hockey players. *Int J Sports Med*. 2021;42(2):132–7.
17. Pons M, Ferrer H. Lesiones traumatológicas en el hockey sobre patines. *Apunt Educ Fis Deporte*. 1991;23:35–44.
18. Durigon V, Massari G, Pizzi A. Roller hockey. *Med Sport*. 2014;67(1):141–51. (Roma).
19. Burns PB, Rohrich RJ, Chung KC. The levels of evidence and their role in evidence-based medicine. *Plast Reconstr Surg*. 2011;128(1):305–10.

20. Egocheaga J, Yague P, Mones L. Características de la patología lesiva en dos deportes de patinaje. *Med Rehabil.* 2004;17(1):12–6.
21. Marques G. Prevalencia do “Time Low Injury” Em Jovens Hoquistas do Escalao Etário 14–16 Anos. Coimbra: Universidade de Coimbra; 2007.
22. Pereira TM. Avaliação dos Problemas Músculo-Esqueléticos Como Preditores do Estado de Saúde em Atletas de Hóquei em Patins. Coimbra: Instituto Politécnico de Coimbra; 2013.
23. Reverter J, de Vega M, Hernandez V. Occupational injury in Spanish professional roller hockey during two seasons: a comparative study. *J Phys Educ Sport.* 2018;18(3):1767–72.
24. Florit D, Pedret D, Casals M, Malliaras P, Sugimoto D, Rodas G. Incidence of tendinopathy in team sports in a multidisciplinary sports club over 8 seasons. *J Sports Sci Med.* 2019;18(4):780–8.
25. Junge A, Langevoort G, Pipe A, Peytavin A, Wong F, Mountjoy M, et al. Injuries in team sport tournaments during the 2004 olympic games. *Am J Sports Med.* 2006;34(4):565–76.
26. Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, et al. International olympic committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sports 2020 (including the STROBE extension for sports injury and illness surveillance (STROBE-SIIS)). *Orthop J Sports Med.* 2020;8(2):2325967120902908.
27. Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med.* 2006;40(3):193–201.
28. Arboix J, Aguilera J. Comparación entre criterios de pierna dominante y pierna fuerte en hockey patines. *J Sport Health Res.* 2021;13(1):13–22.
29. Arboix-Alió J, Aguilera-Castells J, Rey-Abella F, Buscà B, Fort-Vanmeerhaeghe A. Asimetrías neuromusculares entre miembros inferiores en jugadores de hockey sobre patines. *RICYDE.* 2018;14(54):358–72.
30. Sousa T, Sarmento H, Field A, Vaz V. The perceptions of elite rink hockey head coaches: preparation/observation and intervention. *Int J Perform Anal Sport.* 2021;21(2):277–94.
31. Arboix-Alió J, Buscà B, Aguilera-Castells J, Trabal Taña G, Sánchez-Lopez M-J. Comparison of home advantage in men’s and women’s Portuguese roller hockey league. *CPD.* 2019;20(1):181–9.
32. van Mechelen W, Hlobil H, Kemper HCG. Incidence, severity, aetiology and prevention of sports injuries. *Sports Med.* 1992;14(2):82–9.
33. van Tiggelen D, Wickes S, Stevens V, Roosen P, Witvrouw E. Effective prevention of sports injuries: a model integrating efficacy, efficiency, compliance and risk-taking behaviour. *Br J Sports Med.* 2008;42(8):648–52.
34. Nielsen RO, Simonsen NS, Casals M, Stamatakis E, Mansournia MA. Methods matter and the ‘too much, too soon’ theory (part 2): what is the goal of your sports injury research? Are you describing, predicting or drawing a causal inference? *Br J Sports Med.* 2020;54(22):1307–9.
35. Orchard JW, Meeuwisse W, Derman W, Häggglund M, Soligard T, Schwelnus M, et al. Sport medicine diagnostic coding system (SMDCS) and the orchard sports injury and illness classification system (OSIICS): revised 2020 consensus versions. *Br J Sports Med.* 2020;54(7):397–401.
36. Nielsen RO, Shrier I, Casals M, Nettel-Aguirre A, Møller M, Bolting C, et al. Statement on methods in sport injury research from the 1st METHODS MATTER Meeting, Copenhagen, 2019. *Br J Sports Med.* 2020;54(15):941.
37. Fortington LV, van der Worp H, van den Akker-Scheek I, Finch CF. Reporting multiple individual injuries in studies of team ball sports: a systematic review of current practice. *Sports Med.* 2017;47(6):1103–22. 26.
38. Ruiz-Pérez I, López-Valenciano A, Elvira JL, García-Gómez A, de Ste Croix M, Ayala F. Epidemiology of injuries in elite male and female futsal: a systematic review and meta-analysis. *Sci Med Footb.* 2021;5(1):59–71. 2.
39. Mónaco M, Rincón JAG, Ronsano BJM, Whiteley R, Sanz-Lopez F, Rodas G. Injury incidence and injury patterns by category, player position, and maturation in elite male handball elite players. *Biol Sport.* 2019;36(1):67–74.
40. Castillo D, Raya-González J, Weston M, Yanci J. Distribution of external load during acquisition training sessions and match play of a professional soccer team. *J Strength Cond Res.* 2021;35(12):3453–8.
41. Bahr R, Clarsen B, Ekstrand J. Why we should focus on the burden of injuries and illnesses, not just their incidence. *Br J Sports Med.* 2018;52(16):1018–21.
42. Prien A, Grafe A, Rössler R, Junge A, Verhagen E. Epidemiology of head injuries focusing on concussions in team contact sports: a systematic review. *Sports Med.* 2018;48(4):953–69.
43. Kirkwood G, Parekh N, Ofori-Asenso R, Pollock AM. Concussion in youth rugby union and rugby league: a systematic review. *Br J Sports Med.* 2015;49(8):506–10.
44. La Real Federación Española de Patinaje y Prokover presentan el casco oficial de hockey patines - Hockey Patines [Internet]. [cited 2021 Mar 12]. Available from: <https://fep.es/website/14-13246-la-real-federacion-espanola-de-patinaje-y-prokover-presentan-el-casco-oficial-de-hockey-patines.html>.
45. McKay CD, Tufts RJ, Shaffer B, Meeuwisse WH. The epidemiology of professional ice hockey injuries: a prospective report of six NHL seasons. *Br J Sports Med.* 2014;48(1):57–62.
46. Biasca N, Wirth S, Tegner Y. The avoidability of head and neck injuries in ice hockey: an historical review. *Br J Sports Med.* 2002;36(6):410–27.
47. Moreno-Alcaraz VJ, Cejudo A, Sainz de Baranda P. Injury types and frequency in Spanish inline hockey players. *Phys Ther Sport.* 2020;42:91–9.
48. Vitale JA, Castellini G, Gianola S, Stucovitz E, Banfi G. Analysis of the Christiania stop in professional roller hockey players with and without previous groin pain: a prospective case series study. *Sport Sci Health.* 2019;15(3):641–6.
49. Pampaloni E, Pera E, Maggi D, Lucchinelli R, Chiappino D, Costa A, et al. Association of cetylated fatty acid treatment with physical therapy improves athletic pubalgia symptoms in professional roller hockey players. *Helyion.* 2020;6(7):e04526.
50. McLeod G, O’Connor S, Morgan D, Kountouris A, Finch CF, Fortington LV. Medical-attention injuries in community cricket: a systematic review. *BMJ Open Sport Exerc Med.* 2020;6(1):e000670.

CAPÍTOL 3

ESTUDI II

EPIDEMIOLOGÍA LESIONAL EN LA LIGA ESPAÑOLA DE HOCKEY PATINES MASCULINA Y FEMENINA: UN ESTUDIO DESCRIPTIVO

**Bernat de Pablo
Guillem Trabal
Javier Yanguas
David Dominguez
Gil Rodas
Martí Casals**

Títol: Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo

Paraules clau: Lesiones. Epidemiología. Vigilancia de lesiones

Referència: de Pablo B, Trabal G, Yanguas J, Dominguez D, Rodas G, Casals M. *Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo*. 2022; 39(6): 190-196.

doi: 10.18176/archmeddeporte.00112

A les següents pàgines s'inclou l'article que recull les lesions de tots els jugadors i jugadores participants en la OK Lliga (màxima divisió de l'hoquei patins a Espanya) femenina i masculina durant la temporada 2019/20.

Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo

Bernat de Pablo^{1,2,3}, Guillem Trabal⁴, Javier Yanguas², David Dominguez⁵, Gil Rodas^{2,5}, Martí Casals^{6,7}

¹Hospital Universitari Mutua Terrassa, Terrassa, Barcelona. ²Servicios Médicos F.C. Barcelona, Barcelona. ³Escuela de Doctorado, Universitat de Vic – Universitat Central de Catalunya, Vic, Barcelona. ⁴Facultat d'Educació, Traducció, Esports i Psicologia, Universitat de Vic, Universitat Central de Catalunya, Vic, Barcelona. ⁵Unitat de Medicina de l'Esport, Hospital de Barcelona / Hospital Sant Joan de Déu, Barcelona / Hospital Clínic de Barcelona. ⁶Centre d'Estudis de l'Esport i l'Activitat Física (CEEAF), Facultat de Medicina, Universitat de Vic – Universitat Central de Catalunya, Vic, Barcelona. ⁷Institut Nacional d'Educació Física de Catalunya (INEFC), Universitat de Barcelona, Barcelona.

doi: 10.18176/archmeddeporte.00112

Recibido: 26/04/2022
Aceptado: 13/09/2022

Resumen

El propósito del presente estudio es describir los patrones lesionales durante una temporada de los deportistas de la máxima competición masculina y femenina de Hockey Patines en España.

Se realizó un estudio descriptivo de las lesiones con baja deportiva (el/la deportista no puede participar como mínimo en un entrenamiento o partido debido a la lesión) recogidas por los equipos biomédicos de cada equipo. Se estudiaron 137 deportistas (98 hombres, con una media de edad de $26,7 \pm 5,9$ años y 39 mujeres con una media de edad de $23,3 \pm 4,6$ años). Se recogieron un total de 94 lesiones con baja deportiva, siendo las más frecuentes las lesiones musculares (38 episodios, 40,4% de las lesiones totales), en especial del músculo aductor largo (23 episodios, 60,5% de las lesiones musculares). La mayoría de lesiones registradas fueron leves (1-7 días de baja deportiva) aunque el tiempo medio de baja fue de $19,4 \pm 29,6$ días. Se recogieron 8 episodios de relesión (8,5% de las lesiones totales) y 2 lesiones que precisaron tratamiento quirúrgico (2,1% de las lesiones totales).

Al estudiar a las deportistas femeninas destaca que presentaron un mayor número de lesiones ligamentosas de extremidades inferiores en comparaciones con los varones y no se describió ningún episodio de tendinopatía.

Al estudiar las lesiones específicas de los porteros/as se evidenció que las lesiones que causaban más baja deportiva eran las lesiones de rodilla.

El presente estudio es el primero en describir las lesiones en jugadores/as de primer nivel de hockey patines y debe marcar un punto de partida para el estudio y prevención de las lesiones en este deporte.

Palabras clave:
Lesiones. Epidemiología.
Vigilancia de lesiones.

Injury epidemiology among male and female Spanish rink hockey players: a cross-sectional study

Summary

The purpose of the present study is to describe the injury patterns among male and female athletes of the Spanish Rink hockey league.

A cross-sectional study was performed, concerning the time-loss injuries (the athlete is prevented to participate in a training session / game because of the injury registered by the medical staff of every team). 137 athletes were included (98 male, age 26.7 ± 5.9 years; 39 female, age 23.3 ± 4.6 years).

Ninety-four time-loss injuries were recorded, being the most frequent the muscle injury (38 episodes, 40.4%), especially the ones affecting the adductor longus muscle (23 episodes, 60.5% of the muscle injuries). The majority of the registered injuries were classified as mild (1-7 days of time-loss) but the and the median return-to-play was 19.4 ± 29.6 days. Eight episodes of reinjury were described (8.5% of total injuries) and 2 injuries required surgical treatment (2.1% of total injuries).

Concerning female athletes, we can highlight a increased number of ligament injuries in the lower limbs compared with male athletes and the absence of tendinopathies causing time-loss.

The knee injuries were the injuries with a higher return-to-play in goalkeepers.

The present study is the first to describe the injury patterns among rink hockey elite athletes and must set a starting point to study and prevent injuries in this sport.

Key words:
Time-loss injuries. Roller hockey.
Epidemiology. Injury surveillance.

Correspondencia: Bernat de Pablo Marquez
E-mail: bernatdepablo@gmail.com

Introducción

El hockey patines (HP) es un deporte con gran tradición en España, principalmente en las regiones de Cataluña, Galicia, Asturias y Madrid. La máxima división nacional (OK Liga masculina y femenina) concentra a muchos de los mejores deportistas mundiales, ya que el hockey patines español es el deporte más laureado a nivel internacional, con 17 mundiales masculinos y 7 mundiales femeninos¹.

Se trata de un deporte colectivo, dinámico y complejo donde se enfrentan dos equipos de cinco jugadores (cuatro jugadores de pista y un portero). Los jugadores se deslizan sobre patines clásicos (dos pares de ruedas paralelas) y utilizan un stick para propulsar una bola sólida y redonda con el fin de anotar gol¹. El HP se considera un deporte de contacto debido a la fácil interacción entre los elementos dinámicos (pelota y stick) y estáticos (vallas y portería) del juego, que aumentan el riesgo de contacto entre participantes²⁻⁴. Existen factores que diferencian el HP de otros deportes indoor: (i) la velocidad que alcanzan los deportistas es muy alta (hasta 30 km/h) en comparación con otros deportes⁵, (ii) el uso de ruedas paralelas causa diferentes mecanismos de giro y frenado, en comparación con otros deportes de patinaje como el hockey en línea o el hockey hielo³, (iii) la velocidad de la bola, que puede alcanzar los 115 km/h^{4,5}. Se debe tener en cuenta también que la figura del portero presenta unas características diferentes al jugador de pista, ya sea por postura, movilidad y por el hecho de tener como objetivo defender una bola que se desplaza a grandes velocidades^{6,7}. Considerando estos factores, se puede considerar que el HP es un deporte con un elevado riesgo de lesión musculoesquelética^{8,9}, lo que puede influir en el rendimiento de los deportistas y en su recuperación.

Pese que existen pocos estudios relacionados con la epidemiología lesional del hockey patines, la literatura científica disponible apunta a un elevado riesgo de lesiones, principalmente secundarias a traumatismos^{8,10,11}. De todos modos, los estudios existentes hasta el momento son estudios descriptivos basados en muestras muy pequeñas y heterogéneas.

Las lesiones deportivas con baja deportiva (*time-loss injuries*, TLI) pueden influir en el rendimiento deportivo y la salud del deportista, así como en los resultados colectivos de los equipos¹². Los programas de vigilancia de lesiones permiten analizar los patrones lesionales de un deporte, establecer la magnitud del problema, definir un primer paso para la creación de programas de prevención de lesiones y conocer nuevos problemas para conocer más en profundidad el patrón lesional de los atletas^{12,13}.

El objetivo del presente estudio es describir los patrones de lesión con baja deportiva (*time loss injuries*) en los participantes en la máxima división española (OK Liga) masculina y femenina de HP durante toda una temporada.

Material y método

Diseño del estudio

Estudio descriptivo usando un muestreo no probabilístico intencional de 14 equipos de la OK Liga masculina y femenina, máxima categoría senior española de HP (10 equipos de la primera división sénior masculina [SM] y cuatro equipos de la primera división sénior femenina

[SF]). La OK Liga masculina y femenina en la temporada 2020/21 estaban constituidas por 16 equipos cada una.

Se estudiaron 137 deportistas. 98 SM (71,5% de la muestra), con una media de edad de $26,7 \pm 5,9$ años (rango: 18,1 – 45,2) y 39 SF (28,5%), con una media de edad de $23,3 \pm 4,6$ años (rango: 15,9 – 35,2). Del total de 98 SM, 78 (79,6%) eran jugadores de pista y 20 (20,4%) eran porteros y de las 39 SF, 32 (82%) eran jugadoras de pista y 7 (18%) porteras.

Para que los deportistas fueran incluidos en el estudio debían cumplir los siguientes criterios: el deportista debía jugar en el equipo senior y formar parte de la plantilla original del mismo. Los deportistas de categorías inferiores que sólo participaran ocasionalmente en los entrenamientos/partidos fueron excluidos.

Todos los deportistas dieron su consentimiento para la recolección de los datos lesionales. El estudio se diseñó de acuerdo con la Declaración de Helsinki¹⁴ y fue aceptado por el Comité de Ética (código 014/CEICGC/2021).

Datos

El registro de los datos de los deportistas y las características lesionales fueron reportados por el equipo médico de cada equipo durante toda la temporada 2020/21, iniciándose la recogida el primer día de pretemporada y finalizándose en el último partido de la temporada. El número de partidos oficiales de la temporada osciló entre 35 y 45 en función de los resultados deportivos.

La información clínica referente al tipo de lesión, mecanismo de lesión y días de baja deportiva fueron registrados en una plantilla común previamente diseñada.

Las lesiones no relacionadas con el HP y las ausencias relacionadas con enfermedades médicas u otros motivos no fueron registradas.

Definiciones, categorías y cálculo de incidencia lesional

Las lesiones fueron clasificadas siguiendo la *Orchard Sports Injury Classification System* (OSICS) versión 10¹⁵. El tipo de lesión, localización y aparición fueron recogidos siguiendo el Consenso del Comité Olímpico Internacional¹³. Los conceptos de lesión con baja deportiva (*time-loss injury*) y regreso a la actividad deportiva (*return-to-play*, RTP) fueron recogidos basándose en las definiciones sugeridas por la *Union of European Football Associations* (UEFA)^{16,17}.

Las definiciones utilizadas en el estudio se muestran en la Tabla 1.

Análisis estadístico

Se llevó a cabo un análisis descriptivo de las lesiones *time-loss* calculando la frecuencia absoluta y frecuencia relativa en relación al número total de lesiones en cada categoría de interés para las variables cualitativas.

En el caso de las variables cuantitativas, se calcularon medidas resumen de tendencia central (media) y de dispersión estadística (desviación estándar y rango).

Calculamos las medidas resumen de las incidencias *time-loss* según la fórmula $i=n/e$, donde n es el número de lesiones durante el período de estudio y es el número respectivo de atletas expuestos (AE) o participantes), con proporciones de incidencia presentadas como lesiones

por 100 jugadores por temporada. Además, se calculó la razón de incidencia acumulada (*Cumulative incidence ratio* (CIR)) para comparar las proporciones de incidencia lesional entre ambos sexos. Para el cálculo de incidencias y medida de asociación CIR se ha utilizado la función *pois.exact* de la librería *epitools* y la función *epi.2by2* de la librería *epiR* en R, respectivamente. En estos cálculos se estima la incidencia e intervalos de confianza al 95% mediante una distribución de Poisson. Todos los análisis se realizaron utilizando SPSS v21 y el paquete estadístico R (The R Foundation for Statistical Computing, Viena, Austria), versión 3.4.

Resultados

Lesiones totales (*time-loss injuries*)

Se registraron un total de 94 lesiones con baja deportiva (*time-loss injuries*, TLI), 61 (64,9%) en SM y 33 (35,1%) en SF.

La media de TLI por deportista y temporada fue de $0,7 \pm 0,9$ ($0,6 \pm 0,8$ en SM y $0,9 \pm 1$ en SF). Una SF padeció 4 TLI durante la temporada, 6 deportistas sufrieron 3 TLI (4 SM y 2 SF), 14 deportistas sufrieron 2 TLI (9 SM y 5 SF), 44 deportistas sufrieron 1 TLI (31 SM y 13 SF). 51 deportistas (37,2% del total) no padecieron ninguna lesión durante la temporada 2020/21. En jugadores de pista la media de lesiones fue de $0,7 \pm 0,9$ y en porteros de $0,4 \pm 0,7$.

Se recogieron una media de $6,7 \pm 3,22$ (rango 3-13) TLI por equipo y temporada. La media en los equipos masculinos fue de $6,1 \pm 3$ (rango 3-11) y en equipos femeninos $8,2 \pm 3,6$ (rango 5-13).

Frecuencias relativas

Las TLI más frecuentes fueron las lesiones musculares, con 38 (40,4%) episodios. Las lesiones musculares afectaron principalmente al muslo, con 30 (31,9%) episodios de lesión muscular en esta localización, de las cuáles 23 afectaron al músculo aductor largo, 4 al recto anterior, 2 al músculo grácil y 1 al músculo semitendinoso. Se cuantificaron 11 (11,7%) lesiones tendinosas, siendo todas ellas diagnosticadas en varones (Tabla 1).

La mayoría de las lesiones afectaron a las extremidades inferiores (68,1%), seguido por la extremidad superior (15,9%), cabeza y cuello (11,7%) y tronco (6,4%). En la extremidad inferior la localización más frecuente fue el muslo, con 34 lesiones (36,2%), seguido por la rodilla con 13 (13,8%) y el tobillo con 8 (8,5%).

Se registraron un total de 53 (56,4%) TLI durante los entrenamientos y 41 (43,6%) durante los partidos. Diferenciando por género, de las 61 TLI registradas en la liga masculina 37 (60,6%) acontecieron durante entrenamientos y 24 (39,4%) durante partidos. En la liga femenina se constataron más lesiones durante partidos ($n=17$, 51,5%) que durante entrenamientos ($n=16$, 48,5%) De las lesiones sin contacto la mayoría se produjeron durante los entrenamientos ($n=40$, 64,5%). De las lesiones por contacto, en cambio, la mayoría se produjeron durante los partidos ($n=22$ 68,7%) (Tabla 2).

La localización de las lesiones catalogadas por posición de juego y género se muestran en la Figura 1.

Se produjeron 8 episodios de relesión, 2 de ellos en un mismo jugador. El índice de relesión fue del 9,3% de las lesiones. Tres relesiones se dieron por episodios de osteopatía dinámica de pubis y 3 episodios por reaparición de lesiones musculares en el músculo aductor largo.

Proporción de incidencia

La Tabla 3 muestra la proporción de incidencia de las TLI descritas en el estudio.

La proporción de incidencia lesional total fue de 68,6 (IC 95% 61,2-76,8) lesiones/100 deportistas/temporada, siendo mayor en jugadoras de pista mujeres, 90,6 (IC 95% 81,1-101,3), que en jugadores de pista hombres 67,9 (IC 95% 58,3-79,1). La razón de proporciones de incidencias (CIR) entre jugadores de pista de ambos sexos de lesionarse para todo el período de estudio fue de 1,33 (IC 95%, 1,10-1,61), lo que indica que las jugadoras tenían 1,33 veces más probabilidades de lesionarse que los jugadores de pista masculino.

La incidencia de lesión muscular fue de 32,8 (IC 95% 25,2-42,5), siendo 26,4 (IC 95% 27,1-48,9) en varones y 25,6 (IC 95% 15-43,8) en mujeres.

Tabla 1. Definiciones utilizadas en el estudio.

Concepto	Definición
<i>Time-loss injury</i>	Cualquier dolencia física manifestada por el deportista que apareciera durante un entrenamiento o partido que obligara al deportista a ausentarse del siguiente entrenamiento o partido ^{16,17} .
<i>Return-to-play</i>	Tiempo de ausencia (en días) desde el día de la lesión hasta que el deportista puede participar de nuevo en un partido o sesión de entrenamiento completa ^{16,17} .
Re-lesión	Cualquier lesión del mismo tipo y en el mismo sitio anatómico que una lesión del mismo individuo los dos meses posteriores al RTP ¹⁷ .
Incidencia lesional	Calculado acorde a la fórmula $i=n/e$ donde n es el número de lesiones durante el período de estudio y e era el número de Atletas Expuestos (AE) con una proporción de incidencia presentada en lesiones por 100 deportistas por temporada ¹⁸ .
Severidad	La severidad de las lesiones fue clasificada según el RTP en leve (1 a 7 días), moderada (8 a 28 días) o severa (>28 días) siguiendo la clasificación de Van Mechelen <i>et al.</i> ¹² .
Aparición	Clasificándose en Aparición aguda o progresiva ¹⁵ .
Mecanismo causal	Clasificándose en sobreuso o traumatismo directo (con un rival o con un objeto del juego) ¹⁵ .

Adaptado de Tuominen *et al.* 2015¹⁹.

Figura 1. Localizaciones más frecuentes de TLI en jugadores de pista (izquierda) y porteros (derecha).

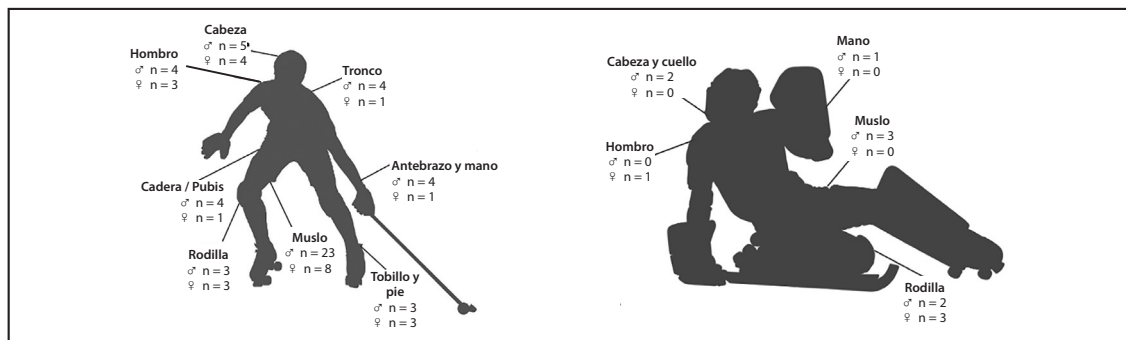


Tabla 2. Características de las lesiones.

	Total N (%)	SM N (%)	SF N (%)
Total lesiones	94	61	33
Momento			
Entrenamiento	53 (56,4%)	37 (60,6%)	16 (48,5%)
Partido	41 (43,6%)	24 (39,3%)	17 (51,5%)
Tipo de lesión			
Muscular	38 (40,4%)	28 (45,9%)	10 (30,3%)
Contusión/herida	16 (17%)	7 (11,5%)	9 (27,3%)
Ligamentosa	12 (12,8%)	5 (8,2%)	7 (21,2%)
Tendinosa	15 (15,9%)	11 (18%)	-
Fractura	7 (7,4%)	5 (8,2%)	2 (6%)
Artritis	6 (6,4%)	2 (3,3%)	4 (12,1%)
Luxación	4 (4,2%)	4 (6,5%)	-
Onset			
Sobreuso aparición aguda	28 (29,7%)	16 (26,3%)	12 (35,2%)
Sobreuso aparición progresiva	34 (36,2%)	26 (42,6%)	8 (23,5%)
Traumatismo	32 (34,1%)	19 (31,1%)	13 (38,3%)
Mecanismo			
Sin contacto	62 (66%)	43 (70,5%)	19 (57,6%)
Contacto con deportista	10 (10,6%)	5 (8,2%)	5 (15,1%)
Contacto con objeto	22 (23,4%)	13 (21,3%)	9 (27,3%)
Severidad			
Leves (1-7 días)	46 (48,9%)	25 (41%)	21 (63,6%)
Moderadas (8 a 28 días)	28 (29,8%)	20 (32,8%)	8 (24,2%)
Graves (>28 días)	20 (21,3%)	16 (26,2%)	4 (12,1%)

Figura 2. Posiciones iniciales utilizadas por el portero. A la izquierda, rodilla en el suelo, a la derecha, en posición de media pantalla (fuente propia).



Clasificando por severidad, 46 lesiones fueron consideradas leves (1-7 días de RTP), 28 fueron consideradas moderadas (7-28 días de RTP) y 20 fueron consideradas graves (>28 días de RTP) (Tabla 2).

Las lesiones musculares presentaron un RTP promedio de 18,6 ± 25,2 (rango 1-90, moda 2), siendo 15 moderadas, 14 leves y 9 graves.

Dentro de la severidad de la lesión, diferenciamos de manera especial aquellas que requirieron de una operación quirúrgica. Estas representaron un 2,1% de las lesiones registradas (n=2), con una incidencia de 1,72 (IC 95% 4,4-68,1). Las dos lesiones quirúrgicas registradas en nuestro estudio fueron dos luxaciones glenohumorales, con un tiempo de RTP de 105 y 185 días respectivamente.

En porteros, las lesiones con un RTP más prolongado fueron las que afectaron a la rodilla, con un RTP promedio de 28,6 días ± 37,8 (rango 4-95).

Discusión

El objetivo del presente estudio es describir los patrones de lesión en los participantes en la primera división española (OKLiga) masculina y femenina de HP durante toda una temporada.

En primer lugar, debemos destacar que existen estudios previos sobre epidemiología lesional en deportistas masculinos de HP, pero no existe ningún estudio previo con deportistas femeninas. Así, los

La incidencia de lesión tendinosa fue de 9,5 (IC 95% 5,4-16,6). De las 11 lesiones tendinosas, 7 afectaron a los músculos aductores del muslo.

La incidencia lesional en porteros fue 44,4 (IC 95% 29,1-67,7). 40 en SM (IC 95% 23,4-68,4) 57,1 en SF (IC 95% 30,1-108,5). La incidencia lesional en jugadores de pista fue 74,5 (IC 95% 66,8-83,1).

Return-to-play y severidad

El RTP de las lesiones descritas fue de 19,4 ± 29,6 (rango 1-185, moda 2), siendo de 23,5 ± 34,6 (rango 1-185, moda 2) en SM y de 11,7 ± 14,3 (rango 1-60, moda 2) en SF.

Tabla 3. Proporciones de incidencia de las TLI según las características de la lesión y las características del/la deportista.

		Total	Senior masculino				Senior femenino			
			Jugadores de pista		Porteros		Jugadoras de pista		Porteras	
		N	N	Incidencia (95% IC)	N	Incidencia (95% IC)	N	Incidencia (95% IC)	N	Incidencia (95% IC)
Lesiones totales		94	53	67,9 (58,3-79,1)	8	40 (23,4-68,4)	29	90,6 (81,1-101,3)	4	57,1 (30,1-108,5)
Momento	Entrenamiento	54	36	46,1 (36,3-58,7)	3	15 (5,2-42,6)	12	37,5 (23,9-58,6)	3	42,8 (18,2-100,8)
	Partido	40	18	23,1 (15,4-34,6)	5	25 (11,7-53,4)	16	50 (35,4-70,7)	1	14,2 (2,3-87,6)
Aparición	Sobreuso agudo	29	14	17,9 (11,2-28,8)	3	15 (5,3-42,6)	10	31,2 (18,7-52,2)	2	28,6 (8,8-92,2)
	Sobreuso progresivo	34	25	32 (23,2-44,3)	1	5 (0,7-33,8)	7	21,8 (11,4-42,1)	1	14,3 (2,3-87,6)
	Trauma	31	13	16,7 (10,1-27,4)	4	2 (0,8-48)	12	37,5 (23,9-58,6)	2	28,6 (8,8-92,2)
Mecanismo	Sin contacto	62	40	51,2 (41,3-63,7)	3	15 (5,3-42,6)	16	50 (35,3-70,7)	3	42,8 (18,2-100)
	Contacto con atleta	14	6	7,7 (3,5-16,7)	0	-	8	25 (13,7-45,6)	0	-
	Contacto con objeto	18	8	10,2 (5,3-19,7)	4	20 (8,3-48)	5	15,6 (7-34,9)	1	14,3 (2,3-87,7)
Severidad	Leve	47	21	26,9 (18,7-38,8)	4	20 (8,3-48)	19	59,4 (44,6-79,1)	3	42,8 (12,82-100,8)
	Moderado	28	19	24,3 (16,5-36)	1	5 (0,7-33,8)	7	21,9 (11,4-42,1)	1	14,2 (2,3-87,6)
	Severo	20	13	16,7 (10,1-27,3)	3	15 (5,3-42,6)	4	12,5 (4,9-31,3)	0	-
Tipo de lesión	Muscular	38	25	32 (23,2-44,3)	2	10 (2,7-37,2)	10	31-2 (18,7-52,2)	0	-
	<i>Aductor longus</i>	23	17	21,8 (14,3-33,2)	0	-	5	15,6 (7-34,9)	0	-
	<i>Rectus femoris</i>	4	1	1,2 (0,1-8,9)	0	-	3	9,8 (3,2-27,5)	0	-
	Contusión / herida	16	3	3,8 (1,3-11,6)	3	15 (5,2-42,6)	9	28,1 (16,1-48,9)	1	14,3 (2,3-87,7)
	Esguince	13	3	3,8 (1,3-11,6)	2	10 (2,7-37,2)	6	18,7 (9,1-38,5)	2	28,6 (8,8-92,2)
	Tendinopatía	11	11	14,1 (8,1-24,4)	0	-	0	-	0	-
	Fractura	6	4	5,1 (1,9-13,3)	1	5 (0,7-33,8)	1	3,1 (0,5-21,5)	0	-
	Artritis	5	2	2,6 (0,6-10)	0	-	2	6,2 (1,6-23,9)	1	14,3 (2,3-87,7)
	Luxación	5	4	5,1 (1,9-13,3)	0	-	1	3,1 (0,5-21,5)	0	-

resultados obtenidos en deportistas masculinos serán comparados con los resultados publicados hasta el momento y los resultados obtenidos en deportistas femeninas serán utilizados para definir un punto de partida para el estudio de lesiones en dicha población de deportistas. En segundo lugar, en ninguno de los estudios publicados previamente sobre lesiones en HP se incluían deportistas de diferentes equipos de la misma liga, permitiendo ampliar la muestra y evitar sesgos.

En cuanto al número de TLI por temporada, los dos únicos estudios publicados hasta el momento en el ámbito de la primera división española (en equipos masculinos) mostraron una media superior de lesiones por jugador y temporada (dos TLI por jugador y temporada en el estudio de Reverter⁸ y 1,1 TLI por jugador y temporada en el estudio de Egocheaga¹⁰).

Los dos equipos que se proclamaron campeones de liga fueron los que sufrieron más lesiones (11 en la liga masculina y 13 en la liga femenina), ello se podría explicar por el mayor número de partidos, al ser los dos equipos que llegaron a las finales fueron los que más partidos oficiales disputaron. Aún así, al no disponer de los datos de horas de entrenamientos no se puede determinar una causalidad con la mayor exposición.

Respecto a la localización anatómica más frecuente, los resultados obtenidos confirman la tendencia de estudios previos, donde la extremidad inferior era la zona más frecuentemente afectada, seguida de la extremidad superior y la cabeza y cuello^{8,10}.

La lesión muscular fue la más frecuentemente descrita en el estudio, concordando con dos publicaciones previas en deportistas españoles^{8,10}. En ninguno de dichos estudios se definieron los músculos afectados ni la severidad de las lesiones. Los resultados presentados permiten concluir que el músculo más afectado en los jugadores de HP es el aductor largo, con 23 de las 38 lesiones musculares descritas y una incidencia de 19,8 (IC 95% 13,7-28-6). Se describieron también 11 lesiones tendinosas, para una incidencia de 9,5 (IC 95% 5,4-16,6) y los músculos más frecuentemente afectados fueron los aductores del muslo. En el estudio de Florit²⁶ donde se estudió la incidencia de tendinopatía en un equipo profesional de HP durante 8 temporadas la incidencia de tendinopatías que acarrearán time-loss fue de 10,7 (IC 95% 9,5-12), por lo que los resultados fueron similares. En dicho estudio la zona más frecuentemente afectada fue también la zona aductora del muslo.

Con los resultados obtenidos podemos concluir que la región del pubis es la más susceptible a lesiones musculares y tendinosas en HP.

Dichos resultados concuerdan con estudios publicados en hockey hielo, deporte de patinaje extensamente estudiado, donde dicha zona concentra la mayoría de las lesiones por sobreuso¹⁹.

Mecanismo

La mayoría de las lesiones registradas se han producido sin contacto, dichos resultados coinciden con el estudio de Reverter⁸, realizado en un solo equipo de OK Lliga, con una proporción similar. Estudios publicados en deportes biomecánicamente similares, como el hockey línea²⁰ o el hockey hielo¹⁹ constataron que la mayoría de lesiones descritas se daban por contacto directo. La normativa del HP, que castiga de forma severa el contacto en comparación las otras disciplinas del patinaje, puede favorecer dichas diferencias.

Al analizar el mecanismo causal de las lesiones constatamos que las lesiones sin contacto se produjeron en mayor medida en entrenamientos, mientras que en competición ocurrió lo contrario, siendo más frecuentes las lesiones por contacto. Ello se explica por la propia naturaleza de la actividad, teniendo la competición un mayor contacto y exigencia que el entrenamiento. Dicha tendencia se ha visto en otros deportes como el fútbol²¹ pero no se había estudiado previamente en HP y permite llegar a la conclusión que no se entrena como se juega.

Lesiones craneales

En el mundo del HP ha crecido en los últimos años la preocupación por las lesiones craneales y las consecuencias que ellas puedan tener en los deportistas. Dicha preocupación ha llevado a algunas federaciones nacionales a promover el uso de casco protector en categorías inferiores²². Estudios previos^{9,23} han demostrado que las lesiones craneofaciales son frecuentes en el HP, aunque no especificaron si se realizaban estudios entre los deportistas de primer nivel. En el estudio de Reverter⁸ se registraron dos episodios de conmoción cerebral y 14 contusiones y heridas en región craneofacial durante dos temporadas en 23 deportistas, con una incidencia de 39,1 (IC 95% 31,5-48,5).

Los resultados obtenidos detectaron nueve TLI que afectaran la cabeza, con una incidencia de 7,7 (IC 4,1-14,5), menor que en el estudio de Reverter, con un solo episodio de conmoción cerebral. Las diferencias con el estudio de Pelaez⁹ que incluía deportistas amateurs y de categorías inferiores y presentaba una elevada tasa de conmoción cerebral se podría explicar con la mayor habilidad del deportista profesional tanto a nivel de patinaje como a nivel del manejo de la bola y el stick: en otros deportes como el patinaje en línea se ha demostrado que una mayor inexperiencia en el patinaje aumenta el riesgo de lesiones^{20,25}.

Pese que la concienciación sobre las lesiones craneales está creciendo mucho en el mundo del deporte, existe un riesgo de infradiagnóstico, tanto por parte de los deportistas como de los equipos médicos²⁴. Es importante que las federaciones faciliten información a los atletas, cuerpos técnicos, equipos médicos e incluso familias, con el fin de mantener una actitud vigilante sobre los traumatismos craneales y las potenciales consecuencias de los mismos a largo plazo²⁵.

Lesiones en deportistas femeninas

Las tendencias mencionadas anteriormente, como la localización más frecuente y el mecanismo causal, se asemejan a los deportistas

masculinos. Pese a ello, las jugadoras de pista presentaron 1,33 veces más riesgo de lesionarse que los jugadores de pista.

De los resultados obtenidos, cabe destacar que en las deportistas femeninas se evidenciaron más lesiones en partidos que en entrenamientos. Dicho resultado puede ser debido a que, pese que los equipos femeninos compiten a máximo nivel, no son profesionales y el volumen de entrenamiento no es el mismo que en equipos profesionales masculinos. Dicha afirmación se debería ver confirmada con un estudio de las horas de exposición tanto a entrenamiento como a partidos de equipos masculinos y femeninos.

Cabe destacar también que se han registrado una proporción más elevada de lesiones ligamentosas en extremidades inferiores, principalmente de rodilla y tobillo, en comparación con el sexo masculino.

Por último, no se han evidenciado tendinopatías por sobreuso. Dicho hallazgo no se ha visto en otros deportes de patinaje y debería ser estudiado con más profundidad.

Lesiones en porteros/as

La posición de portero/a en HP, además de ser clave para el desarrollo del deporte²⁶, tiene una serie de particularidades que obligan a estudiarla de forma diferencial respecto a los jugadores de campo. La posición que adoptan los porteros, alternando una posición recostada en el suelo con una posición de rodilla al suelo (Figura 2) provoca un mayor stress sobre la zona de las rodillas siendo más frecuentes las lesiones en dicha localización en comparación con los jugadores de campo.

Dado que los porteros utilizan protecciones, las lesiones por contusión directa han sido menos frecuentes que en jugadores de pista. Ello rompe el estereotipo expuesto por Trabal⁶ que el rol de portero es más peligroso que la del jugador de campo.

Así pues, se deberían crear estrategias de prevención para evitar lesiones de rodilla en los porteros de HP. Igualmente, se deberían buscar herramientas de mejora para la protección de la región cervical en estos deportistas.

Limitaciones

El estudio se realizó durante la temporada 2020/21, marcada por la pandemia mundial de COVID-19. Los casos COVID-19 y los confinamientos preventivos presentados durante la temporada pudieron interrumpir los entrenamientos y partidos de los equipos, con una potencial afectación de su rendimiento.

Se desconoce hasta el momento los efectos que pueda tener la infección por SARS-COV2 en el rendimiento de los deportistas. No se correlacionaron los resultados obtenidos con la infección por SARS-COV2.

La variabilidad en la configuración de los equipos médicos de cada club pudo hacer variar los procesos diagnósticos y terapéuticos de las lesiones.

No se dispone de las horas de exposición en entrenamientos y partidos por lo que no se permite un cálculo óptimo de la incidencia lesional (tasa de incidencia lesional). Aunque el objetivo de nuestro estudio es solamente descriptivo (no comparativo) además de contener poca muestra, en este trabajo se ha evaluado una medida de asociación CIR para calcular la razón de proporción de incidencias entre jugadores y

jugadoras de pista. El riesgo de lesionarse entre las jugadoras vs jugadores parece ser relevante. Aun así, en futuros estudios sería recomendable poder disponer de información de tasas de incidencia con horas de exposición y así poder calcular tanto medidas de frecuencia como de asociación para ser más rigurosos con estos hallazgos.

Aplicaciones prácticas

En equipos de la máxima división de hockey patines en España la lesión muscular es la más frecuente, destacando las lesiones del músculo aductor largo. Dichas lesiones tienen incidencia sobre la disponibilidad para entrenar/jugar de los deportistas, por lo que sería adecuado diseñar protocolos de prevención para este tipo de lesiones.

Las lesiones traumáticas son especialmente frecuentes en el deporte, debido a su propia naturaleza. Las lesiones traumáticas en la cabeza son un motivo de preocupación y es importante realizar una monitorización de las estrategias de prevención (casco de protección) pendientes de implantación por parte de los estamentos reguladores del hockey patines.

Por primera vez se definen las lesiones más frecuentes en las jugadoras de hockey patines. Los resultados deben ser un punto de partida para ampliar los estudios en esta población de deportistas.

Agradecimientos

A Marc Bosqué, Marc Godayol, Vicenç Rizo, Jordi Boada, Pedro Abal, Aleix Rovira, Roger Sotelino, Marc Pi, Adrià Gimenez, Pol Parareda, Ramón Fernández por su ayuda en la recolección de datos.

Conflicto de interés

Los autores no declaran conflicto de interés alguno.

Bibliografía

- Moreno D. *Anàlisi dels gols en hoquei patins a les lligues espanyola, italiana i portuguesa*. Tesis doctoral. Universitat de Barcelona, Barcelona, 2019.
- Fernández D, Varo F, Carmona G, Reche X. Quantification of external load of elite rink hockey players in official matches. *J Sports Med Phys Fitness*. 2020;60:1520-5.
- Vitale JA, Castellini G, Gianola S, Stucovitz E, Banfi G. Analysis of the christiania stop in professional roller hockey players with and without previous groin pain: a prospective case series study. *Sport Sci Health*. 2019;15:641-6.
- Vaz M, Ramos N, Abrantes J, Queiros de Melo F, Conceição F. Biomechanics of the penalty stroke in roller hockey. *Rev Port Cienc Desporto*. 2011;2:129-32.
- Ballester E. *El hockey sobre Patines: Variables del rendimiento en el disparo a portería*. Tesis doctoral. Universitat de Lleida, Lleida, 2017.
- Trabal Tañá G. *Estudi etnogràfic del porter d'hoquei sobre patins: una vida entre paradoxes*. *Apunts Sport Med*. 2016;126:23-9.
- Trabal G, Riera J. Goalkeeper effectiveness in the direct free hit of rink Hockey. *Apunts Sport Med*. 2020;139:56-64.
- Reverter J, de Vega M, Hernandez V. Occupational injury in spanish professional roller hockey during two seasons: a comparative study. *J Phys Educ Sport*. 2018;18:1767-72.
- Pelaez EG, Dascenzi PF, Savastano LE, Cremaschi FE. Lesiones craneofaciales producidas en hockey sobre patines. *Rev Arget Neurocir*. 2008;22:181-5.
- Egocheaga J, Yague P, Mones L. Características de la patología lesiva en dos deportes de patinaje. *Med Rehab*. 2004;17:12-6.
- Husen M, Burgsmüller L, Burggraf M, Jäger M, Dudda M, Kauther M. Injuries and overuse syndromes in rink hockey players. *Int J Sports Med*. 2021;42:132-7.
- Van Mechelen W, Hlobil H, Kemper HCG. Incidence, severity, aetiology and prevention of sports injuries. *Sports Med*. 1992;14:82-99.
- Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, et al. International olympic committee consensus statement: Methods for recording and reporting of epidemiological data on injury and illness in sports 2020 (Including the STROBE extension for sports injury and illness surveillance (STROBE-SIIS)). *Orthop J Sports Med*. 2020;8:2325967120902908.
- World medical association declaration of Helsinki. *JAMA*. 2013;310:2191-4.
- Orchard J. Revision, uptake and coding issues related to the open access Orchard Sports Injury Classification System (OSICS) versions 8, 9 and 10.1. *Open Access J Sports Med*. 2010;1:207-14.
- Hagglund M. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *Br J Sports Med*. 2005;39:340-6.
- Ekstrand J, Hagglund M, Walden M. Injury incidence and injury patterns in professional football: the UEFA injury study. *Br J Sports Med*. 2011;45:553-8.
- Florit D, Pedret D, Casals M, Malliaras P, Sugimoto D, Rodas G. Incidence of tendinopathy in team sports in a multidisciplinary sports club over 8 seasons. *J Sports Sci Med*. 2019;18:780-8.
- Tuominen M, Stuart MJ, Aubry M, Kannus P, Parkkari J. Injuries in men's international ice hockey: a 7-year study of the international ice hockey federation adult world championship tournaments and olympic winter games. *Br J Sports Med*. 2015;49:30-6.
- Moreno-Alcaraz VJ, Cejudo A, Sainz de Baranda P. Injury types and frequency in spanish inline hockey players. *Phys Ther Sport*. 2020;42:91-9.
- Noya J, Sillero M. Epidemiología de las lesiones en el fútbol profesional español en la temporada 2008-2009. *Arch Med Deporte*. 2012;29:750-66.
- Real Federación Española de Patinaje. www.fep.es. Consultado 1 de febrero 2022.
- Lopes L, Santos M. Mouthguard and orofacial traumatismo in young roller hockey practitioners. *Global J Med Res*. 2013;19:5-11.
- Meehan WP, Mannix RC, O'Brien MJ, Collins MW. The prevalence of undiagnosed concussions in athletes. *Clin J Sport Med*. 2013;23:339-42.
- Schmidt JD, Welch D, ML Weber, Bierema L, Miller LS, Courson R, et al. Coach, sports medicine, and parent influence on concussion care seeking intentions and behaviors in collegiate student-athletes. *J Clin Transl Res*. 2020;5:215-26.
- Trabal G, Daza G, Arboix J. Influencia de las variables contextuales en la intervención del portero de hockey patines en la falta directa. *Cuad Psicol Deporte*. 2020;20:139-51.

CAPÍTOL 4

ESTUDI III

TIME-LOSS INJURIES AMONG MALE AND FEMALE SPANISH RINK HOCKEY PLAYERS

**Bernat de Pablo
Isaac Subirana
Marcos Quintana
Gil Rodas
Martí Casals**

Títol: Time-loss injuries among male and female Spanish rink hockey players

Paraules clau: Lesiones. Epidemiología. Vigilancia de lesiones

Referència: de Pablo B, Subirana I, Quintana M, Rodas G, Casals M. Time-loss injuries among male and female Spanish rink hockey players. En revisió a la revista *International Journal of Sports Medicine*.

A les següents pàgines s'inclou l'article que recull les lesions de tots els jugadors i jugadores participants en la OK Lliga (màxima divisió de l'hoquei patins a Espanya) femenina i masculina, així com de la OK Lliga Plata masculina (segona divisió de l'hoquei patins a Espanya) durant la temporada 2021/22

Time-loss injuries among female and male Spanish rink hockey players

Abstract

The present study describes the time-loss injuries (TLI) among female and male athletes of the Spanish RH league during the 2021/22 season.

We performed a cross-sectional study on TLI, whereby the athlete is prevented from participating in a training session or game because of the injury.

A total of 463 athletes were included, 326 (70.4%) senior male and 137 (29.6%) senior female. Two hundred and eighty-two TLI were recorded, the most common form being muscle injuries (112 episodes, 39.7%), especially those affecting the thigh adductor muscles (52 episodes, 46.4% of muscle injuries). Most injuries were classified as mild (1-7 days of time-loss) and the median return-to-play was 9.5 days (range 1-180).

Injury patterns were compared according to gender, position and moment: the results showed significant differences between senior males and senior females, between field players and goalkeepers, as well as between training and game, in terms of injury nature and type. The injury proportion was significantly higher for field players (IP: 70.4; CI 95% 62.1-79.5) compared to goalkeepers (IP = 24.2; CI 95% 15.3-36.3), and senior males had a significantly higher risk than senior females (RD: 7.72%).

The present study sets a starting point for studying and preventing injuries in this rink hockey athletes.

Keywords

Time-loss injuries, rink hockey, roller hockey, epidemiology, injury surveillance.

Introduction

Rink hockey (RH), also known as roller hockey, quad hockey, or hardball hockey, consists of a rich history. The sport extended its popularity on a global scale and has been regularly played in countries such as Spain, Italy, Portugal, and Argentina, with a high number of participants (1).

RH is a collective, dynamic, and complex sport played on classic skates (2 pairs of parallel wheels). Two teams of 4 players and a goalkeeper face off in 2 periods lasting 25 minutes each (2). It is considered a contact sport because of the dynamic (ball and stick) and static (fences and goal) elements, which add additional risk to the contact between participants (3–5). Several factors differentiate RH from other indoor sports: (i) the speed reached by the athletes is extremely high (8.3 m/s) (3); (ii) the parallel wheels cause the players to turn and stop differently than in other skating sports, such as inline or ice hockey (4); and (iii) the speed of the ball may reach up to 115 km/h (5,6). It is important to point out that the goalkeeper position is different to that of the field players regarding the movements, the playing position, and the high risk of collision with the ball (7,8). Finally, we can conceptualize RH as a sport with a high risk of musculoskeletal injury (9,10), which may influence competition performance, return to sports, and injury burden.

Despite epidemiological studies on RH athletes being scarce (11), recent studies have been published on RH injuries in international tournaments (1), Spanish national competitions (12), and amateur competitions (13,14). In general, time-loss injuries (TLI) can affect athletes' health and performance (15) and may influence teams' success and economy (16). Understanding injury patterns through epidemiological surveillance programs may allow us to define the extent of the problem and take the first step in creating prevention programs (17,18).

In this context, our study aims to describe injury patterns in the Spanish female and male rink-hockey national competitions.

Methods

Study design

This cross-sectional study was based on a non-probabilistic sampling within the teams of the three national leagues of the *Real Federación Española de Patinaje (RFEP)*.

Participants

We studied all teams in the male and female first division leagues, and 19 of the 24 (79.2%) teams in the male second division league. The 5 remaining teams declined to participate. 463 athletes were studied: 326 (70.4%) senior males (SM) with a mean age of 24.9 ± 5.7 years (15.3-46.1); and 137 (29.6%) senior females (SF) with a mean age of 21.6 ± 4.1 years (14.8-

36.5). The only inclusion criterion was that the athlete had to belong to the senior team roster at the beginning of the season. Youth players who occasionally participated in training or games were excluded.

Data

Athletes' data were recorded and anonymized. All athletes gave their consent to the data collection. The study was designed following the Helsinki declaration (19) and the international standards requested by this journal (20) and was accepted by the Ethics Committee (code 014/CEICGC/2021).

The medical staff of each team reported injury characteristics. Injury data were collected from the first day of the preseason till the last game of the 2021/22 season and recorded in a predefined template. According to the sporting results, the number of official games ranged from 35 to 45. Injuries not related to RH and medical illnesses were omitted.

Injuries were classified following the Orchard Sports Injury Classification System (OSICS) version 10 (21). The type of injury, localization, and onset were recorded following the International Olympic Committee (IOC) consensus (18). TLI and return-to-play (RTP) were recorded following the definitions of the Union of European Football Associations (UEFA) (22,23). Recording both relative and absolute measures of association are recommended in a clinical or public health setting to identify the difference in the proportion of persons sustaining sports-related injuries (24).

The definitions of the injury characteristics are shown in **Table 1**.

INSERT TABLE 1

Statistical analysis

A descriptive analysis of the TLI was conducted to calculate the absolute and relative frequencies of the qualitative variables.

Central tendency measures (median) and statistical dispersion (standard deviation and range) were calculated for the quantitative variables.

The frequency measures for TLI were calculated following the formula $i=n/e$, with "n" being the number of new injuries during the studied period and "e" being the number of exposed athletes. Incidence proportion was presented as injuries per 100 athletes per season. Also, the Cumulative Incidence Ratio (CIR) and Risk difference (RD) were used to compare the injury incidence between male and female athletes.

CIR is estimated by showing results, as cumulative incidence ratio, as a ratio of two groups (for example, male vs. female within the variable gender), with the aim to identify the association strength compared with the reference (denominator for the ratio). In contrast, the absolute measure of risk difference, is calculated by subtracting rates from 2 exposures

group with the aim to identify how many more TLI are sustained in one group as compared with another group (24). In sports epidemiology, relative measures are much more used than the absolute ones although STROBE statement for observational studies and the CONSORT statement for randomized trials recommend researchers to report both (25,26).

The incidence proportion was calculated via the tool “*pois.exact*” and the CIR and RD were calculated via the tool “*epi.2by2*”, both from the *epitools* and *epiR* libraries, respectively. A confidence interval (CI) was estimated with a Poisson distribution of 95%. The analysis was conducted using SPSS v21 and the statistical package R (The R Foundation for Statistical Computing, Vienna, Austria), version 4.1.1.

Results

Four hundred and sixty-three athletes were studied: 326 (70.4%) senior males (SM) with a mean age of 24.9 ± 5.7 years (15.3 - 46.1); and 137 (29.6%) senior females (SF) with a mean age of 21.6 ± 4.1 years (14.8 - 36.5). Of the SM, 260 (79.7%) were field players, and 66 (20.3%) were goalkeepers. Of the SF, 108 (78.8%) were field players, and 29 (21.2%) were goalkeepers.

Time-loss injuries

Two hundred and eighty-two TLI were recorded, 206 (73%) among SM and 76 (27%) among SF. Twenty-three TLI (8.2%) were recorded in goalkeepers (14 SM and 9 SF) and 259 (91.8%) in field players (192 SM and 67 SF).

The mean and standard deviation of TLI per athlete per season was 0.6 ± 0.8 : 0.6 ± 0.7 in SM and 0.5 ± 0.8 in SF. The mean and standard deviation TLI per team per season was 5.8 ± 3.4 , with a range of 1-17.

Descriptive of Time-loss injuries by female and male competitions

Table 2 shows that males had a higher proportion in 1st division (55.8% vs 44.2%), as well as a higher proportion of upper limb injuries (23.8% vs 11.8%; p-value=0.036). SM also had a higher proportion of bone injuries (17.5% vs 5.26%; p-value=0.002) and muscle-tendon injuries (58.3% vs 60.5%; p-value=0.109). On the other hand, SF showed a significantly higher proportion of lower limb injuries (43.4% vs 28.2%; p-value=0.928). SM also had a higher proportion of non-contact injuries (61.2% vs 69.7%; p-value=0.187) and mild injuries (41.3% vs 51.3%; p-value=0.066). These results suggest that there are significant differences between SM and SF in terms of injury nature and type.

INSERT TABLE 2

Descriptive of Time-loss injuries by position

Table 3 shows that field players had a higher proportion muscle-tendon injuries (59.8% vs 47.8%; p-value=0.694) and bone injuries (14.3% vs 13.0%; p-value=0.899) and muscle-tendon injuries. On the other hand, goalkeepers showed a significantly higher proportion of lower limb injuries (60.9% vs 29.7%; p-value=0.020). Field players also had a higher proportion of non-contact injuries (64.9% vs 47.8%; p-value=0.116) and mild injuries (45.6% vs 26.1%; p-value=0.038). These results suggest that there are significant differences between field players and goalkeepers in terms of injury nature and type.

****INSERT TABLE 3****

Descriptive of Time-loss injuries by moment

Studying the injuries by moment, the most commonly affected body area was the upper limb (14.0% vs 30.9%, p<0.001; training vs game), the most frequent type of injury was muscle-tendon (72.7% vs 37.3%, p<0.001; training vs game), the onset was overuse progressive (53.5% vs 11.8%, p<0.001; training vs game) and the main mechanism was non-contact (79.1% vs 39.1%, p<0.001; training vs game). Most of the injuries were mild (49.4% vs 35.5%, p=0.015; training vs game) and 6.38% of the players had a recurrent injury (p=0.010; training vs game) (Table 4).

****INSERT TABLE 4****

Incidence proportion

The TLI incidence proportion (IP) was 60.9 (CI 95% 54-68.4) TLI/100 athletes/season. The IP was 63.2 (CI 95% 54.9-72.4) in SM, and 55.5 (CI 95% 43.7-69.4) in SF. The cumulative incidence ratio (CIR) was 1.1 (CI 95% 1-1.3), higher in SM athletes in comparison to SF athletes, with no significant differences (p=0.12). As for the risk difference, SM have 7.72% more risk of TLI than SF (Table 5). There were significant differences between field players and goalkeepers (p<0.001), and between SM and SF among field players (p=0.024).

The incidence proportion was significantly higher in field players (IP = 70.4; CI 95% 62.1-79.5) than in goalkeepers (IP = 24.2; CI 95% 15.3-36.3), with a cumulative incidence ratio of 2.9 (CI 95% 2-4.2), and a risk difference of 46.2 (CI 95% 36.4-56). Field players among gender: The incidence proportion was significantly higher in male field players (IP = 73.8; CI 95% 63.8-85.1) than in female field players (IP = 62.0; CI 95% 48.1-78.8), with a cumulative incidence ratio of 1.2 (CI 95% 1-1.4), and a risk difference of 11.8 (CI 95% 11.2-22.4). Goalkeepers among gender: The incidence proportion was significantly lower in male

goalkeepers (IP = 21.2; CI 95% 11.6-35.6) than in female goalkeepers (IP = 31.0; CI 95% 14.2-58.9), with a cumulative incidence ratio of 0.7 (CI 95% 0.3-1.4), and a risk difference of -9.8 (CI 95% -29.3-9.7).

****INSERT TABLE 5****

Return-to-play and severity

In general, the median RTP was 9.5 days (range 1-180):10 days (range 1-180) in SM and 7 days (range 1-93) in SF.

Specifically, the median RTP for muscle injuries was 7 days (range 1-91). Fractures were the injuries with the greatest RTP median: 21.5 days (range 3-180).

Severe injuries were carefully studied, especially those requiring surgical intervention. Twelve injuries (4.3%) required surgery, with an IP of 2.6 (CI 95% 1.3-4.5) and a median RTP of 12 days (range 4-80). Four episodes of chronic tibial compartment syndrome, with a median RTP of 90 days (range 51-100), must be highlighted.

Discussion

The present study includes the largest number of elite RH players to date (n=463, 326 male and 137 female). The objective was to describe the injury patterns in the participants of the national categories of RH in Spain during the 2020/21 season. The results must set the starting point to create injury prevention programs and strategies.

Our results for TLI per player per season (0.6 ± 0.8) coincide with the ones from de Pablo et al. in the Spanish RH during the 2019/20 season (0.7 ± 0.9) (12). The values that we obtained are lower than in other sports like professional soccer (2 TLI per player per season) (23) or futsal (2.5 TLI per player per season) (27).

The most frequent localization of injuries was in the lower limb, more specifically, the groin/thigh area. The same tendency has been reported in other studies on RH (11,13) and other skating sports (28,29). The muscle and tendinous injuries were the most frequent in this localization, with the thigh adductor muscles being the most frequently affected. These data confirm those of previous studies (9,13,30) that the adductor muscles are most frequently affected in skating sports. These can be explained by the role of adductor muscles in the stabilization of hip and pelvis during hip flexion in lateral sliding, with a flexion and internal rotation of the thigh (31)

On the contrary, the latter present a lower incidence of hamstring injuries than in other sports such as soccer or field hockey. Indeed, skating biomechanics, with a lower vertical contact, no feet fixation during acceleration boosts, and the adduction/abduction movement during the stride, can explain the lower solicitation of the hamstring muscles and, therefore, a lower

rate of injuries in this area (32,33). This may represent an advantage in skating sports, because hamstring injuries, especially the ones to the *biceps femoris*, cause a great burden on professional athletes (34,35).

The high incidence of injuries in the thigh adductor muscles suggests a need for diagnostic tools to evaluate the risk of injury in this area. Also, studies involving groin area injuries suggested that the time-loss measure can underestimate symptoms in this area, as 90% of the athletes reported groin problems but no time-loss. Even when evaluating hip and groin related sporting function, there was no differences between players reporting groin problems with or without time loss. These findings may suggest that the time-loss injuries data in overuse groin/adductor may be studied with precaution (36).

Craniofacial injuries, especially concussions, are a matter of concern in sports and RH in particular. Some studies(9,32) shown that these kinds of injuries are frequent in RH (9,23). Because of these concerns, some federations have established the mandatory wearing of a helmet for youth RH players (33). Our study reported twenty craniofacial injuries, with an IP of 4.3 (CI 2.2-6.6). Five fractures were reported (nose fracture n=3, dental fracture n=1, and orbicular fracture n=1), one episode of concussion, and one ocular injury. The median RTP was 7 days (range 1-42). With only 1 concussion in such a large sample number, and considering the results obtained in other sports (39,40), it is possible that there has been an underdiagnoses of concussions among RH athletes in our study. Finally, players and medical staff must have up-to-date knowledge about how to handle sports concussions and it is also vital that they understand the possible long-term consequences of this pathology (40).

Notably, most severe injuries were reported during games, consistently with results in other contact sports (41,42).

A non-contact mechanism caused the majority of reported TLI in our study. Our results coincide with the ones reported by Reverter (9) in one team of the Spanish first division during two seasons. However, injury surveillance studies in elite athletes of other sports, such as inline hockey (28) and ice hockey (29), showed a higher prevalence of contact injuries. This difference may be caused by the RH rules, which severely punish contact, on the contrary of other skating disciplines.

Analyzing the onset of the injuries, we found that the non-contact injuries were mainly reported during training sessions, while most TLI reported during games were caused by contact. This increase in contact injuries during games can be explained by the nature of the sport itself, with higher demand and contact during games compared to training sessions. This tendency has been described in soccer (42) but never in RH, allowing one to conclude that the athletes do not practice as they play.

The injury incidence proportion of the present study was higher among field players than goalkeepers, contradicting the myth that the goalkeeper's position is the most dangerous in RH (7). We must highlight that goalkeepers' muscle injury patterns differed from field players: the hamstring area was more frequently affected than the adductor muscles. This observation can be explained by the specific position and movements of the goalkeepers. Also, three injuries of the medial ligament of the knee were reported, with a median RTP of 80 days (range 35-91). These overuse injuries can be again explained by the specific position of the goalkeeper and, because of their long RTP, must be specifically studied in goalkeepers.

The majority (44%) of the reported injuries were considered mild (1 to 7 days of RTP), followed by moderate (36.5%) and severe (19.5%). In comparison with other contact sports, the prevalence of severe injuries (> 28 days of RTP) is higher than in professional soccer, where it is 9.2% (42) but lower than inline hockey or rugby, where it is 47.6% (28) and 26% (43), respectively.

Female athletes' injuries

There is a lack of studies concerning female RH athletes. As reported in other sports, injury patterns in female athletes are different from male athletes and must be studied differently (44).

The characteristics of the injuries, such as location or mechanism, are similar to male athletes, with injuries affecting the thigh area and the thigh adductor muscles being the most frequently reported.

However, a higher prevalence of sprains in the lower limbs was detected, primarily affecting the knee and ankle. The median RTP of these injuries was 9 days (range 4-93). Some studies have linked higher ligamentous laxity in women to a higher risk of sprains (45,46). It is relevant to highlight that no cruciate ligament injuries have been described in our study.

Limitations

A subtle difference in medical activities in clinical staff participants can be awarded. Differences in philosophy and clinical methods in medical care may have influenced the results.

The calculation of injury incidence and burden, according to hours of exposure to games and training, was impossible because of a lack of data.

Conclusions / Practical applications

The most frequent injury in RH Spanish national competitions during the 2021/22 season was muscle injury, primarily affecting the thigh adductor muscles. These injuries may affect the availability and performance of RH athletes, so creating prevention programs is a priority. According to the bibliography, eccentric exercises can modify the muscle's architecture, preventing injury. Moreover, studies in other sports show that specific eccentric exercises

reduce the number of injuries in the adductor longus (47). Therefore, the effectiveness of these exercises must be evaluated in RH athletes.

Studies on ice hockey elite players showed that a clinical evaluation at the beginning of the season could detect disbalances that may lead to groin area injuries (48). Implementing these evaluation protocols in RH players must be considered to find risk factors and avoid injuries.

Direct contact injuries are frequent in RH athletes because of the sport's nature. Craniofacial injuries are a cause for concern in RH athletes. Therefore, it is crucial to evaluate the effect of prevention programs, for example, protective helmets in young RH players, to know if they may be effective in elite players.

Tables

Table 1: Operational definitions used in the study

Table 2: Characteristics of time-loss injuries in the Spanish rink-hockey national competitions by gender

Table 3: Characteristics of time-loss injuries in the Spanish rink-hockey national competitions by position

Table 4: Characteristics of time-loss injuries in the Spanish rink-hockey national competitions by moment

Table 5: Proportion incidence, cumulative incidence ratio (CIR), risk difference (RD) and all their corresponding 95% confidence intervals (CI 95%) by gender and position

References

1. de Pablo B, Sugimoto D, Arboix-Alio J, Rodas G, Casals M. Analysis of injuries during the 2019 Rink Hockey World Championship. *Phys Sportsmed.* 2022;1–7.
2. Moreno D. Anàlisi dels gols en hoquei patins a les lligues espanyola, italiana i portuguesa. Thesis. Universitat de Barcelona, Barcelona; 2019.
3. Fernández D, Varo F, Carmona G, Reche X. Quantification of external load of elite rink hockey players in official matches. *J Sports Med Phys Fitness.* 2020;60(12): 1520-1525
4. Vitale JA, Castellini G, Gianola S, Stucovitz E, Banfi G. Analysis of the Christiania stop in professional roller hockey players with and without previous groin pain: a prospective case series study. *Sport Sci Health.* 2019;15(3):641–6.
5. Vaz M, Ramos N, Abrantes J, Queiros de Melo F, Conceição F. Biomechanics of the penalty stroke in roller hockey. *Revista Portuguesa de Ciências do Desporto.* 2011;2(11):129–32.
6. Ballester E. El hockey sobre Patines: Variables del rendimiento en el disparo a portería. Thesis. Universitat de Lleida, Lleida; 2017.

7. Trabal Tañá G. Estudi etnogràfic del porter d'hoquei sobre patins: una vida entre paradoxes. *Apunts Educación Física y Deportes*. 2016;(126):23–9.
8. Trabal G, Daza G, Riera J. Goalkeeper Effectiveness in the Direct Free Hit of Rink Hockey. *Apunts Educación Física y Deportes*. 2020;(139):56–64.
9. Reverter J, de Vega M, Hernandez V. Occupational injury in Spanish professional roller hockey during two seasons: a comparative study. *Journal of Physical Education and Sport*. 2018;18(03):1767–72.
10. Pelaez EG, Dascenzi PF, Savastano LE, Cremaschi FE. Lesiones craneofaciales producidas en hockey sobre patines. *Rev Arget Neurocir*. 2008;22(4):181–5.
11. de Pablo B, Peña J, Moreno D, Casals M. Injury incidence and patterns in rink hockey: a systematic review. *Apunts Sports Medicine*. 2022; 57(214): 1380
12. de Pablo B, Trabal G, Yanguas J, Dominguez D, Rodas G, Casals M. Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo. *Archivos de Medicina del Deporte*. 2022; 39(6): 190-196
13. Quintana-Cepedal M, Rodríguez MÁ, Crespo I, del Valle M, Olmedillas H. Epidemiology of Rink Hockey-Related Injuries. *J Sport Rehabil*. 2022; 32(1): 1–6.
14. Husen M, Burgsmüller L, Burggraf M, Jäger M, Dudda M, Kauther M. Injuries and Overuse Syndromes in Rink Hockey Players. *Int J Sports Med*. 2021;42(2): 132-137
15. Hägglund M, Waldén M, Magnusson H, Kristenson K, Bengtsson H, Ekstrand J. Injuries affect team performance negatively in professional football: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med*. 2013;47(12):738–42.
16. Eliakim E, Morgulev E, Lidor R, Meckel Y. Estimation of injury costs: financial damage of English Premier League teams' underachievement due to injuries. *BMJ Open Sport Exerc Med*. 2020;6(1):e000675.
17. van Mechelen W, Hlobil H, Kemper HCG. Incidence, Severity, Aetiology and Prevention of Sports Injuries. *Sports Medicine*. 1992;14(2): 82-99
18. Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, et al. International Olympic Committee Consensus Statement: Methods for Recording and Reporting of Epidemiological Data on Injury and Illness in Sports 2020 (Including the STROBE Extension for Sports Injury and Illness Surveillance (STROBE-SIIS)). *Orthop J Sports Med*. 2020;8(2): 232
19. World Medical Association Declaration of Helsinki. *JAMA*. 2013 Nov 27;310(20).
20. Harriss DJ, MacSween A, Atkinson G. Ethical Standards in Sport and Exercise Science Research: 2020 Update. *Int J Sports Med*. 2019 Dec 15;40(13):813–7.
21. Orchard J. Revision, uptake and coding issues related to the open access Orchard Sports Injury Classification System (OSICS) versions 8, 9 and 10.1. *Open Access J Sports Med*. 2010; 1: 207-14
22. Hägglund M. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *Br J Sports Med*. 2005;39(6): 340-6
23. Ekstrand J, Hägglund M, Walden M. Injury incidence and injury patterns in professional football: the UEFA injury study. *Br J Sports Med*. 2011;45(7): 553-8
24. Nielsen RO, Bertelsen ML, Verhagen E, Mansournia MA, Hulme A, Møller M, et al. When is a study result important for athletes, clinicians and team coaches/staff? *Br J Sports Med*. 2017;51(20):1454–5.

25. Vandenberghe JP, Von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and elaboration. *Epidemiology*. 2007;18(6):805–35.
26. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *BMJ*. 2010;340.
27. Martínez-Riaza L, Herrero-González H, López-Alcorocho JM, Guillen-García P, Fernández-Jaen TF. Epidemiology of injuries in the Spanish national futsal male team: a five-season retrospective study. *BMJ Open Sport Exerc Med*. 2017;2(1):e000180.
28. Moreno-Alcaraz VJ, Cejudo A, Sainz de Baranda P. Injury types and frequency in Spanish inline hockey players. *Physical Therapy in Sport*. 2020 Mar;42: 91-99
29. Anderson GR, Melugin HP, Stuart MJ. Epidemiology of Injuries in Ice Hockey. *Sports Health: A Multidisciplinary Approach*. 2019;11(6): 514-9
30. Egocheaga J, Yagué P, Mones L. Características de la patología lesiva en dos deportes de patinaje. *Medicina de rehabilitación*. 2004;17(1):12–6.
31. Mechó S, Balias R, Bossy M, Valle X, Pedret C, Ruiz-Cotorro Á, et al. Isolated Adductor Magnus Injuries in Athletes: A Case Series. *Orthop J Sports Med*. 2023;11(1):232596712211388.
32. Morin JB, Gimenez P, Edouard P, Arnal P, Jiménez-Reyes P, Samozino P, et al. Sprint Acceleration Mechanics: The Major Role of Hamstrings in Horizontal Force Production. *Front Physiol*. 2015 Dec 24;6: 404
33. Kaartinen S, Venojärvi M, Lesch KJ, Tikkaen H, Vartiainen P, Stenroth L. Lower limb muscle activation patterns in ice-hockey skating and associations with skating speed. *Sports Biomech*. 2021;1–16.
34. Lempainen L, Kosola J, Pruna R, Sinikumpu JJ, Valle X, Heinonen O, et al. Tears of biceps femoris, semimembranosus, and semitendinosus are not equal—a new individual muscle-tendon concept in athletes. *Scandinavian Journal of Surgery*. 2021;110(4):483–91.
35. Jokela A, Stenroos A, Kosola J, Valle X, Lempainen L. A systematic review of surgical intervention in the treatment of hamstring tendon ruptures: current evidence on the impact on patient outcomes. *Ann Med*. 2022;54(1):978–88.
36. Esteve E, Clausen MB, Rathleff MS, Vicens-Bordas J, Casals M, Palahí-Alcàcer A, et al. Prevalence and severity of groin problems in Spanish football: A prospective study beyond the time-loss approach. *Scand J Med Sci Sports*. 2020;30(5):914–21.
37. Lopes L, Santos M. Mouthguard and Orofacial Traumatismo in Young Roller Hockey Practitioners. *Global Journal Med Research*. 2013;19(5):5-11.
38. La Real Federación Española de Patinaje y Prokover presentan el casco oficial de hockey patines - Hockey Patines [Internet]. [cited 2021 Mar 12]. Available from: <https://fep.es/website/14-13246-la-real-federacion-espanola-de-patinaje-y-prokover-presentan-el-casco-oficial-de-hockey-patines.htm>
39. Schmidt JD, Welch D, ML Weber, Bierema L, Miller LS, Courson R, et al. Coach, sports medicine, and parent influence on concussion care seeking intentions and behaviors in collegiate student-athletes. *J Clin Transl Res*. 2020;5(4):215–26.
40. Meehan WP, Mannix RC, O'Brien MJ, Collins MW. The Prevalence of Undiagnosed Concussions in Athletes. *Clinical Journal of Sport Medicine*. 2013;23(5):339–42.

41. Nagle K, Johnson B, Brou L, Landman T, Sochanska A, Comstock RD. Timing of Lower Extremity Injuries in Competition and Practice in High School Sports. *Sports Health: A Multidisciplinary Approach*. 2017;9(3):238–46.
42. Javier Noya, Manuel Sillero. EPIDEMIOLOGÍA DE LAS LESIONES EN EL FÚTBOL PROFESIONAL ESPAÑOL EN LA TEMPORADA 2008-2009. *Archivos de Medicina del Deporte*. 2012;29(150):750–66.
43. Fuller C, Taylor A, Douglas M, Raftery M. Rugby World Cup 2019 injury surveillance study. *SA J Sports Med*. 2020;32(1): 1-6
44. Wiese-Bjornstal DM, Franklin AN, Dooley TN, Foster MA, Wings JB. Observations About Sports Injury Surveillance and Sports Medicine Psychology among Female Athletes. *Women Sport Phys Act J*. 2015;23(2):64–73.
45. Hosea TM, Carey CC, Harrer MF. The Gender Issue: Epidemiology of Ankle Injuries in Athletes Who Participate in Basketball. *Clin Orthop Relat Res*. 2000;372:45–9.
46. Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The Incidence and Prevalence of Ankle Sprain Injury: A Systematic Review and Meta-Analysis of Prospective Epidemiological Studies. *Sports Medicine*. 2014;44(1):123–40.
47. Harøy J, Clarsen B, Wiger EG, Øyen MG, Serner A, Thorborg K, et al. The Adductor Strengthening Programme prevents groin problems among male football players: a cluster-randomised controlled trial. *Br J Sports Med*. 2019;53(3):150–7.
48. EMERY CA, MEEUWISSE WH. Risk factors for groin injuries in hockey. *Med Sci Sports Exerc*. 2001;33(9):1423–33.

Table 1. Operational definitions used in the study

Measures	Definition
Time-loss injuries (TLI)	Any physical complaint or manifestation experienced by a player that requires the medical staff to restrict participation fully or partially in a future training session or match (17)
Return-to-play (RTP)	Recovery time (in days) from the day of the injury until the player safely returns to training or competition.
Injury incidence rate (IR)	Number of TLI/100 players per season.
Episodes of re-injury	Any injury of the same type and in the same body region that is sustained within 60 days after the RTP.
Severity of the injury	Seriousness of the injury. According to the RTP, the TLI was classified as mild (1-7 days), moderate (8-28 days), or severe (>28 days).
Mechanism of the injury	The way the injury is produced. It can be classified in direct or indirect trauma.
Onset of the injury	The way the injury starts. It can be classified in overuse acute, overuse progressive or acute.

Table 2: Characteristics of time-loss injuries in the Spanish rink-hockey national competitions by gender

	All N=282	Senior Male N=206	Senior Female N=76	p-value
Category:				
1st division	191 (67.7%)	115 (55.8%)	76 (100%)	Ref.
2nd division	91 (32.3%)	91 (44.2%)	0 (0.00%)	.
Position:				
Field player	259 (91.8%)	192 (93.2%)	67 (88.2%)	Ref.
Goalkeeper	23 (8.16%)	14 (6.80%)	9 (11.8%)	0.188
Body area:				
Head & neck	20 (7.09%)	16 (7.77%)	4 (5.26%)	0.255
Upper limb	58 (20.6%)	49 (23.8%)	9 (11.8%)	0.036
Lower limb	91 (32.3%)	58 (28.2%)	33 (43.4%)	0.928
Trunk & Spine	34 (12.1%)	22 (10.7%)	12 (15.8%)	Ref.
Groin & Pelvis	79 (28.0%)	61 (29.6%)	18 (23.7%)	0.181
Type of injury:				
Muscle-tendon	166 (58.9%)	120 (58.3%)	46 (60.5%)	0.109
Bone injury	40 (14.2%)	36 (17.5%)	4 (5.26%)	0.002
Cartilage-ligament	36 (12.8%)	21 (10.2%)	15 (19.7%)	Ref.
Others	40 (14.2%)	29 (14.1%)	11 (14.5%)	0.207
Onset:				
Overuse acute	81 (28.7%)	58 (28.2%)	23 (30.3%)	Ref.
Overuse progressive	105 (37.2%)	72 (35.0%)	33 (43.4%)	0.661
Acute	96 (34.0%)	76 (36.9%)	20 (26.3%)	0.250
Mechanism:				
Non-contact	179 (63.5%)	126 (61.2%)	53 (69.7%)	Ref.
Contact	103 (36.5%)	80 (38.8%)	23 (30.3%)	0.187
Moment:				
Training	172 (61.0%)	126 (61.2%)	46 (60.5%)	Ref.
Game	110 (39.0%)	80 (38.8%)	30 (39.5%)	0.919
Severity:				
Mild (1-7 days)	124 (44.0%)	85 (41.3%)	39 (51.3%)	0.066
Moderate (8-28 days)	103 (36.5%)	76 (36.9%)	27 (35.5%)	0.264
Severe (> 28 days)	55 (19.5%)	45 (21.8%)	10 (13.2%)	Ref.
Reinjury	18 (6.38%)	10 (4.85%)	8 (10.5%)	0.104
Surgery	12 (4.26%)	11 (5.34%)	1 (1.32%)	0.141

Table 3: Characteristics of time-loss injuries in the Spanish rink-hockey national competitions by position

	All N=282	Field player N=259	Goalkeeper N=23	p-value
Gender:				
Senior Male	206 (73.0%)	192 (74.1%)	14 (60.9%)	Ref.
Senior Female	76 (27.0%)	67 (25.9%)	9 (39.1%)	0.188
Category:				
1st division	191 (67.7%)	177 (68.3%)	14 (60.9%)	Ref.
2nd division	91 (32.3%)	82 (31.7%)	9 (39.1%)	0.468
Body area:				
Head & neck	20 (7.09%)	18 (6.95%)	2 (8.70%)	0.320
Upper limb	58 (20.6%)	56 (21.6%)	2 (8.70%)	Ref.
Lower limb	91 (32.3%)	77 (29.7%)	14 (60.9%)	0.020
Trunk & Spine	34 (12.1%)	32 (12.4%)	2 (8.70%)	0.614
Groin & Pelvis	79 (28.0%)	76 (29.3%)	3 (13.0%)	0.937
Type of injury:				
Muscle-tendon	166 (58.9%)	155 (59.8%)	11 (47.8%)	0.694
Bone injury	40 (14.2%)	37 (14.3%)	3 (13.0%)	0.899
Cartilage-ligament	36 (12.8%)	33 (12.7%)	3 (13.0%)	Ref.
Others	40 (14.2%)	34 (13.1%)	6 (26.1%)	0.400
Onset:				
Overuse acute	81 (28.7%)	71 (27.4%)	10 (43.5%)	Ref.
Overuse progressive	105 (37.2%)	104 (40.2%)	1 (4.35%)	0.001
Acute	96 (34.0%)	84 (32.4%)	12 (52.2%)	0.980
Mechanism:				
Non-contact	179 (63.5%)	168 (64.9%)	11 (47.8%)	Ref.
Contact	103 (36.5%)	91 (35.1%)	12 (52.2%)	0.116
Moment:				
Training	172 (61.0%)	157 (60.6%)	15 (65.2%)	Ref.
Game	110 (39.0%)	102 (39.4%)	8 (34.8%)	0.681
Severity:				
Mild (1-7 days)	124 (44.0%)	118 (45.6%)	6 (26.1%)	0.038
Moderate (8-28 days)	103 (36.5%)	94 (36.3%)	9 (39.1%)	0.279
Severe (> 28 days)	55 (19.5%)	47 (18.1%)	8 (34.8%)	Ref.
Reinjury	18 (6.38%)	16 (6.18%)	2 (8.70%)	0.615
Surgery	12 (4.26%)	12 (4.63%)	0 (0.00%)	.

Table 4: Characteristics of time-loss injuries in the Spanish rink-hockey national competitions by moment

	All N=282	Training N=172	Game N=110	p-value
Gender:				
Senior Male	206 (73.0%)	126 (73.3%)	80 (72.7%)	Ref.
Senior Female	76 (27.0%)	46 (26.7%)	30 (27.3%)	0.919
Category:				
1st division	191 (67.7%)	118 (68.6%)	73 (66.4%)	Ref.
2nd division	91 (32.3%)	54 (31.4%)	37 (33.6%)	0.695
Position:				
Field player	259 (91.8%)	157 (91.3%)	102 (92.7%)	Ref.
Goalkeeper	23 (8.16%)	15 (8.72%)	8 (7.27%)	0.681
Body area:				
Head & neck	20 (7.09%)	8 (4.65%)	12 (10.9%)	0.923
Upper limb	58 (20.6%)	24 (14.0%)	34 (30.9%)	Ref.
Lower limb	91 (32.3%)	50 (29.1%)	41 (37.3%)	0.111
Trunk & Spine	34 (12.1%)	30 (17.4%)	4 (3.64%)	<0.001
Groin & Pelvis	79 (28.0%)	60 (34.9%)	19 (17.3%)	<0.001
Type of injury:				
Muscle-tendon	166 (58.9%)	125 (72.7%)	41 (37.3%)	<0.001
Bone injury	40 (14.2%)	16 (9.30%)	24 (21.8%)	0.404
Cartilage-ligament	36 (12.8%)	11 (6.40%)	25 (22.7%)	Ref.
Others	40 (14.2%)	20 (11.6%)	20 (18.2%)	0.093
Onset:				
Overuse acute	81 (28.7%)	44 (25.6%)	37 (33.6%)	Ref.
Overuse progressive	105 (37.2%)	92 (53.5%)	13 (11.8%)	<0.001
Acute	96 (34.0%)	36 (20.9%)	60 (54.5%)	0.027
Mechanism:				
Non-contact	179 (63.5%)	136 (79.1%)	43 (39.1%)	Ref.
Contact	103 (36.5%)	36 (20.9%)	67 (60.9%)	<0.001
Severity:				
Mild (1-7 days)	124 (44.0%)	85 (49.4%)	39 (35.5%)	0.015
Moderate (8-28 days)	103 (36.5%)	60 (34.9%)	43 (39.1%)	0.277
Severe (> 28 days)	55 (19.5%)	27 (15.7%)	28 (25.5%)	Ref.
Reinjury	18 (6.38%)	16 (9.30%)	2 (1.82%)	0.010

Table 5: Proportion incidence, cumulative incidence ratio (CIR), risk difference (RD) and all their corresponding 95% confidence intervals (CI 95%) by gender and position

	Incidence Proportion (CI 95%)	CIR (CI 95%)	RD (CI 95%)
Gender			
Senior Female	55.5 (43.7 – 69.4)	1 (Ref.)	0 (Ref.)
Senior Male	63.2 (54.9 – 72.4)	1.1 (1 - 1.3)	7.7 (2.1 - 17.5)
Position			
Goalkeeper	24.2 (15.3 - 36.3)	1 (Ref.)	0 (Ref.)
Field player	70.4 (62.1 – 79.5)	2.9 (2 - 4.2)	46.2 (36.4 - 56)
Field player among gender			
Female field players	62.0 (48.1 - 78.8)	1 (Ref.)	0 (Ref.)
Male field players	73.8 (63.8 – 85.1)	1.2 (1 - 1.4)	11.8 (11.2 - 22.4)
Goalkeepers among gender			
Female goalkeepers	31.0 (14.2 - 58.9)	1 (Ref.)	0 (Ref.)
Male goalkeepers	21.2 (11.6 - 35.6)	0.7 (0.3 - 1.4)	-9.8 (-29.3 - 9.7)

CAPÍTOL 5

ESTUDI IV

ANALYSIS OF INJURIES DURING THE 2019 RINK HOCKEY WORLD CHAMPIONSHIP

**Bernat de Pablo
Dai Sugimoto
Jordi Arboix
Gil Rodas
Martí Casals**

Títol: Analysis of injuries during the 2019 Rink Hockey World Championship

Paraules clau: Roller hockey; injuries; injury incidence; sports medicine

Referencia: de Pablo B, Sugimoto D, Arboix-Alio J, Rodas G, Casals M
Analysis of injuries during the 2019 Rink Hockey World Championship,
The Physician and Sportsmedicine, 2022 Oct 3;1-7;

doi: 10.1080/00913847.2022.2129502

En les següents pàgines presentem els resultats de l'article que va estudiar les lesions durant la preparació i competició del Campionat del Món d'Hoquei patins celebrat a Barcelona l'estiu del 2019. Es van estudiar els equips nacionals d'Espanya, Portugal i Argentina, incloent els equips sènior masculí, sènior femení i sub 19 masculí.

Analysis of injuries during the 2019 Rink Hockey World Championship

Bernat de Pablo ^{a,b,c}, Dai Sugimoto ^{d,e}, Jordi Arboix-Alio ^f, Gil Rodas ^{b,g} and Martí Casals ^{h,i,j}

^aEmergency Department, Hospital Universitari Mutua Terrassa, Barcelona, Spain; ^bMedical Department, Futbol Club Barcelona, Barça Innovation Hub, Barcelona, Spain; ^cDoctoral Program in Medicine and Biomedical Sciences, University of Vic - Central University of Catalonia (UVic-UCC), Barcelona, Spain; ^dFaculty of Sport Sciences, Waseda University, Tokyo, Japan; ^eSports Medicine Unit, The Micheli Center for Sports Injury Prevention, Waltham, MA, USA; ^fDepartment of Sports Science, Ramon Llull University, Fpcee Blanquerna, Barcelona, Spain; ^gSports Medicine Unit, Hospital Clinic & Hospital Sant Joan de Déu, Barcelona, Spain; ^hSport and Physical Activity Studies Centre, Faculty of Medicine, Universitat de Vic - Universitat Central de Catalunya, Vic, Catalunya, Spain; ⁱSport Performance Analysis Research Group (SPARG), University of Vic - Central University of Catalonia, Vic, Barcelona, Spain; ^jNational Institute of Physical Education of Catalonia (INEFC), University of Barcelona (UB), Barcelona, Spain

ABSTRACT

Objectives: The purpose of this study is to describe the incidence and characteristics of injuries at the 2019 Rink Hockey World Championship.

Methods: A cross-sectional study was performed among rink hockey athletes from three National Teams (Argentina, Portugal, and Spain). All injuries were reported by the medical staff of each National Team during the preparation period and the competition in the 2019 World Championship (Barcelona, Spain). Injury rate was calculated as the number of injuries per 1000 hours of player-hours of exposure.

Results: A total of 91 players ($n = 61$, 67% male; and $n = 30$, 33% female) participated in the study: 31 Senior Male (34%), 30 Senior Female (33%), and 30 Under-19 Male (33%). A total of 54 games were played by 9 teams from 3 countries, comprising of 4562 and 4380 hours of total athletic game and training exposure recorded, respectively. Fifty-one injuries (20 injuries with time-loss and 31 medical attention -injuries with no time-loss) were reported. The overall injury incidence rate was 11.2/1000 hours (95% CI, 8.5–14.7). The injury incidence during games (27.5; 95% CI, 11.6–65.2) was higher than the injury incidence during training sessions (3.4; 95% CI, 2–5.7). The incidence rate for game for the entire study period was 8.19 times higher (95% CI, 2.61–21.36) than that for training. The global injury burden was 45.4 days/1000 hours for a total exposure time. Acute was the most frequently documented onset and the non-contact was the most common mechanism. The most frequently reported injuries were head contusion ($n = 5$, 25%), followed by thigh injuries ($n = 3$, 15%).

Conclusions: The injury incidence reported in a Rink Hockey international competition was 11.2/1000 hours. The risk of injury was higher during games than during training. Prevention strategies for injuries in these kinds of championships may be worth discussing. The craniofacial injuries were the most frequently reported.

ARTICLE HISTORY

Received 12 January 2022
Accepted 21 September 2022

KEYWORDS

Roller hockey; injuries; injury incidence; sports medicine

1. Introduction

Rink hockey (RH), also known as roller hockey, quad hockey, or hardball hockey, consists of a rich history.

RH extended its popularity on a global scale and has been played regularly in countries such as Spain, Italy, Portugal, and Argentina, with a high number of participants. These countries have often won international championships since the first World Cup in 1936. Despite not being a regular Olympic sport, RH was one of the demonstration sports in the 1992 Summer Olympic Games in Barcelona.

RH is a collective, dynamic, and complex sport, played on classic skates (2 pairs of parallel wheels) with a stick used to handle a solid, round ball. Two teams of 4 players and a goalkeeper face off in 2 periods of 25-minutes each [1].

It is considered a contact sport because of the dynamic (ball, stick) and static (fences, goal) elements, which add additional risk factors for contact between participants. Several factors differentiate RH from other indoor sports: (i) the speed reached by the athletes is extremely high (30 km/h) [2]; (ii) the use of parallel wheels produces a different

mechanism for turning and stopping, in comparison with other skating sports such as inline or ice hockey [3]; and (iii) the speed of the ball may reach as fast as 115 km/h [4]. Considering these factors, we can conceptualize RH to be a sport with high musculoskeletal injury risk, which may influence competition performance, return to sports and injury burden.

Injury and illness surveillance, and epidemiological studies are fundamental to protect athletes' health and performance and even team success [5,6]. The injury surveillance system is well-established in many professional sports and has been routinely implemented in more than 40 international football tournaments [6–9] since 1998. Therefore, knowing injury patterns in each sport may allow us to define the extent of the problem and take the first step in creating prevention programs [10,11]. Finally, the International Olympic Committee (IOC) encourages ongoing in- and out-of-competition surveillance programs and studies to describe injury and illness trends and patterns, understand their causes, and develop systems to protect athletes' health [10].

There have been RH epidemiology studies in the past. However, those studies were limited in national leagues [11,12] and youth categories of national teams [13,14]. Additionally, in these studies, samples were small and there was great heterogeneity in injury classification and registration. To our knowledge, there are no studies on injury epidemiology in RH in international competitions.

Therefore, the aim of this study is to describe RH related injury incidence and characteristics at the international RH level.

2. Material and methods

Study design, setting, and participants

A cross-sectional design using non-probability sampling was performed on 91 athletes from 3 National Teams monitored during the preparation of and competition at the World Roller Games (Fédération Internationale Roller Sports). The competition took place in the cities of Barcelona and Vilanova i la Geltrú (Spain) in July 2019 (prior to the COVID-19 global pandemic). The teams played 3 classifying games followed by 3 crossing games to determine the final classification.

All athletes gave oral consent for their injury data to be collected as long as personal information was de-identified and kept confidential. The study was designed according to the Declaration of Helsinki [15] and was accepted by the Ethics Committee (reference 014/CEICGC/2021).

Data collection

The injuries and athletes' time exposure (training and games) were registered by the medical staff of each National Team during the preparation training sessions before the beginning of the competition and during the competition itself. Clinical information and data on type of injury, time loss injuries (TLI), medical attention (MA) injuries, and return-to-play (RTP) were systematically recorded and shared in a common template. Injuries that were unrelated to RH and absences resulting from illness were not included in this study.

All data were collected using a predetermined Microsoft Excel® sheet and distributed among the Medical Staff participants before the preparation training sessions began.

Definitions, categories, and calculation of injury incidence and injury burden

Injury types were classified using version 10 of the Orchard Sports Injury Classification System (OSICS) [16]. Type, location, and onset of the injuries were collected following the International Olympic Committee Consensus [17]. The TLI, MA, and RTP concepts were obtained from consensus definitions and data collection procedures suggested by the Union of European Football Associations (UEFA) [6,18]. In Table 1 we present the operational definitions used in our study.

Statistical analysis

A descriptive study of main study variables was performed. Absolute and relative frequencies for categorical variables and

Table 1. Operational definitions used in the study.

Measures	Definition
Training Exposure (TE)	Team-based and individual physical activities under the control or guidance of the team's coaching or fitness staff that are aimed at maintaining or improving football skills or physical condition (19)
Game Exposure (GE)	Play between teams from different clubs, academies, or federations (19)
Total Athletic Exposure (TAE)	The sum of GE and TE
Time-loss injury (TLI)	Any physical complaint or manifestation experienced by a player that requires the medical staff to fully or partially restrict participation in a future training session or match (10)
Medical Attention (MA)	Any physical complaint or manifestation experienced by a player that requires the assistance of the medical staff, without compromising the participation in training sessions or matches (18,20)
Return-to-play (RTP)	Recovery time (in days) from the day of the injury until the player safely returns to training or competition.
Injury incidence rate (IR)	Number of TLI/1000 player-hours of athletes' exposure.
Training injury incidence rate (TIR)	Number of time-loss injuries per 1000 player-hours of TE.
Game injury incidence rate (GIR)	Number of time-loss injuries per 1000 player-hours of GE
Injury Burden	A measure of the TLI impact, taking both incidence (how often) and severity (duration) into account. Calculated as the total days lost per 1000 player-hours (18)

All terms and definitions were adapted from reference 21.

measures of central tendency and statistical dispersion for continuous variables were computed. Demographic information including athletic exposures were categorized by each country (Argentina, Spain, and Portugal) and team (SM, SF, and U19F).

To study the injury frequency among the RH players, IRs were computed globally as well as per moment (training and game), per country, and per team. For the computation of the 95% confidence intervals (CIs), Poisson distribution was used, which assumes that all injuries occur independently of each other. IRs were compared by means of the incidence rate ratio (IRR). IRRs were used to compare game vs training, and male vs female. The average (mean) time of RTP after an injury was calculated per team and category. All analyses were performed with the R statistical package (The R Foundation for Statistical Computing), version 3.6.0.

3. Results

Sample and athletes' exposure

Ninety-one Caucasian athletes were studied. Table 2 reports the configuration of each national team, divided in Senior Male (SM), Senior Female (SF), and Under-19 Male (U19M); mean age of the athletes, standard deviation (SD), and range; and athletes' time exposure. Sixty-one senior players (31 SM, mean age 29.5 ± 5 years; 30 SF, mean age 24.1 ± 4 years), and 30 U19M athletes were studied (all male, mean age 17.7 ± 0.7 years). Of the total number of players, 30 (33%) were from the Spanish national team; 31 (34%) from the Portuguese; and 30 (33%) from the Argentinean.

The TAE was 4562 hours, the TE was 4380 hours (1650 h in SM, 1300 h in SF and 1430 h in U19M) and the GE was

Table 2. Age and athletic exposure of RH players, classified by category and team.

Team		SM	SF	U19M
Argentina	N	10	10	10
	Mean age and SD (years)	31.6 ± 5.7	26.1 ± 4.1	17.5 ± 1.0
	Age range (years)	22.1–43.5	22–34.2	15.7–18.4
	Team training hours	540	480	490
	Team game hours	21	20	20
Spain	N	10	10	10
	Mean age and SD (years)	28.3 ± 5.0	23.3 ± 4.0	17.7 ± 0.4
	Age range (years)	21.7–34.6	16.7–30	17.2–18.4
	Team training hours	540	410	470
	Team game hours	20	20	20
Portugal	N	11	10	10
	Mean age and SD (years)	28.6 ± 4.2	22.8 ± 3.6	17.8 ± 0.7
	Age range (years)	22.8–37.4	16.3–29.2	16.1–18.4
	Team training hours	570	410	470
	Team game hours	21	20	20
Total	N	31	30	30
	Mean age and SD (years)	29.5 ± 5.0	24.1 ± 4.0	17.7 ± 0.7
	Age range (years)	21.7–43.5	16.3–34.2	15.7–18.4
	Total training hours	1.650	1.300	1.430
	Total game hours	62	60	60

SD: Standard Deviation; SM: Senior Male; SF: Senior Female; U19M: Under-19 Male

182 hours (6 games per team, 40 minutes per game, extra-time was required in one game). The exposure data collected are shown in Table 2.

Injury characteristics

The injury data is summarized in Table 3 and Table 4.

Number of injuries

Twenty TLI were recorded (Table 3 & Table 4). 4 (20%) were recorded in SM players, 5 (25%) in U19M players and 11 (55%) in SF players.

Thirty-one MA were recorded: 21 (67.7%) in SM, 7 (22.6%) in U19M and 3 (9.7%) in SF.

Injured body area

In terms of the area of the body affected, the TLI distribution was: 5 (25%) head, 5 hip/thigh 5 lower leg (ankle, knee), 3 trunk/back, and 2 upper extremity (10%) (Figure 1).

Regarding MA, the most affected body area was the lumbosacral area in 9 cases (29%), followed by the head in 7 (22.6%) (Figure 1).

Three TLI muscle strains were registered, all in the thigh area: the affected muscles were rectus femoris (1), biceps femoris (1) and adductor longus (1). Also 2 MA muscle strains were registered, affecting biceps femoris (1) and adductor longus (1).

Mechanism and onset

The most frequent mechanism was the non-contact (TLI n = 8, 40% and MA n = 18, 58.8%), followed by direct contact (TLI n = 7, 35% and MA n = 13, 41.9%).

The most frequent onset was acute (TLI n = 11, 55% and MA n = 13, 41.9%) followed by repetitive gradual (TLI n = 6, 30% and MA n = 13, 41.9%).

Incidence

The total time-loss IR was 4.4, the TIR was 3.4, and the GIR was 27.5. Analyzing the incidence by gender, combining SM and U19M, the IR in male athletes was 2.8, the TIR was 1.9 and GIR 24.6. In female

Table 3. Injuries (TLI & MA).

	Total injuries			TLI			MA	
	N	Exposure, h	IR (95% CI)* Injuries/1000 h	N	IR (95% CI)* TLI/1000 h	Injury burden (95% CI) (days/1000 h)	N	IR (95% CI)* MA/1000 h
Total	51	4562	11.2 (8.5–14.7)	20	4.4 (2.8–6.8)	45.4 (39.7–51.8)	31	6.8 (4.8–9.6)
Training	32	4380	7.3 (5.1–10.3)	15	3.4 (2–5.7)	32.4 (27.5–38.1)	17	3.9 (2.4–6.2)
Game	19	182	104.4 (68.2–159.8)	5	27.5 (11.6–65.2)	357.1 (293.9–434)	14	76.9 (46.5–127.2)
SM	25	1712	14.6 (9.9–21.5)	4	2.3 (0.8–6.2)	32.1 (24.8–41.7)	21	12.2 (8–18.8)
Training	16	1650	9.7 (5.9–15.8)	2	1.2 (0.3–4.8)	15.1 (10.2–22.3)	14	8.5 (5–14.3)
Game	9	62	145.2 (79.3–265.6)	2	32.2 (8.2–126.1)	483.9 (374.2–625.7)	7	112.9 (56.2–226.8)
SF	14	1360	10.3 (6.1–17.3)	11	8.1 (4.5–14.6)	64.7 (52.9–79.2)	3	2.2 (0.7–6.8)
Training	10	1300	7.7 (4.1–14.3)	9	6.9 (3.6–13.3)	42.3 (32.7–54.8)	1	0.7 (0.1–5.4)
Game	4	60	66.7 (25.9–171.8)	2	33.3 (8.5–130.2)	550 (437.5–691.4)	2	33.3 (8.5–130.2)
U19M	12	1490	8.05 (4.6–14.1)	5	3.35 (1.4–8)	42.9 (33.8–54.6)	7	4.7 (2.2–9.8)
Training	9	1430	6.3 (3.3–12.1)	4	2.8 (1–7.4)	43.3 (34–55.3)	5	3.5 (1.4–8.4)
Game	3	60	50 (16.6–150.6)	1	16.6 (2.4–116.4)	33.3 (8.5–130.2)	2	33.3 (8.5–130.2)

h: hours; IR: Incidence Rate; CI: Confidence Interval; RTP: Return-to-play; TLI: Time-loss injuries; MA: Medical Attention; SM: Senior Male; SF: Senior Female, U19M: Under-19 Male

* As the numbers of 'n' were low in some scenarios, the incidence should be interpreted with caution

Table 4. TLI and MA characteristics reported by category.

	Total N = 20	SM N = 4	SF N = 11	U19M N = 5
Total TLI				
Mechanism				
Direct contact	7	1	5	1
Indirect contact	5	1	3	1
Non-contact	8	2	3	3
Onset				
Acute	11	2	8	1
Repetitive gradual onset	6	1	3-	2
Repetitive acute onset	3	1		2
Moment				
Training	15	2	9	4
Competition	5	2	2	1
Time loss in days ± SD (range)	10.4 ± 9,1 (2–30)	13.8 ± 7.5 (5–20)	8 ± 9.4 (2–30)	12.8 ± 9.9 (2–24)
TLI incidence*				
IR (95% CI)	4.4/1000 h (2.8–6.8)	2.3/1000 h (0.8–6.2)	8.1/1000 h (8.5–14.6)	3.35/1000 h (1.4–8)
TIR (95% CI)	3.4/1000 h (2–5.7)	1.2/1000 h (0.3–4.8)	6.9/1000 h (3.6–13.3)	2.8/1000 h (1 – 7.4)
GIR (95% CI)	27.5/1000 h (11.6 – 65.2)	32.2/1000 h (8.2–126.1)	33.3/1000 h (8.5–130.2)	16.6 /1000 h (2.4–116.4)
Total MA				
	Total N = 31	SM N = 21	SF N = 3	U19M N = 7
Mechanism				
Direct contact	13	9	1	3
Indirect contact	–	–	–	–
Non-contact	18	12	2	4
Onset				
Acute	13	9	1	3
Repetitive gradual onset	13	10	2-	1
Repetitive acute onset	5	2		3
Moment				
Training	17	14	1	2
Competition	14	7	2	5
MA Incidence*				
Total MA rate (95% CI)	6.8 /1000 h (4.8–9.6)	12.2/1000 h (8–18.8)	2.2/1000 h (0.7–6.8)	4.7/1000 h (2.2–9.8)
Training MA rate (95% CI)	3.9/1000 h (2.4–6.2)	8.5/1000 h (5–14.3)	0.7/1000 h (0.1–5.4)	3.5/1000 h (1.4–8.4)
Game MA rate (95% CI)	76.9/1000 h (46.5–127.2)	112.9/1000 h (56.2–226.8)	33.3/1000 h (8.5–130.2)	33.3/1000 h (8.5–130.2)

CI: Confidence Interval; MA: Medical Attention; SD: Standard Deviation; TLI: Time-loss injury

* As the numbers of 'n' were low in some scenarios, the incidence should be interpreted with caution

athletes (SF) the IR was 8.1, the TIR was 6.9 and the GIR was 33.3. The IRR for senior athletes in this study was 1.41 (95% CI, 0.74–2.80), which indicates that among senior males was 1.41 times higher compared with that among senior females.

The global, training, and game MA incidence rate were 6.8, 3.9, and 76.9, respectively. The incidence rate for game injuries for the entire study period was 8.19 times higher (95% CI, 2.61–21.36) than that for training injuries.

Severity

Analyzing only the TLI, the mean RTP period was 10.35 ± 9.1 days. The total injury burden was 45.4: 32.1 in SM, 64.7 in SF, and 42.9 in U19M. In terms of TLI severity, 11 (55%) were considered mild (1 to 7 days), 8 (40%) moderate (8 to 28 days), and 1 (5%) severe (>28 days).

The head time-loss injuries showed a mean RTP of 14 ± 11.7 days and an injury burden of 15.3 days/ 10^3 h TAE.

The muscle time-loss injuries showed a mean RTP of 21.3 ± 2.3 days, and the injury burden 14 days/ 10^3 h TAE.

4. Discussion

This study is the first to describe injuries occurring in RH players during an international tournament. Some studies

have been performed in national leagues [11,12,19,20], but to the best of our knowledge, there are no previous studies in international competitions. The results of our study showed a higher incidence of injuries during games comparing with training sessions. These study findings highlight that the most reported injury location was the craniofacial area and the reported muscle injuries mainly affected the thigh area.

Injury incidence

A key variable for understanding the frequency of injuries in athletes is the incidence rate (number of injuries/1000 h) [10]. In RH, only two studies presented data on injury rate (IR) using standardized formulas and both studies focused on international Portuguese youth players [13,14]. The IRs were 3.23 and 4.9, respectively; TIRs 1.77 and 3.7; and GIRs 18.45 and 17.55. In our study, the data in youth players (U19M) were similar, with IR 3.35, TIR 2.79, and GIR 16.6. As three studies in youth players show similar incidence rates, we can conclude these are the expected injury rates in youth RH players.

As no previous studies have reported IRs in senior players, we can only compare our results with data collected from senior male athletes during international tournaments of other indoor sports. Ice hockey reported a GIR of 59.6 (however, for ice hockey, inability to return to the game, lacerations that needed

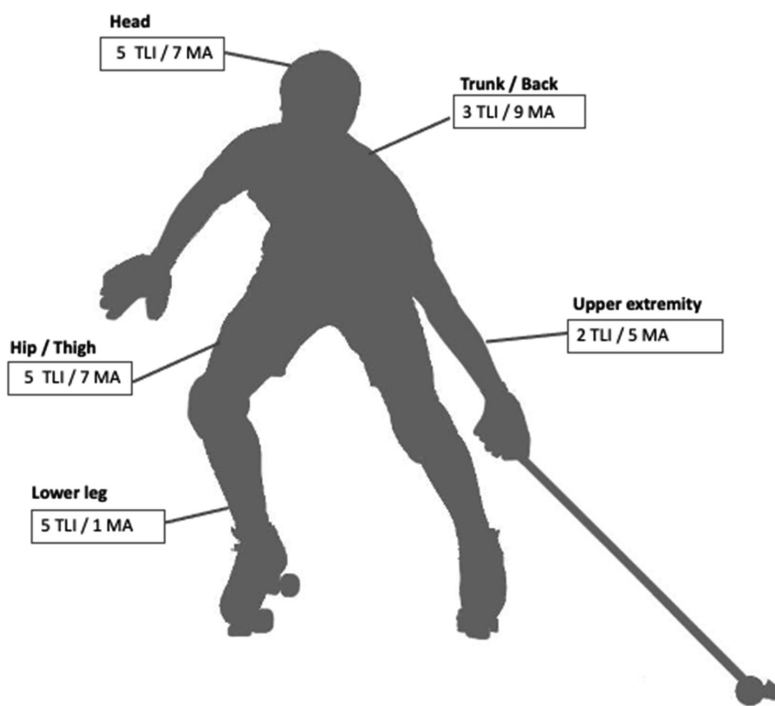


Figure 1. Injured body area of rink hockey players with time loss injuries (TLI) and medical attention (MA).

MA, and dental injuries were also considered) [21], handball reported 104.5 of GIR [22], and futsal reported 196.5 of GIR [7]. As we can see, all sports reported a higher IR during games.

Finally, a meta-analysis conducted in futsal compared the GIRs in international tournaments and national leagues, concluding that they were significantly higher in international tournaments [23]. In this context, the data obtained in our study can be used as a starting point to define injury incidence in senior RH players during international competitions.

The GIR obtained in our study was lower compared to the other screened indoor sports.

The fact that the incidence rate was 8.2 higher in games comparing with training must be highlighted. The competition format differs from national competitions, centering 6 games in 8 days and with a lower number of training sessions between games. The injury characteristics, including injury rates, onset, and RTP can differ from injuries sustained in national competitions, where games are more separated in time.

Injury severity

The majority (55%) of the reported TLI in our study were considered mild, followed by moderate (40%), and severe (5%). Previous studies on male RH players in national leagues showed that moderate TLI were the most frequent, followed by mild and severe [12–14]. The characteristics of the international competition that we analyzed (intensive competition,

with 6 games in 8 days, compared with full-season, where teams use to play once a week) may be a factor of these differences, as it has been reported in other sports [22].

The total injury burden was 45.4 (Table 3): 32.1 in SM, 64.7 in SF, and 42.9 in U19M. The injury burden during game was 357.1.

No previous studies about injury burden in RH have been published. In other sports' international competitions, injury burden has been reported to be even higher than what we found in RH: 2.296 days in the rugby world championship games [24].

We also have references of injury burden in other sports or competitions, such as: 62.2 in male ice hockey players during one season in Norway [25]; and 130 in male football players participating in the UEFA Champions League for 11 seasons [26]. The injury burden reported in these studies was higher in comparison with our study.

Craniofacial injuries

As described by Lopes and Pelaez [19,20] craniofacial injuries are frequent in RH. Given recent public health concerns related to concussions, there has been an increase in awareness and media coverage surrounding this kind of injury [27]. Indeed, in our study, the most affected region of the body was the craniofacial area (12 events: 5 TLI, 7 MA).

In comparison with ice hockey or inline hockey, where using a helmet is mandatory for all players, the use of head

protection is only recommended in youth RH players and only in some countries. Likewise, a mouth guard is only recommended in youth and professional RH players. Some Federations are considering implementing helmet use in all categories and our results can be useful to facilitate this decision. Moreover, measures other than helmet use were applied in the 2006 Futsal World Cup, when referees were encouraged to severely sanction injurious fouls such as intentional elbowing to the head. In that competition, the number of head injuries dropped from 25 to 13, in comparison with previous ones [7].

Based on all these observations, the proposed measures should be implemented by international federations of different sports to decrease head injuries.

Muscle injuries

In two studies conducted among Spanish male professional RH players during a regular season, the most frequent injury was muscle strain, despite affected muscles and injury severity were not reported [11,12]. In our study muscle strain was not the most frequent injury, representing the 15% of the reported injuries: 3 TL muscle strains (1 *biceps femoris*, 1 *rectus femoris*, 1 *adductor longus*) with an incidence of 0.6. The median RTP of the muscle TLI was 21.3 ± 2.3 days, and the injury burden 14 days/10³h TAE. We also recorded 2 MA for muscles (1 *biceps femoris*, 1 *adductor longus*).

In other sports, muscle injuries affecting the thigh are a common and major concern because of their relationship with injury burden and time-loss [28]. Therefore, multiple programs to prevent muscle injuries have been implemented to decrease their effect in athletes' performance [29]. Though the number of muscle injuries in our study was not very high, the fact that all muscle TLI and MA affected the thigh may allow us to theorize that thigh muscles can also be the most affected in RH. However, these results need to be confirmed with larger studies.

Women's hockey

No previous studies recorded injuries in female RH players. Although the number of female RH players was low, it may be interesting to analyze their pattern specifically in females. The TLI and MA characteristics are reported in Table 4. The SF teams reported the majority of TLI in our study ($n = 11$, 55%), with direct contact being the most frequent mechanism, and the onset mainly acute.

Importantly, we did not record muscle strains among female athletes despite similar exposure with male athletes.

Five TLI (45.4%) involved the craniofacial area, with 2 episodes of concussion, 1 mandibular fracture, and 1 nose fracture. These data can be related to other sports injury reports, where female athletes are also more susceptible to sports-related concussions than male athletes (28).

Limitations

One of the limitations of this study was that there were only athletes from three National Teams (Argentina, Portugal, and

Spain). A future study is warranted that includes a larger sample size and potentially performs the same type of investigation, which will provide more power, consistency, and generalizability to the findings. The characteristics of the study sample (elite players competing in an international competition) may hinder the extrapolation of the results to other populations of RH players.

When estimating injury incidences and corresponding 95% CIs, we did not distinguish between the initial injury per competition and subsequent injuries within the same competition. Instead of making an association between the 2 injuries (initial and subsequent injuries per athlete), we computed them as the overall injury IRs. Hence, injuries were assumed to be independent, implying exponentially distributed times until the occurrence of an injury. However, it is possible that, for example, a mechanism exists whereby initial injury potentially leads to subsequent injuries.

We cannot eliminate a concern of a subtle difference in medical activities in clinical staff participants. For instance, it is difficult to evaluate how gradual onset medical attention and/or physical complaints can be recorded the same method in this study. Philosophy and cultural differences in terms of medical care might have influenced the results. Moreover, a classification of the injuries by field position was not possible because of data unavailability.

5. Conclusions

Despite those limitations, this study provides a first of its kind overview of the injury patterns and characteristics of RH players in international competitions. The study findings highlight that the most reported injury location was the craniofacial area and the reported muscle injuries mainly affected the thigh area. The head injuries give cause for concern among RH community and must be targeted in future studies. IR and injury burden were lower than other indoor sports in international and intensive competition.

The present study is a starting point for RH injury surveillance and pattern identification. Future studies are warranted to identify risk factors of injuries and develop a prevention program to reduce injury in RH athletes. Once the main injury risk factors are identified, a more personal approach, working with every athlete as an individual can be set with the final goal of optimal health and sport performance.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

ORCID

Bernat de Pablo  <http://orcid.org/0000-0003-2317-038X>
 Jordi Arboix-Alió  <http://orcid.org/0000-0002-7295-5864>
 Martí Casals  <http://orcid.org/0000-0002-1775-8331>

References

- Moreno D. Anàlisi dels gols en hoquei patins a les lligues espanyola, italiana i portuguesa (Universitat de Barcelona). Published online. 2019;
- Fernández D, Varo F, Carmona G, et al. Quantification of external load of elite rink hockey players in official matches. *J Sports Med Phys Fitness*. 2020;60:12.
- Vitale JA, Castellini G, Gianola S, et al. Analysis of the Christiania stop in professional roller hockey players with and without previous groin pain: a prospective case series study. *Sport Sci Health*. 2019;15(3):641–646.
- Vaz M, Ramos N, Abrantes J, Queiros de Melo F, Conceição F. Biomechanics of the penalty stroke in roller hockey. *Revista Portuguesa de Ciências do Desporto*. 2011;2(11):129–132.
- Warnock R. The effect of injuries on player and team performance: an empirical analysis of the production function in the National Hockey League (Economics Student Theses and Capstone Projects). Published online. 2018;
- Hagglund M. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *Br J Sports Med*. 2005;39:6.
- Junge A, Dvorak J. Injury risk of playing football in Futsal World Cups. *Br J Sports Med*. 2010;44:15.
- Junge A, Dvorak J. Injury surveillance in the world football tournaments 1998–2012. *Br J Sports Med*. 2013;47:12.
- Junge A, Langevoort G, Pipe A, et al. Injuries in Team Sport Tournaments during the 2004 olympic games. *Am J Sports Med*. 2006;34 4 :565–576.
- Bahr R, Clarsen B, Derman W, et al. International olympic committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sports 2020 (Including the STROBE extension for sports injury and illness surveillance (STROBE-SIIS)). *Orthop J Sports Med*. 2020;8:2.
- Egocheaga J, Yague P, Mones L. Características de la patología lesiva en dos deportes de patinaje. *Medicina de rehabilitación*. 2004;17(1):12–16.
- Reverter J, de Vega M, Hernandez V. Occupational injury in Spanish professional roller hockey during two seasons: a comparative study. *J Physic Educ Sport*. 2018;18(3):1767–1772.
- Marques G. Prevalência do “time low injury” em jovens hoquistas do escalão etário 14-16 anos (Universidade de Coimbra). Published online. 2007;
- Gonçalves BF. Lesões desportivas em jovens hoquistas do escalão etário 14-16 anos (Universidade de Coimbra). Published online. 2008;
- World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191–4. DOI: 10.1001/jama.2013.281053
- Orchard J. Revision, uptake and coding issues related to the open access orchard sports injury classification system (OSICS) versions 8, 9 and 10.1. *Open Access J Sports Med*. Published online 207. Oct 2010. DOI:10.2147/OAJSM.S7715.
- van Mechelen W, Hlobil H, Kemper HCG. Incidence, severity, aetiology and prevention of sports injuries. *Sports Med*. 1992;14:2.
- Ekstrand J, Hagglund M, Walden M. Injury incidence and injury patterns in professional football: the UEFA injury study. *Br J Sports Med*. 2011;45:7.
- Pelaez EG, Dascenzi PF, Savastano LE, et al. Lesiones craneofaciales producidas en hockey sobre patines. *Rev Arget Neurocir*. 2008;22 (4):181–185.
- Lopes L, Santos M. Mouthguard and Orofacial Traumatismo in young roller hockey practicers. *Global J Med Research*. 2013;19 (5):5–11-undefined
- Tuominen M, Stuart MJ, Aubry M, et al. Injuries in men’s international ice hockey: a 7-year study of the International Ice Hockey Federation adult world championship tournaments and olympic winter games. *Br J Sports Med*. 2015;49:1.
- Bere T, Alonso JM, Wangenstein A, et al. Injury and illness surveillance during the 24th Men’s Handball World Championship 2015 in Qatar. *Br J Sports Med*. 2015;49:17.
- Ruiz-Pérez I, López-Valenciano A, Elvira JL, et al. Epidemiology of injuries in elite male and female futsal: a systematic review and meta-analysis. *Sci Med Football*. 2021;5:1.
- Fuller C, Taylor A, Douglas M, et al. Rugby World Cup 2019 injury surveillance study. *South Afr J Sports Med*. 2020;32:1.
- Nordstrøm A, Bahr R, Talsnes O, et al. Prevalence and burden of health problems in male elite ice hockey players: a prospective study in the Norwegian professional league. *Orthop J Sports Med*. 2020;8:2.
- Hägglund M, Waldén M, Magnusson H, et al. Injuries affect team performance negatively in professional football: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med*. 2013;47:12.
- McGroarty NK, Brown SM, Mulcahey MK. Sport-Related concussion in female athletes: a systematic review. *Orthop J Sports Med*. 2020;8:7.
- Bahr R, Clarsen B, Ekstrand J. Why we should focus on the burden of injuries and illnesses, not just their incidence. *Br J Sports Med*. 2018;52:16.
- Ekstrand J, Spreco A, Bengtsson H, et al. Injury rates decreased in men’s professional football: an 18-year prospective cohort study of almost 12 000 injuries sustained during 1.8 million hours of play. *Br J Sports Med*. 2021 Feb 5;55:1084–1092. Published online.

CAPÍTOL 6

CONCLUSIONS, LIMITACIONS I FUTURES LÍNIES DE RECERCA

CONCLUSIONS, LIMITACIONS I FUTURES LÍNIES DE RECERCA

Aquesta tesi mostra, d'una banda la literatura existent sobre epidemiologia de les lesions en hoquei patins a partir d'una revisió sistemàtica seguint la metodologia PRISMA i per altra banda, un anàlisi en profunditat el patró lesional en esportistes d'elit tan masculins com femenins, a través d'estudis observacionals descriptius.

REVISIÓ BIBLIOGRÀFICA

La utilització de revisions sistemàtiques, seguint una metodologia estandarditzada, han esdevingut una eina utilitzada en diversos esports per tal de conèixer l'estat del coneixement sobre les lesions esportives. Esports com el futbol (50), l'handbol (51), el futbol sala (52), l'hoquei herba (53) o l'hoquei gel (54) han fet servir aquesta eina per tal de resumir la informació existent sobre la informació reportada en l'epidemiologia de les lesions dels esportistes i la qualitat d'aquesta informació.

Pel que fa l'hoquei patins la revisió bibliogràfica realitzada en l'estudi I (anomenat «Injury incidence and patterns in rink hockey: A systematic review» ha permès concloure que l'evidència científica sobre lesions en hoquei patins publicada fins al moment de la revisió (agost de 2020) és escassa i encara amb moltes possibilitats de millora en quan a les metodologies emprades. Les lesions més freqüentment reportades han estat les lesions musculars, principalment a l'extremitat inferior, encara que no s'han mostrat mesures de freqüència. Les lesions cranials han sigut un motiu de preocupació en la literatura revisada. Cal destacar que no es van trobar publicacions sobre lesions en esportistes femenines i tampoc estudis que reportessin la incidència lesional.

ESTUDIS OBSERVACIONALS EN ESPORTISTES D'ELIT

La tesi analitza mitjançant estudis observacionals les mostres més amples de jugadors d'elit de HP presentades fins al moment.

Els estudis II i III inclouen mostres de les màximes competicions espanyoles, gestionades per la *Real Federación Española de Patinaje*. L'estudi II (anomenat «Epidemiología lesional en la liga española de hockey patines masculina y femenina: un estudio descriptivo») avalua 137 esportistes (98 homes i 39 dones) participants en la primera divisió masculina i femenina de la temporada 2020/21. L'estudi III (anomenat «Time-loss injuries among male and female Spanish rink hockey players»). avalua 282 esportistes (206 homes i 76 dones) participants de la primera i segona divisió masculina i primera divisió femenina de la temporada 2021/22.

En l'estudi IV titulat «Analysis of injuries during the 2019 Rink Hockey World Championship» s'estudien 91 esportistes (61 homes i 30 dones) de 3 nacionalitats diferents participants en el Campionat del Món celebrat a Barcelona l'any 2019. Pel que fa a les competicions internacionals, cal considerar que les característiques de les mateixes, dissenyades en format intensiu (6 partits en 8 dies) poden ocasionar diferències en el perfil lesional en comparació amb les competicions nacionals de temporada sencera (1-2 partits per setmana), com ja s'ha demostrat en altres esports (55). Els resultats d'aquest estudi són pioners en l'avaluació de les lesions en una competició internacional d'aquestes característiques i han de servir com a punt de partida per l'anàlisi de mostres més grans, amb més equips que participin en la recollida de dades.

CARACTERÍSTIQUES DE LES LESIONS

Les extremitats inferiors han estat la localització més freqüentment lesionada en tots els estudis (II,III i IV), coincidint també en els estudis publicats anteriorment i descrits en la revisió bibliogràfica. Aquesta localització coincideix amb esports com el futbol (50), futbol sala (52) i hoquei herba (53).

Cal destacar que les lesions musculotendinoses han estat les lesions més reportades en els estudis II i III, i les segones més reportades en l'estudi IV. Els músculs més freqüentment afectats, tant en esportistes masculins com femenins, han estat els músculs adductors de la cuixa.

La proporció d'incidència de lesions musculars ha estat de 32,8 (IC 95% 25,2-42,5) en l'estudi II i 24,2 (IC 95% 19,1-29,1) en l'estudi III. Comparant per gènere, la PI en gènere masculí va ser de 26,4 (IC 95% 27,1-48,9) en l'estudi II i 23,9 (IC 95% 18,9-29,9) en l'estudi III. Pel que fa a les PI en gènere femení van ser de 25,6 (IC 95% 15-43,8) i 24,8 (17,2-34,7) respectivament. Pel que fa a les lesions tendinoses la regió més afectada ha estat igualment la musculatura adductora de la cuixa. La PI en l'estudi II va ser de 9,5 (IC 95% 5,4-16,6) i en l'estudi III de 10,6 (IC 95% 7,8-14). Aquests resultats coincideixen amb els de Florit et al. (56) que va estudiar les tendinopaties dels esportistes masculins de la secció d'hoquei patins del Futbol Club Barcelona durant 8 temporades, descrivint una PI de 10,7 (IC 95% 9,5-12).

La biomecànica de l'hoquei patins, amb un desplaçament lateral i posterior de l'extremitat inferior durant el gest de patinar pot explicar l'origen d'aquestes lesions., reforçat pel fet que les lesions de la musculatura adductora també són freqüents en altres esports de patinatge (44,57). La mateixa biomecànica, amb menor contacte vertical i sense fixació del peu durant les arrencades, pot explicar la baixa incidència de lesions en la musculatura isquiotibial, molt freqüents en esports com el futbol (58) o l'hoquei herba (53,59) i que generen molt temps de baixa esportiva (60). En un estudi realitzat sobre lesions de la musculatura isquiotibial en les diferents modalitats esportives del Futbol Club Barcelona al llarg de 10 temporades, s'ha demostrat que la PI de lesions de la musculatura isquiotibial en els jugadors d'hoquei patins és de 0,5 lesions/100 atletes/temporada. La mediana de baixa esportiva d'aquestes lesions d'isquiotibial va ser de 12 dies (10-55) (61).

Els programes de prevenció de lesions musculotendinoses han estat implementats i quantificats en diversos esports, principalment en el futbol (62). Els resultats obtinguts indiquen que caldria posar més atenció i recursos en la prevenció de lesions musculotendinoses a la regió adductora de la

cuixa, creant programes de prevenció per tal de disminuir la incidència de les mateixes i el seu efecte sobre la salut i el rendiment dels esportistes.

Un resultat rellevant dels estudis realitzats és que no s'han descrit lesions dels lligaments encreuats de genoll. Aquestes lesions, una veritable epidèmia en altres esports com el futbol (59), el basquetbol (63) i l'handbol (51), generen una baixa esportiva molt llarga, limitant el rendiment a curt i mitjà termini dels esportistes. Cal destacar la naturalesa de l'hoquei patins, on no existeix fixació del peu a l'hora de fer rotacions de genoll podria explicar la nul·la incidència d'aquest tipus de lesions en els estudis realitzats.

Les lesions lligamentoses descrites en el nostre estudi han afectat al lligament lateral extern del turmell i al lligament lateral intern del genoll, aquest últim principalment a porters.

Pel que fa a la severitat de les lesions, en els tres estudis observacionals (II, III i IV) la majoria de lesions registrades van ser lleus (1- 7 dies). Això contrasta amb altres esports com el hoquei línia (57) o el futbol (64) on la majoria de lesions descrites durant una temporada van ser greus (més de 28 dies).

Pel que fa a les re-lesions, tan en l'estudi II com en l'estudi III un 6,4% de les TLI descrites van ser re-lesions. Aquests resultats són menors que en el futbol, en l'estudi de Noya et al (65) on la taxa de re-lesions va ser del 11,9% i en l'estudi de Calligeris et al. (64) on va ser de un 12%.

LESIONS TRAUMÀTIQUES

Les lesions traumàtiques (contusions, fractures) són freqüents en l'hoquei patins, en relació a la pròpia natura de l'esport (10), aquesta tendència també s'ha vist en l'hoquei gel (66) i l'hoquei línia (57). Dins les lesions descrites destaquen les fractures, especialment rellevants pel que fa a dies de baixa, representant una mediana de RTP de 21,5 dies (rang 3-180) en l'estudi III.

Les lesions traumàtiques han tingut especial importància en l'estudi IV, sent les lesions més freqüents durant el Campionat del Món disputat a Barcelona. Aquestes lesions van ser més freqüents durant els partits que

durant els entrenaments, fet que pot ser explicat pel format intensiu de la competició.

Les lesions craniofacials són un motiu més de preocupació en el món de l'hoquei patins. Això ho demostra que dels pocs articles que hi havia publicats fins al moment sobre epidemiologia lesional, dos estiguessin orientats a l'estudi d'aquesta patologia (67,68). En dades no publicades de la Federació Catalana de Patinatge (4), en l'estudi dels comunicats de lesions en esportistes federats de HP, les lesions de la zona craniofacial van suposar el 24% de lesions totals. És per aquest motiu que la temporada 2021/22 es va instaurar l'obligatorietat de casc protector en categories inferiors a 15 anys (69), equiparant-lo a l'hoquei gel, on es va instaurar l'ús de casc en totes les categories l'any 1965 (70). L'efecte d'aquesta mesura preventiva encara no ha estat quantificada. D'altra banda, la utilització de casc en categories sènior no és obligatori tot i que les dades obtingudes han evidenciat ser una causa freqüent de lesions tant en competicions nacionals com internacionals.

Seguint la seqüència de prevenció de lesions dins del món de l'hoquei patins, les lesions craniofacials són les que han arribat més lluny, doncs s'ha definit un problema i s'han proposat mesures preventives (l'ús del casc). Dins dels següents passos a seguir caldrà valorar l'efectivitat d'aquesta mesura, en quan a disminució de la incidència de lesions craniofacials. En el cas que la mesura es demostrï efectiva caldria valorar la seva aplicació a totes les categories.

D'altra banda, esports com el rugbi, l'hoquei gel o el futbol americà han posat en pràctica normatives de tolerància 0 a les lesions cranials, buscant canvis de normativa de joc i realitzant formació a entrenadors, jugadors, àrbitres i staff sobre les repercussions que poden tenir aquest tipus de lesions en els esportistes a curt, mig i llarg termini (71-73). Aquestes mesures no estan vigents en l'hoquei patins i caldria valorar la seva implementació per contribuir a disminuir la incidència d'aquestes lesions.

MESURES D'INCIDÈNCIA

Els estudis realitzats han reportat per primera vegada el càlcul d'incidència (taxes d'incidència i proporció d'incidència) en les lesions de l'hoquei patins.

En l'estudi IV s'ha calculat la taxa d'incidència de 9 equips de 3 combinats nacionals durant una competició internacional. Es tracta del primer estudi en HP que analitza la taxa d'incidència utilitzant les hores d'exposició tan en entrenaments com en partits. Les xifres obtingudes han estat inferiors a competicions internacionals d'altres esports indoor, com el futbol sala (74), handbol (55) o hoquei gel (44). La majoria de lesions reportades han estat d'origen traumàtic, principalment a la zona craniofacial, seguides per lesions per sobreús de tipus muscular i tendinós.

En els estudis II i III s'ha calculat la proporció d'incidència (PI) en les màximes competicions nacionals espanyoles durant la temporada 2020/21 (estudi II) i 2021/22 (estudi III). La proporció d'incidència de lesions totals en l'estudi II va ser de 68,6 (IC 95% 61,2-76,8) lesions/100 esportistes/temporada i en l'estudi III va ser de 60,9 lesions/100 esportistes/temporada. Desglossat per gènere, tan en l'estudi II com en l'estudi III s'ha vist que la PI és superior en jugadores femenines que en jugadors masculins, encara que les diferències que no han estat significatives.

Tant la taxa d'incidència de l'estudi IV com les proporcions d'incidència dels estudis II i III han estat majors en partits que en entrenaments, tant en esportistes masculins com femenines. Aquesta tendència coincideix amb altres esports (50), confirmant la teoria que no s'entrena com es competeix. Igualment, s'ha vist que les lesions sense contacte es produïen principalment en entrenaments i les lesions amb contacte es produïen durant la competició.

En l'estudi III s'han fet servir per primera vegada en estudis d'hoquei patins els càlcul de mesures absolutes i relatives de risc, permetent mostrar tant la raó entre incidències com la diferència entre les mateixes. L'obtenció d'aquestes mesures, recomanades en la guia STROBE (75,76) , seria recomanable en futurs estudis d'epidemiologia lesional, per tal d'obtenir dades el més acurades possibles.

LESIONS EN PORTERS

Els porters són un peça clau en el desenvolupament dels partits de hoquei patins (31). La seva postura al jugar és totalment diferent als jugadors de camp, fent que la seva biomecànica sigui igualment diferencial. També, el fet d'haver de col·locar-se en la trajectòria de la bola per tal d'evitar el gol fa que el risc de traumatisme per contacte amb la bola sigui major que en el jugador de pista, encara que està equipat amb proteccions (**Figura 6**). Altres esports com l'hoquei gel ha estudiat de forma diferencial les lesions en porters donada la seva posició i la seva postura específica, principalment a nivell de lesions de maluc i pelvis i contusions cranials (77,78).



Figura 6: Proteccions i posició de genoll a terra adoptada pels porters de hoquei patins. Font: Guillem Trabal.

El fet que un dels 5 membres de l'equip tingui una funció diferenciada fa que el seu risc lesional sigui diferent. Els resultats de la tesi diferencien per primera vegada els patrons lesionals en porters, demostrant que la incidència lesional és menor que en jugadors de camp, desmentint el mite que la de porter és la posició més perillosa de l'hoquei patins (79) Les lesions lligamentoses de genoll, principalment del lligament lateral intern, i les lesions de musculatura isquiotibial han resultat més prevalents en porters

que en jugadors de camp, fet que es pot explicar per la postura adoptada pels mateixos (**Figura 6**). Així doncs, les estratègies preventives hauran de ser diferents entre els jugadors de camp i els porters.

LESIONS EN JUGADORES D'HOQUEI PATINS

Fins al moment no s'havien descrit els patrons lesionals en jugadores d'elit d'hoquei patins. En els últims anys la evidència científica ha demostrat que els patrons lesionals femenins són diferents als masculins, i per tant han de ser estudiats de forma diferencial (80). Tot i així cal destacar el poc número d'estudis que descriuen els patrons de lesions en esportistes femenines en tots els esports, encara que la creixent professionalització de l'esport femení en la última dècada està fent que augmenti l'interès de la comunitat científica envers aquesta branca de la medicina esportiva i es plantegin nous estudis que aportin nous coneixements (81-84) i permetin enfocar les lesions d'una forma diferencial en aquesta població.

En el col·lectiu d'esportistes femenines s'ha observat una major prevalença de lesions lligamentoses a l'extremitat inferior, tant de turmell com de genoll. Diversos estudis han relacionat una major laxitud en el gènere femení, comportant un major risc de lesions lligamentoses (85,86). Tot i així, mentre que en altres esports s'ha detectat una preocupant incidència de lesions greus de genoll, principalment del lligament encreuat anterior (87), en cap dels nostres estudis s'ha detectat una lesió greu en aquesta estructura.

Pel que fa a la proporció d'incidència, en l'estudi II la PI en esportistes femenines va ser de 84,6 (IC 95% 74-96,7) TLI/100 esportistes/temporada i en l'estudi III va ser de 55,5 (IC95% 43,7-69,4). Existeixen pocs estudis que analitzin la proporció d'incidència lesional en equips d'elit femenins: en hoquei herba s'han descrit xifres de 200,6 TLI/100 esportistes/temporada (88), en handbol 126,7 (89) i en futbol de 146,1 (90).

Així doncs, els resultats de la nostra tesi marquen un punt de partida pel que fa a l'epidemiologia lesional en esportistes femenines d'hoquei patins, posant en evidència que cal un enfoc específic per gènere a l'hora d'estudiar l'epidemiologia lesional.

LIMITACIONS

Els estudis realitzats s'han fet principalment en els equips sènior que tenen infraestructura suficient per poder realitzar una vigilància epidemiològica de les lesions. No s'han pogut obtenir dades d'esportistes amateurs o de categories inferiors.

Igualment, només s'han realitzat estudis durant un període limitat de temps, com una temporada o una competició internacional.

En els estudis II i III no s'ha pogut obtenir les dades referents a les hores d'exposició (entrenaments i partits), obligant a utilitzar la proporció d'incidència, a diferència de l'estudi IV on vam utilitzar la taxa d'incidència. Aquest fet dificulta la comparació entre els estudis, encara que analitzen formats de competició diferents.

El fet que les lesions siguin reportades pels professionals de cada club pot fer que existeixi biaixos pel que fa al diagnòstic i maneig, on inevitablement hi haurà diferències de criteri donada la variabilitat interpersonal de la pràctica clínica.

CONCLUSIONS

- L'hoquei patins és un esport amb llarga tradició que té un patró lesional específic.
- La investigació sobre lesions en hoquei patins és escassa, amb estudis amb una metodologia molt diversa que dificulta comparacions entre ells i limita la obtenció de patrons específics i l'obtenció de conclusions homogènies.
- Les lesions més freqüents en esportistes d'hoquei patins són les lesions musculars, especialment a extremitats inferiors i a la regió medial de la cuixa (musculatura adductora).
- Les lesions traumàtiques són també freqüents en aquest esport. Les lesions cranials són motiu de preocupació i és important realitzar una monitorització de les estratègies de prevenció (utilització de casc) proposades pels estaments reguladors de l'hoquei patins.

- Les jugadores femenines presenten un patró lesional similar que en esportistes masculins, sense presentar diferències significatives entre gèneres tot i que caldrien més estudis.
- Els porters tenen un patró lesional específic, destacant les lesions de genoll.

APLICACIONS PRÀCTIQUES

Un cop coneguts els patrons lesionals en l'hoquei patins podem dissenyar i implementar mesures preventives per tal de limitar la incidència de les lesions sobre la salut i el rendiment dels esportistes.

Amb la informació obtinguda per aquesta tesi doctoral podem definir quines són les lesions que s'haurien de prioritzar en aquestes estratègies preventives.

FUTURES LÍNIES D'INVESTIGACIÓ

- Realitzar un estudi prospectiu durant més d'una temporada per confirmar els patrons lesionals descrits en aquesta tesi doctoral.
- Realitzar estudis d'epidemiologia lesional en categories sènior no nacionals i en categories inferiors.
- Recopilar les hores d'exposició (entrenament i partit) per facilitar el càlcul de incidència lesional i *injury burden*.
- Calcular la incidència lesional segon la càrrega externa valorada mitjançant GPS.
- El casc protector s'ha implementat com a eina per prevenir les lesions craniofacials en categories inferiors. Caldria veure la seva repercussió per valorar si cal mantenir-la i considerar la seva implementació com a estratègia preventiva en categoria sènior.
- Proposar estratègies per la reducció de les lesions craniofacials com les que s'han implementat en altres esports.
- Crear i avaluar programes de prevenció de lesions de la musculatura adductora de la cuixa.

- Crear i avaluar programes de prevenció de les lesions de genoll en porters/es.

REFERÈNCIES BIBLIOGRÀFIQUES

1. Moreno D. Anàlisi dels gols en hoquei patins a les lligues espanyola, italiana i portuguesa. Tesi doctoral. Universitat de Barcelona. Barcelona; 2019.
2. Pout R. The early years of English Roller Hockey. Thanet Printing Works; 1993.
3. Kingman J, Dyson R. The scientific literature available on roller hockey. *J Hum Mov Stud.* 2001;41:415-33.
4. Federació Catalana de Patinatge. Disponible a: www.fcpatinatge.cat (consulta octubre 2022)
5. Real Federación Española de Patinaje. Disponible a: www.fep.es (consulta octubre 2022)
6. Arboix-Alió J, Buscà B, Busquets A, Aguilera-Castells J, de Pablo B, Montalvo AM, et al. Relationship between inter-limb asymmetries and physical performance in rink hockey players. *Symmetry.* 2020;12(12):2035.
7. Yagüe P, del Valle M, Egocheaga J, Linnamo V, Fernández A. The competitive demands of elite male rink hockey. *Biol Sport.* 2013; 30(3): 195-9.
8. Fernández D, Varo F, Carmona G, Reche X. Quantification of external load of elite rink hockey players in official matches. *J Sports Med Phys Fitness.* 2020; 60(12): 1550-25.
9. Vaz M, Ramos N, Abrantes J, Queiros de Melo F, Conceição F. Biomechanics of the penalty stroke in roller hockey. *Port J Sports Sci.* 2011;2(11):129-32.

10. Pons M, Ferrer H. Lesiones traumatólogicas en el hockey sobre patines. *Apunts: educació física y deporte*. 1991;23:35-44.
11. Porta M. *Dictionary of Epidemiology*. 6th ed. Porta M, editor. New York: Oxford University Press; 2014.
12. Hägglund M, Waldén M, Til L, Pruna R. The importance of epidemiological research in sports medicine. *Apunts Medicina de l'Esport*. 2010;45(166): 57-59
13. Warnock R. The effect of injuries on player and team performance: an empirical analysis of the production function in the national hockey league. Tesis doctoral. Skidmore College. Nova York 2018.
14. Hägglund M. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *Br J Sports Med*. 2005;39(6): 340-346
15. Hägglund M, Waldén M, Magnusson H, Kristenson K, Bengtsson H, Ekstrand J. Injuries affect team performance negatively in professional football: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med*. 2013;47(12):738-42.
16. Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, et al. International Olympic Committee Consensus Statement: Methods for Recording and Reporting of Epidemiological Data on Injury and Illness in Sports 2020 (Including the STROBE Extension for Sports Injury and Illness Surveillance (STROBE-SIIS)). *Orthop J Sports Med*. 2020;8(2): 2325967120902908.
17. van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports Injuries. A review of concepts. *Sports Med*. 1992;14(2): 82-99.
18. Finch C. A new framework for research leading to sports injury prevention. *J Sci Med Sport*. 2006;9(1-2):3-9.
19. Fuller CW, Ekstrand J, Junge A, Andersen T, Dvorak J, Hägglund M, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med*. 2006;40(3):193-201.

20. Bolling C, van Mechelen W, Pasman HR, Verhagen E. Context matters: revisiting the first step of the 'sequence of prevention' of sports injuries. *Sports Med.* 2018;48(10):2227-34.
21. Roaas A, Nilsson S. Major injuries in Norwegian football. *Br J Sports Med.* 1979;13(1):3-5.
22. Hawkins RD, Fuller CW. An examination of the frequency and severity of injuries and incidents at three levels of professional football. *Br J Sports Med.* 1998;32(4):326-32.
23. Ekstrand J, Hagglund M, Walden M. Injury incidence and injury patterns in professional football: the UEFA injury study. *Br J Sports Med.* 2011;45(7): 553-58.
24. Rothman KJ, Greenland S. Measures of disease frequency. In: Rothman KJ, Greenland S, editors. *Modern Epidemiology*. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 1998. p. 29-46.
25. Phillips LH. Sports injury incidence. *Br J Sports Med.* 2000 Apr 1;34(2):133-6.
26. Aguado X. Cuantificación de los desplazamientos de los jugadores de hockey patines durante la competición. *Apunts Educación Física y Deportes.* 1991;23:71-6.
27. Valente-dos-Santos J, Sherar L, Coelho-e-Silva MJ, Pereira JR, Vaz V, Cupido-dos-Santos A, et al. Allometric scaling of peak oxygen uptake in male roller hockey players under 17 years old. *App Physiol Nutr Metab.* 2013;38(4): 390-95.
28. Arboix J, Aguilera J. Comparación entre criterios de pierna dominante y pierna fuerte en hockey patines. *J Sport Health Res.* 2021;13(1):13-22.
29. Arboix-Alió J, Trabal G, Buscà B, Peña J, Arboix A, Hilenó R. The behaviour of home advantage during the COVID-19 pandemic in european rink hockey leagues. *Int J Environ Res Public Health.* 2021;19(1):228.

30. Arboix-Alió J, Buscà B, Aguilera-Castells J, Trabal Taña G, Sánchez-Lopez MJ. Comparison of home advantage in men's and women's Portuguese roller hockey league. *Cuadernos Psicol Deporte*. 2019;20(1): 181-189.
31. Trabal G, Daza G, Arboix J. Influencia de las variables contextuales en la intervención del portero de hockey patines en la falta directa. *Cuadernos Psicol Deporte*. 2020;20(2):139-51.
32. Trabal G, Daza G, Riera J. Goalkeeper effectiveness in the direct free hit of rink hockey. *Apunts Educación Física y Deportes*. 2020;(139):56-64.
33. Romero E, de Pablo B, Garcia-Almeida T. Anthropometry in elite roller hockey players. *Atena J Sport Sci*. 2020;4(2):1-9.
34. Romero E, de Pablo B, Bernardo G, Salvador J. Anthropometric study in the players of the Spanish Female Team of Roller Hockey. *Atena J Sports Sci*. 2020;2(6):1-10.
35. Sousa T, Valente J, Sarmento H, Duarte JP, Field A, Vaz V. Características antropométricas de los porteros masculinos de hockey sobre patines. *Rev Andal Med Deporte*. 2022; 15(2): 38-42.
36. Ferraz A, Valente-Dos-Santos J, Sarmento H, Duarte-Mendes P, Travassos B. A review of players' characterization and game performance on male rink-hockey. *Int J Environ Res Public Health*. 2020;17(12):4259.
37. Fuller C, Taylor A, Douglas M, Raftery M. Rugby World Cup 2019 injury surveillance study. *South Afr J Sports Med*. 2020;32(1): 1-6.
38. Borowski LA, Yard EE, Fields SK, Comstock RD. The epidemiology of US high school basketball injuries, 2005-2007. *Am J Sports Med*. 2008;36(12): 2328-35.
39. Mónaco M, Gutiérrez Rincón JA, Montoro Ronsano JB, Til L, Drobic F, Nardi Vilardaga J, et al. Epidemiología lesional del balonmano de elite: estudio retrospectivo en equipos profesional y formativo de un mismo club. *Apunts Sports Med*. 2014;49(181):11-9.

40. Bove T, Rodas G, Pedret C, Esparza F, Casals M. Analysis of the injuries of a professional basketball team during 22 seasons attended by the same physiotherapist. *Apunts Sport Med.* 2019;54(204):139-47.
41. Prieto-González P, Martínez-Castillo JL, Fernández-Galván LM, Casado A, Soporki S, Sánchez-Infante J. Epidemiology of sports-related injuries and associated risk factors in adolescent athletes: an injury surveillance. *Int J Environ Res Public Health.* 2021;18(9):4857.
42. Pluim BM. Tennis injuries: occurrence, aetiology, and prevention. *Br J Sports Med.* 2006;40(5):415-23.
43. Anderson GR, Melugin HP, Stuart MJ. Epidemiology of injuries in ice hockey. *Sports Health: A Multidisciplinary Approach.* 2019;11(6): 514-19
44. Tuominen M, Stuart MJ, Aubry M, Kannus P, Parkkari J. Injuries in men's international ice hockey: a 7-year study of the international ice hockey federation adult world championship tournaments and olympic winter games. *Br J Sports Med.* 2015;49(1): 30-6
45. Smith AM, Stuart MJ, Roberts WO, Dodick DW, Finnoff JT, Jorgensen JK, et al. Concussion in ice hockey. *Clinical J Sport Med.* 2017;27(5):503-9.
46. Reverter J, de Vega M, Hernandez V. Occupational injury in Spanish professional roller hockey during two seasons: a comparative study. *J Phys Ed Sport.* 2018;18(03):1767-72.
47. Husen M, Burgsmüller L, Burggraf M, Jäger M, Dudda M, Kautner M. Injuries and overuse syndromes in rink hockey players. *Int J Sports Med.* 2021;42(02): 132-37.
48. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ.* 2009;339:b2535.
49. Rethlefsen ML, Kirtley S, Waffenschmidt S, Ayala AP, Moher D, Page MJ, et al. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. *Syst Rev.* 2021;10(1):39.

50. López-Valenciano A, Ruiz-Pérez I, Garcia-Gómez A, Vera-Garcia FJ, de Ste Croix M, Myer GD, et al. Epidemiology of injuries in professional football: a systematic review and meta-analysis. *Br J Sports Med.* 2020 Jun;54(12):711-8.
51. Vila H, Barreiro A, Ayán C, Antúnez A, Ferragut C. The most common handball injuries: a systematic review. *Int J Environ Res Public Health.* 2022;19(17):10688.
52. Ruiz-Pérez I, López-Valenciano A, Elvira JL, García-Gómez A, de Ste Croix M, Ayala F. Epidemiology of injuries in elite male and female futsal: a systematic review and meta-analysis. *Sci Med Football.* 2021;5(1): 59-71.
53. Barboza SD, Joseph C, Nauta J, van Mechelen W, Verhagen E. Injuries in field hockey players: A systematic review. *Sports Med.* 2018;48(4): 849-66.
54. Emery CA, Hagel B, Decloe M, Carly M. Risk factors for injury and severe injury in youth ice hockey: a systematic review of the literature. *Inj Prev.* 2010;16(2):113-8.
55. Bere T, Alonso JM, Wangensteen A, Bakken A, Eirale C, Dijkstra HP, et al. Injury and illness surveillance during the 24th men's handball world championship 2015 in Qatar. *Br J Sports Med.* 2015;49(17): 1151-6
56. Florit D, Pedret D, Casals M, Malliaras P, Sugimoto D, Rodas G. Incidence of tendinopathy in team sports in a multidisciplinary sports club over 8 seasons. *J Sports Sci Med.* 2019;18(4):780-8.
57. Moreno-Alcaraz VJ, Cejudo A, Sainz de Baranda P. Injury types and frequency in Spanish inline hockey players. *Phys Ther Sport.* 2020;42: 91-99.
58. Ekstrand J, Häggglund M, Waldén M. Epidemiology of Muscle Injuries in Professional Football (Soccer). *Am J Sports Med.* 2011;39(6): 1226-32.

59. Bisciotti GN, Chamari K, Cena E, Bisciotti A, Bisciotti A, Corsini A, et al. Anterior cruciate ligament injury risk factors in football. *J Sports Med Phys Fitness*. 2019;59(10): 1724-38.
60. Rudisill SS, Kucharik MP, Varady NH, Martin SD. Evidence-based management and factors associated with return to play after acute hamstring injury in athletes: a systematic review. *Orthop J Sports Med*. 2021;9(11):232596712110538.
61. Gudelis M, Pruna R, Trujillano J, Lundblad M, Khodae M. Epidemiology of hamstring injuries in 538 cases from an FC Barcelona multi sports club. *Phys Sportsmed*. 2023; 27;1-8.
62. Ekstrand J, Spreco A, Bengtsson H, Bahr R. Injury rates decreased in men's professional football: an 18-year prospective cohort study of almost 12 000 injuries sustained during 1.8 million hours of play. *Br J Sports Med*. 2021; 55(19):1084-91.
63. Tummala S v., Morikawa L, Brinkman J, Crijns TJ, Economopoulos K, Chhabra A. Knee injuries and associated risk factors in national basketball association athletes. *Arthrosc Sports Med Rehabil*. 2022;4(5):e1639-45.
64. Calligeris T. The incidence of injuries and exposure time of professional football club players in the Premier Soccer League during football season. *South Afr J Sports Med*. 2015;27(1):16-9.
65. Noya J, Sillero M. Epidemiologia de las lesiones en el fútbol profesional español en la temporada 2008-2009. *Arch Med Deporte*. 2012;29(150):750-66.
66. McKay CD, Tufts RJ, Shaffer B, Meeuwisse WH. The epidemiology of professional ice hockey injuries: a prospective report of six NHL seasons. *Br J Sports Med*. 2014;48(1); 57-62.
67. Pelaez EG, Dascenzi PF, Savastano LE, Cremaschi FE. Lesiones craneofaciales producidas en hockey sobre patines. *Rev Arget Neurocir*. 2008;22(4):181-5.

68. Lopes L, Santos M. Mouthguard and Orofacial Traumatismo in Young Roller Hockey Practicers. *Global J Med Res.* 2013;19(5):5-11
69. Real Federación Española de Patinaje. La Real Federación Española de Patinaje y Prokover presentan el casco oficial de hockey patines - Hockey Patines [Internet]. Disponible a: <https://fep.es/website/14-13246-la-real-federacion-espanola-de-patinaje-y-prokover-presentan-el-casco-oficial-de-hockey-patines.htm> (consulta agost 2022)
70. Greenhow A, Doherty A. Two sports, two systems, one goal: a comparative study of concussion policies and practices of the australian football league and hockey canada. *Front Sports Act Living.* 2021;3: 672895.
71. Prien A, Grafe A, Rössler R, Junge A, Verhagen E. Epidemiology of head injuries focusing on concussions in team contact sports: a systematic review. *Sports Med.* 2018;48(4):953-69.
72. Kirkwood G, Parekh N, Ofori-Asenso R, Pollock AM. Concussion in youth rugby union and rugby league: a systematic review. *Br J Sports Med.* 2015;49(8):506-10.
73. Schmidt JD, Welch D, ML Weber, Bierema L, Miller LS, Courson R, et al. Coach, sports medicine, and parent influence on concussion care seeking intentions and behaviors in collegiate student-athletes. *J Clin Transl Res.* 2020;5(4):215-26.
74. Junge A, Dvorak J. Injury risk of playing football in Futsal World Cups. *Br J Sports Med.* 2010;44(15): 1089-1092
75. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet.* 2007;370(9596):1453-7.
76. Nielsen RO, Shrier I, Casals M, Nettel-Aguirre A, Møller M, Bolling C, et al. Statement on methods in sport injury research from the 1st METHODS MATTER Meeting, Copenhagen, 2019. *Br J Sports Med.* 2020;54(15): 94.

77. Mehta N, Nwachukwu BU, Kelly BT. Hip injuries in ice hockey goaltenders. *Oper Tech Sports Med.* 2019 ;27(3):132-7.
78. Whiteside D, Deneweth JM, Bedi A, Zernicke RF, Goulet GC. Femoroacetabular impingement in elite ice hockey goaltenders. *Am J Sports Med.* 2015;43(7):1689-97.
79. Trabal Tañá G. Estudi etnogràfic del porter d'hoquei sobre patins: una vida entre paradoxes. *Apunts Educación Física y Deportes.* 2016;(126):23-9.
80. Wiese-Bjornstal DM, Franklin AN, Dooley TN, Foster MA, Wings JB. Observations about sports injury surveillance and sports medicine psychology among female athletes. *Women Sport Phys Act J.* 2015;23(2):64-73.
81. Ruiz-Pérez I, López-Valenciano A, Elvira JL, García-Gómez A, de Ste Croix M, Ayala F. Epidemiology of injuries in elite male and female futsal: a systematic review and meta-analysis. *Sci Med Football.* 2021;5(1): 59-71
82. Reed N, Taha T, Greenwald R, Keightley M. Player and game characteristics and head impacts in female youth ice hockey players. *J Athl Train.* 2017;52(8):771-75.
83. McGroarty NK, Brown SM, Mulcahey MK. Sport-related concussion in female athletes: a systematic review. *Orthop J Sports Med.* 2020;8(7): 2325967120932306.
84. Okholm Kryger K, Wang A, Mehta R, Impellizzeri FM, Massey A, McCall A. Research on women's football: a scoping review. *Sci Med Football.* 2022;6(5): 549-58.
85. Hosea TM, Carey CC, Harrer MF. The Gender Issue: Epidemiology of ankle injuries in athletes who participate in basketball. *Clin Orthop Relat Res.* 2000;372:45-9.
86. Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. *Sports Med.* 2014 ;44(1):123-40.

87. Sutton KM, Bullock JM. Anterior cruciate ligament rupture: differences between males and females. *J Am Ac Orthop Surg.* 2013;21(1):41-50.
88. Rodas G, Medina D, Moize L, Yanguas J, Bros A, Simón B. Epidemiologia lesional en un club d'hoquei sobre herba. *Apunts Sport Med.* 2006;150:60-5.
89. Moller M, Attermann J, Myklebust G, Wedderkopp N. Injury risk in danish youth and senior elite handball using a new SMS text messages approach. *Br J Sports Med.* 2012;46(7):531-7.
90. Faude O, Junge A, Kindermann W, Dvorak J. Injuries in female soccer players. *Am J Sports Med.* 2005 ;33(11):1694-700.

ANNEX 1

Llistat de publicacions relacionades

- **De Pablo B**, Peña J, Grazioli G, Rodas G, Casals M. Pre-participation medical evaluation in rink hockey players. Rev EuroAm Cienc Dep. En revisió
- **De Pablo B**, Romero E, Bernardo J, Salvador J. Anthropometry in International roller hockey players. Arch Soc Chil Med Der. 2022. En premsa.
- Romero E, **De Pablo B**, Bernardo J, Salvador J. Anthropometric study in Spanish Female Roller Hockey players. Atena J Sport Sci. 2020. Vol 2 (6)
- Romero E, **De Pablo B**, Garcia T. Anthropometry in roller hockey players. Atena J Sport Sci. 2020. Vol 2 (4)
- Arboix J, Buscà B, Busquets A, Aguilera J, **De Pablo B**, Montalvo A, Fort A. Relationship between Inter-Limb Asymmetries and Physical Performance in Rink Hockey Players. Symmetry 2020, 12, 2035
- Jarrin P, **De Pablo B**, Tortajada M, Tomas X. Lesión del ligamento de Cooper, a propósito de un caso. Rev And Med Deporte. 2020; 13(4): 241-243
- **De Pablo B**, Rodas G, Valle X (2018). Certificado en Médico de Equipo-Conceptos esenciales. Patología en deportes de equipo: Modulo 3. Patologías específicas por deporte: Deportes indoor. Barça innovation Hub.<http://barcainnovationhub.com/>
- Mata A, Garcia D, Pedrazas D, **De Pablo B**, Alins J, Cuenca JM, Juan M, Diaz FX, Pineda L (2016) Esguince acromioclavicular de segundo grado. En 38 Congreso SEMERGEN (Santiago de Compostela).
- García D, **De Pablo B**, Bertran E, Pedrazas D, Izquierdo MT, Roda J (2017). Complicació infreqüent d'un equinç de turmell. En 2º Congreso SEMERGEN Catalunya (Barcelona).

ANNEX 2

Acceptació Comitè d'Ètica d'Investigacions Clíniques de l'Administració Esportiva de Catalunya

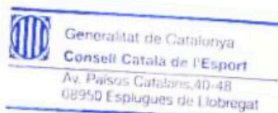


DR. RAMON BALIUS MATAS,
ACTING AS SECRETARY OF THE ETHICS COMMITTEE
FOR CLINICAL RESEARCH
OF THE CATALAN SPORTS COUNCIL.

CERTIFES

At the meeting on April 20, 2021, the Ethics Committee agreed to favorably assess the project presented by Bernat de Pablo MD, Gil Rodas PhD, Marti Casals PhD, number 014/CEICGC/2021, entitled "Epidemiologia lesional en l'hoquei patins".

We note this favorable assessment for the appropriate purposes.



A handwritten signature in blue ink, appearing to be "Ramon Balius Matas", written over a horizontal line.

Dr. Ramon Balius Matas
Esplugues de Llobregat, April 20, 2021

