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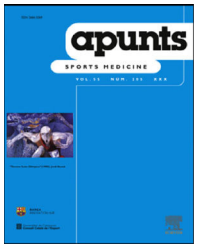

REVIEW

Injury incidence and patterns in rink hockey: A systematic review

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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.

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.

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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]

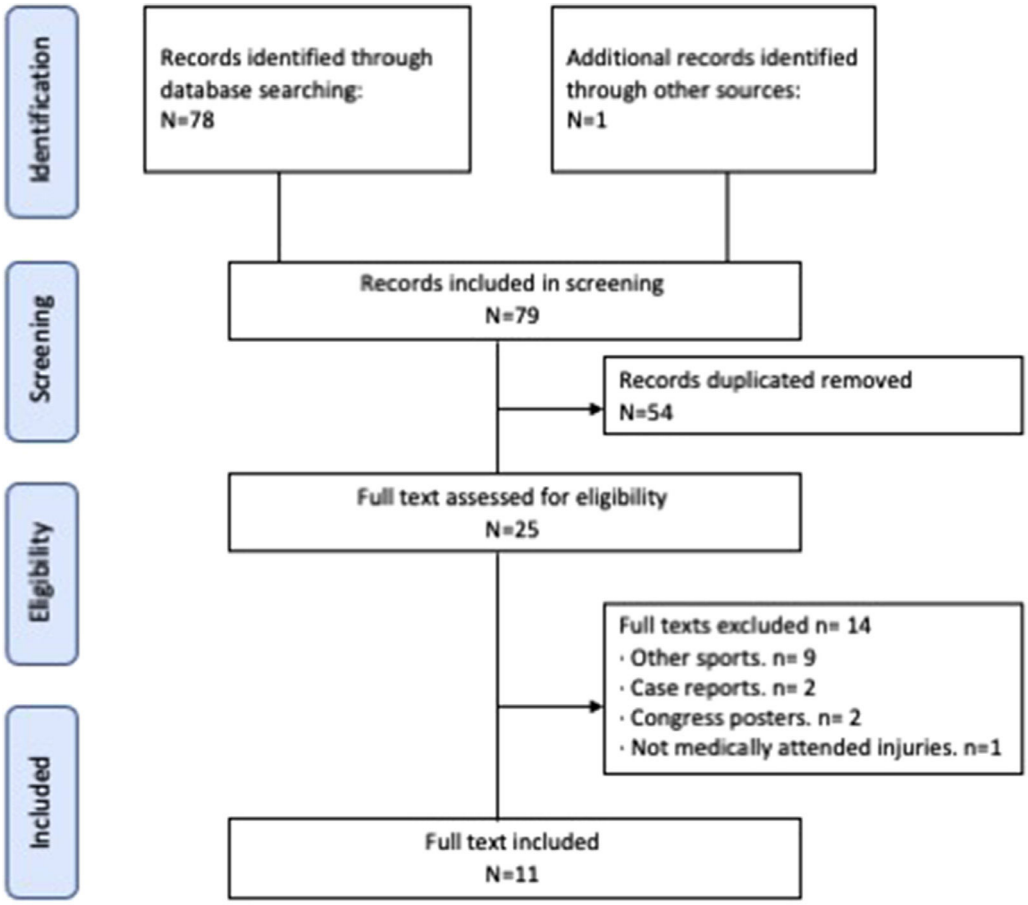

Fig. 1. Flow chart of the selection of articles to review.

Following the description of the study design, the evidence level[19] 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]	Experts' opinion (V)	Injury patterns	Analytical	NR	NR	NR	NR	NR	NR	NR
Egocheaga, 2004 Spain[20]	Descriptive (III)	Injury patterns	Descriptive	*N* = 22 male professional SP	48	NR	Prospective study during two seasons. Injured players visited in a Sport Medicine Unit.	Incidence rate	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 predesigned 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 predesigned 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 predesigned 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	Retrospective questionnaire about injuries during the last season.	Incidence prevalence	NR	Yes
Durigon, 2014 Italy[18]	Experts' opinion (V)	Injury patterns	Analytical	NR	NR	NR	-	NR	NR	NR
Reverter, 2018 Spain[23]	Descriptive (III)	Injury patterns	Descriptive	*N* = 23 male SP 10 Professional 13 Amateurs Mean age: 30.48 ± 7.98 years	88 48 amateur team 40 professional team	Fuller et al. 2006[14]	Prospective study for 2 seasons. Injuries recorded by coaches in a predesigned template.	Incidence proportion? Unclear	NR	Yes
Lopes, 2019 Portugal[15]	Cross sectional (III)	Orofacial injuries	Descriptive	117 YP (116 male, 1 female) Mean age 15.3 years.		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[16]	Cross sectional (III)	Injury patterns Injury Incidence	Descriptive	108 (69 male, 39 female). 65% German 1st division	2947	NR	Retrospective questionnaire about injuries 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 3.23[21]−9.7[14]/1000 exposure hours (EH). The match rate was 17.5[14]−36.7[21](21)/1000 EH, and the training rate was 1.77[21]−7.5[14]/1000 EH.

Other studies presented injury incidence rates using non-standardized formulas. In Egocheaga's study[20] 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 study[23] 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 study[20] 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 Regional YP	4.9 injuries / 1000 h 9.7 injuries / 1000 h	3.7 / 1000 h 7.5 / 1000 h	17.5 / 1000 h 36.7 / 1000 h	Junge et al. 2006[14]	NR
Pereira, 2013 Portugal[22]	Senior & YP	NR	NR	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 *n* = 21 (43.7%), tendon/ligament injuries *n* = 13 (27.1%), bone injuries *n* = 5 (10.4%), others *n* = 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 *n* = 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 *n* = 36 (44.4%), muscle/tendon injuries *n* = 25 (30.9%), contusions *n* = 17 (21%), fractures *n* = 3 (3.C7%).	
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 *n* = 22 (25%), fracture *n* = 20 (22.7%), wound *n* = 16 (18.2%), sprain *n* = 6 (6.8%), contusion *n* = 6 (6.8%), dislocation *n* = 4 (4.5%), concussion *n* = 4 (4.5%), others *n* = 10 (1,4%)	Professional SP: *n* = 16 (40%) traumatic, *n* = 24 (60%) overuse Amateur SP: *n* = 32 (66,7%) traumatic, *n* = 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 *n* = 8 (17%), hamstring *n* = 5 (10.6%), shoulder *n* = 3 (6.4%) YP: Adductor tendinopathy *n* = 5 (18.5%), shoulder *n* = 3 (11.1%), hamstring *n* = 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]

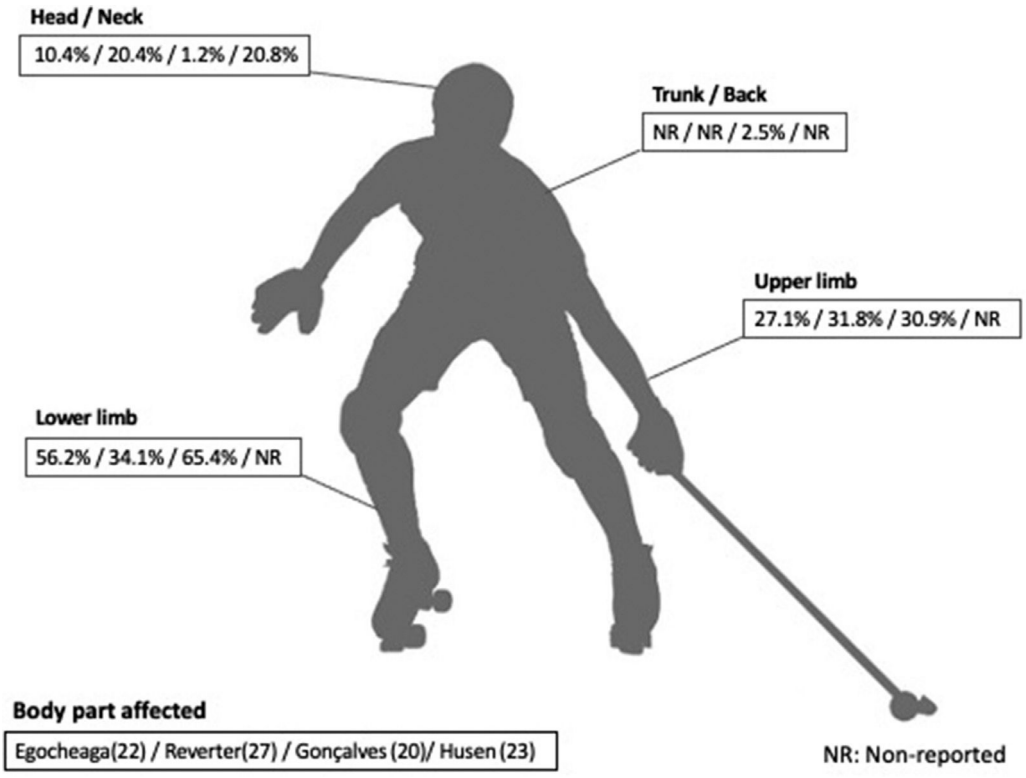

Fig. 2. Most affected body regions reported in RH injury research.

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 study[20] (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 questionnaire[16] 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 study[13] 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 article[17] 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 Team[18] 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 ± 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 ± 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 ± 35.2 (1−115)	11 (39.3%)	13 (46.4%)	4 (14.3%)
	Regional YP	53	38.9 ± 27.2 (4-79)	28 (52.8%)	22 (41.5%)	3 (5.7%)
Pereira, 2013 Portugal[22]	SP & YP	NR	Ankle/feet injuries 13.8 ± 24.2 Knee injuries 11.1 ± 24.3 Groin/hip injuries 10.1 ± 29.9	NR	NR	NR
Durigon, 2014 Italy[18]	NR	NR	NR	NR	NR	NR
Reverter, 2018 Spain[23]	Professional SP	40	NR	6 (15%)	26 (65%)	8 (20%)
	Amateur SP	48	NR	8 (16.7%)	18 (37.5%)	22 (45.8%)
Lopes, 2019 Portugal[15]	YP	NR	NR	NR	NR	NR
Florit, 2019 Spain[24]	Professional SP	47	NR	NR	NR	NR
	Regional YP	27				
Husen, 2020 Germany[16]	Men and women RH players	2947	0.9 ± 1.4 weeks per player per season 12.7 ± 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 heterogenicity 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 OSIICS,[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 3.23[21]−9.7[14]/1000 exposure hours (EH). The match injury incidence ranged from 17.5[14]−36.7[21]/1000 EH and the training incidence from 1.77[21] to 7.5[14]/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 Patinage*) has presented the project to implement a protective helmet in different categories over the 2021−2022 season.[44] This implementation is supported by Lopes[22] and Pelaez[23] 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 spare and presents high methodological heterogenicity. 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.

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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 Fís 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. Avaliaçao dos Problemas Músculo-Esqueléticos Como Preditores do Estado de Saúde em Atletas de Hóquei em Patins. Coimbra: Instututo 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, Hägglund M, Soligard T, Schwellnus 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, 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):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.