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The incidence of floorball injuries—A systematic review and meta-analysis

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ABSTRACT

Objective: Floorball is a swift sport; players perform multiple quick turns during practices and games. The aim of this study was to examine the incidence of floorball injuries. In addition, we aimed to examine the differences in the incidences between sexes and anatomical locations.
Methods: The PubMed (National Library of Medicine), Web of Science (Clarivate), Scopus (Elsevier), and SPORTDiscus (EBSCO) databases were searched from inception to January 6th, 2023. A study was eligible for analysis if the number of injuries per exposure time was reported. The study protocol was prospectively registered in the PROSPERO database (CRD42023390659).
Results: The total pooled incidence of floorball injuries was 2.28 (confidence interval [CI] 1.27 to 4.10) injuries per 1000 h for all included studies. For females, the pooled incidence was 2.33 (CI 1.22 to 4.46) injuries per 1000 h, and for males, the incidence was 1.98 (CI 1.83 to 2.14) injuries per 1000-h. For adults, the pooled incidence was 3.11 (CI 1.58 to 6.12) injuries per 1000 h and for youths, the incidence was 1.40 (CI 0.50 to 3.94) injuries per 1000 h.
Conclusions: The incidence of floorball injuries is high, especially among women. When considering the growing popularity of floorball, these pooled incidences serve as reference values for future injury prevention programs.

1. Introduction

Floorball is a swift sport, and players perform multiple fast, pivoting movements during practices and games. Floorball is played indoors, and during the game, joints are under increased load due to the rapid pivoting movement. The intensity of the game predisposes especially to lower limb injuries (Pasanen et al., 2018; Radtke et al., 2021). Due to the sport's proneness to injuries and its growing popularity, floorball-related injuries are not only a problem of a certain group. Rather than that, high rates of injuries have been reported among youths as well as adults, and females as well as males (Pasanen et al., 2008a, 2016, 2018; Wikström & Andersson, 1997).

The risk of injuries in floorball is high due to the high intensity of the game, including repetitive pivoting motions that affect especially the joints of the lower extremity, and therefore the knee and ankle are the most common injured sites (Löfgren et al., 1994; Tranaeus et al., 2016; Wikström & Andersson, 1997). Different injury prevention strategies have been investigated to decrease injury rates, including the effect of neuromuscular training programs and stability-increasing shoes (Pasanen et al., 2008b; Pasanen et al., 2009; High-cut shoes and lateral heel). Other factors, such as different playing surfaces have also been reported to influence the injury rates (Pasanen et al., 2008c). In addition to the traumatic injuries due to the contact or pivoting motion, high rates of overuse injuries have also been reported among floorball players, most commonly being problems with the back or knee (Leppänen et al., 2015, 2017a; Pasanen et al., 2008a; Snellman et al., 2001; Tranaeus et al., 2016).

Due to the popularity and the rapid increase in player rates, knowledge of injury rates in floorball is needed to further examine the effectiveness of different preventative measures. To the best of our knowledge, no previous meta-analysis has examined the incidence of floorball injuries. In addition, to be able to develop effective prevention programs, accurate estimates of the incidences are needed, both for the overall incidence and for anatomical locations separately. Hence, we aimed to examine, what is the pooled incidence rate of floorball injuries. In addition, we aimed to examine the differences in the incidences between sexes and anatomical locations.

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2. Methods

2.1. Information sources and search strategy

The PubMed (National Library of Medicine), Web of Science (Clarivate), Scopus (Elsevier), and SPORTDiscus (EBSCO) databases were searched from inception to January 6th, 2023, with the following search term: *floorball*. No filters were used. The review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 checklist and PERSiST guidance (PRISMA in Exercise, Rehabilitation, Sport medicine, and SporTs science) (Ardern et al., 2022). The study protocol was prospectively registered in the PROSPERO database (CRD42023390659).

2.2. Eligibility criteria and selection process

Studies, where the participants were floorball players, were considered for this study. A study was eligible for our analysis if the number of injuries per exposure time was reported. A study was excluded if the full text was not available. Furthermore, if the study included a cohort used in other studies, we included the most recent one. Injury types were not defined prior to the screening process, and all injury types (i.e. acute, overuse, game time, practice) were included. Records from the database searches were imported to an online systematic review platform (Covidence; http://www.covidence.org), and duplicates were removed. All the records from the searched databases were screened, and abstracts of those were assessed by two blinded authors (RL and IK). In case of conflict, the consensus was achieved by the third author (MV or JT).

2.3. Data extraction

Data were extracted and recorded in an Excel spreadsheet by all four authors. One of the four authors extracted, and another author validated the extracted data, to reduce potential extraction errors (Buscemi et al., 2006). The extracted data included the study characteristics, such as authors, year of publication, the country where the study was conducted, study period, and study design. For each study, we also collected the original inclusion criteria, the total number of people included in the study, the number of injuries, and exposure time. If incidence, total exposure, or the number of injuries was not reported, the missing value was calculated based on the other two values. If the original data on those was not reported, we contacted the authors by mail to obtain the missing data. Overall, the original exposure time was not reported for one study, but it was later obtained by e-mail from the contact person.

If the exposure time and the number of injuries were reported separately to training and gaming, this information was collected accordingly. All information was also recorded separately for females and males if the original study did so. The JBI critical appraisal list for prevalence studies was used to assess the risk of bias (Munn et al., 2014, 2015). The risk of bias (RoB) assessment was conducted independently by two authors (JT and IK) and conflicts were solved by the third author (MV). The complete RoB assessment template is provided as supplementary material.

2.4. Effect measures

The primary pooled outcome measure was the incidence of injuries per 1000-h exposure. It was calculated separately for each study by dividing the total number of injuries by the total exposure time. After that, these incidences were multiplied by 1000 h to achieve the estimate of injuries per 1000-h exposure.

2.5. Data synthesis and analysis

All studies were analyzed simultaneously, and subgroup analyses were performed for females and males, as well as for youth (mean age under 20 years) and adults. The incidence of injuries was calculated separately for each study, and pooled incidences were reported with 95% confidence intervals (CIs) using either a fixed or random effects model. Heterogeneity was assessed using the I^2-statistics. Random-effects models were used to pool individual studies, as there was inevitably uncontrollable heterogeneity in player-attributable factors (such as the history of previous injuries, or physical testing results). Results from the synthesis of single studies were represented with forest plots. In addition, we also performed a sensitivity analysis with only the highest-quality studies included, meaning that all RoB checklist items were properly addressed. All analyses were performed using the *meta* package from R (version 4.1.2; R Foundation for Statistical Computing, Vienna, Austria).

3. Results

In total, 215 articles were found from the database search. Of those, 18 (8.4%) passed the eligibility assessment and were included further in the analyses (Engel et al., 2019; Leppänen et al., 2017a, 2017b, 2021; Löfgren et al., 1994; Parkkari et al., 2004; Pasanen et al., 2008a, Pasanen et al., 2008b, Pasanen et al., 2008c, 2016, 2018; Rossi et al., 2018; Snellman et al., 2001; Tranaeus et al., 2015, 2016; Wikström & Andersson, 1997; Åkerlund et al., 2020, 2022) (Fig. 1). Most of the studies were conducted in Finland (n = 10, 56%) or in Sweden (n = 6, 33%). The median year of the publication was 2016 (interquartile range 2008–2018). The most recent included patients were from 2020, and the first patients were from 1990 (see Table 1 and supplementary file 1).

3.1. Risk of bias

RoB assessment was conducted for each included study. The quality of included studies was high, as all the 9 checklist items were properly addressed in 12 studies. The minimum number of properly addressed items was 5, which was addressed by a single study. Two studies addressed 6 items properly and the remaining three studies addressed 8 items properly. None of the studies were excluded due to high RoB. The complete RoB assessment template is provided as supplementary material (see supplementary file 2).

3.2. The pooled incidence of floorball injuries

The total exposure time was 981 974 h for all the studies, including 6598 players with 2082 injuries. The total pooled incidence of injuries was 2.28 (CI 1.27 to 4.10) per 1000 h for all the included studies (see Fig. 2).

3.3. Sex- and age-stratified pooled incidences

The incidence for females was reported in 13 studies, for males in 10 studies, for adults in 11 studies, and for youths in 7 studies. For females, the pooled incidence was 2.33 (CI 1.22 to 4.46) per 1000 h and for males, the incidence was 1.98 (CI 1.83 to 2.14) per 1000 h. For adults, the pooled incidence was 3.11 (CI 1.58 to 6.12) per 1000 h, and for youths, the incidence was 1.40 (CI 0.50 to 3.94) per 1000 h (see Figs. 3 and 4).

3.4. Acute injuries

The incidence of acute injuries was reported in 11 studies, including 7 studies on adults and 7 studies on youths. The total pooled incidence of acute injuries was 1.38 (CI 0.53 to 3.59) per 1000 h. The pooled incidence of acute injuries in adults was 2.25 (CI 0.75 to 6.73) per 1000 h and for youths, the pooled incidence was 0.58 (CI 0.11 to 3.05) per 1000 h (see supplementary file 3).

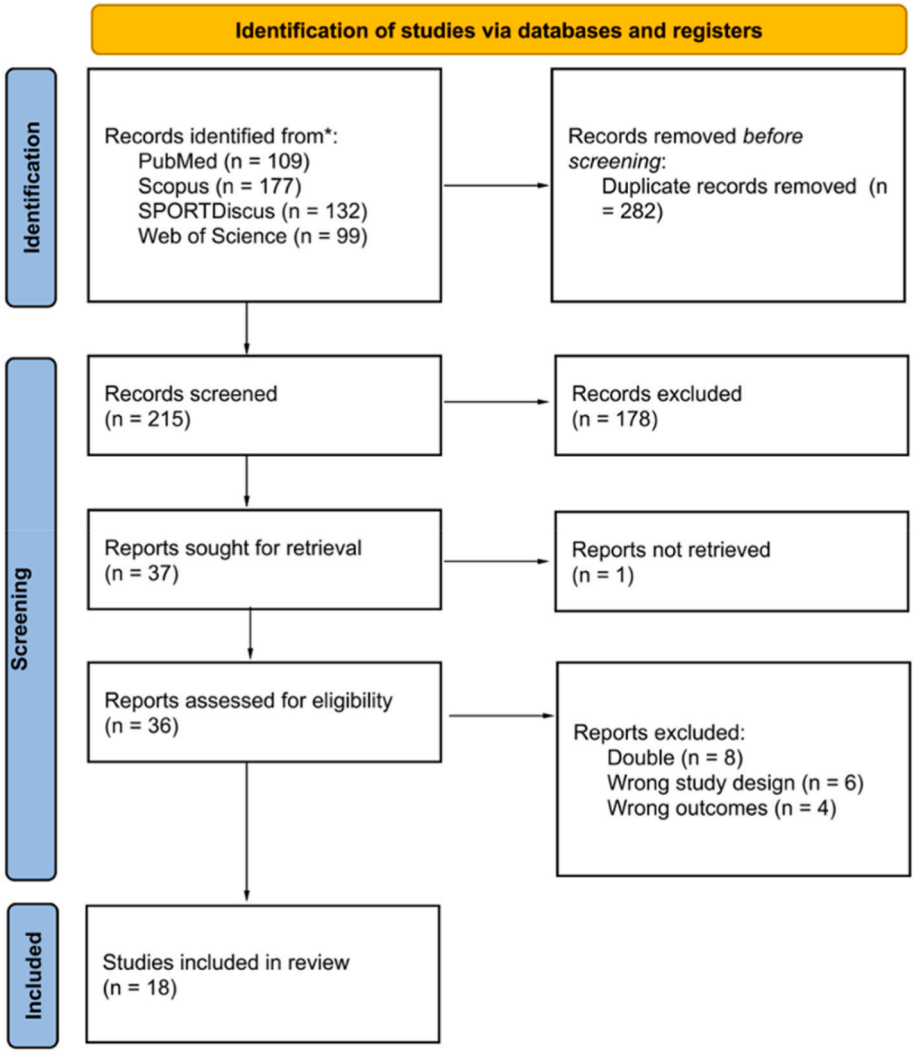

Fig. 1. PRISMA flowchart of the study selection process.

3.5. Overuse injuries

The incidence of overuse injuries was reported in 8 studies, including 4 studies on adults and 4 studies on youths. The total pooled incidence of overuse injuries was 0.95 (CI 0.37 to 2.45) per 1000 h. The pooled incidence of overuse injuries in adults was 0.44 (CI 0.17 to 1.15) per 1000 h and for youths, the pooled incidence was 2.06 (CI 0.56 to 7.64) per 1000 h (see supplementary file 4).

3.6. Training injuries

The incidence of training injuries was reported in 6 studies, including 5 studies with females and 4 studies with males. The overall pooled incidence of training injuries was 0.73 (CI 0.31 to 1.71) per 1000 h. For females, the pooled incidence of training injuries was 0.68 (CI 0.22 to 2.11) per 1000 h and for males, the pooled incidence was 0.92 (CI 0.52 to 1.61) per 1000 h (see supplementary file 5).

3.7. Gametime injuries

The incidence of gametime injuries was reported in 9 studies, including 7 studies with females and 4 studies with males. The overall pooled incidence of gametime injuries was 12.21 (CI 6.07 to 24.56) per 1000 h. For females, the pooled incidence of gametime injuries was 18.92 (CI 10.23 to 35) per 1000 h and for males, the pooled incidence was 10.94 (CI 4.33 to 27.60) per 1000 h (see supplementary file 6).

3.8. Anatomically stratified incidences

The anatomically stratified incidences were reported in 13 studies. Acute injuries were reported in 13 studies and overuse injuries in 7 studies. The overall pooled incidence of knee injuries was the highest (0.75 per 1000 h, CI 0.40 to 1.41). For acute injuries, the pooled incidence of ankle injuries (0.70 per 1000 h, CI 0.38 to 1.30) was the highest, and the pooled incidence of foot injuries (0.11 per 1000 h, CI 0.07 to 0.18) was the lowest. For overuse injuries, the pooled incidence of knee injuries (0.79 per 1000 h, CI 0.26 to 2.40) was the highest, and the pooled incidence of ankle injuries (0.12 per 1000 h, CI 0.05 to 2.88) the lowest (see Fig. 5).

3.8.1. Foot injuries

A total of 5 studies reported the incidence of foot injuries, including 4 studies on acute injuries and 3 studies on overuse injuries. The overall pooled incidence was 0.29 (CI 0.12 to 0.69) per 1000 h. For acute injuries, the pooled incidence was 0.11 (CI 0.07 to 0.18) per 1000 h, and for overuse injuries, the pooled incidence was 0.44 (CI 0.22 to 0.88) per 1000 h (see supplementary file 7).

3.8.2. Ankle injuries

A total of 11 studies reported the incidence of ankle injuries,

Table 1
Characteristics of the included studies.

	All included studies (n = 18)	
Athletes	n	%
Total	6598	–
Adults	5058	76.8%
Youths	1540	23.3%
Sex		
Female	3159	47.9%
Male	2498	37.9%
Unspecified	941	14.3%
Injuries		
Total	2082	–
Training injuries	318	15.3%
Gametime injuries	415	19.9%
Unspecified	1349	64.8%
Injury type		
Acute injuries	874	42%
Overuse injuries	717	34.4%
Unspecified	491	23.6%
Country		
Finland	10	55.6%
Sweden	6	33.3%
Switzerland	1	5.6%
International tournament	1	5.6%
Study setting		
Prospective	15	83.3%
Retrospective	3	16.7%
Exposure, hours		
Total exposure	981 974	
Training exposure	298 709	
Gametime exposure	32 025	
Unspecified	651 240	

including 10 studies on acute injuries and 4 studies on overuse injuries. The overall pooled incidence was 0.62 (CI 0.30 to 1.25) per 1000 h. For acute injuries, the pooled incidence was 0.70 (CI 0.38 to 1.30) per 1000 h, and for overuse injuries, the pooled incidence was 0.12 (CI 0.05 to 2.88) per 1000 h (see supplementary file 8).

3.8.3. Knee injuries

A total of 13 studies reported the incidence of knee injuries, including 11 studies on acute injuries and 5 studies on overuse injuries. The overall pooled incidence was 0.75 (CI 0.40 to 1.41) per 1000 h. For acute injuries, the pooled incidence was 0.54 (CI 0.30 to 0.98) per 1000 h, and for overuse injuries, the pooled incidence was 0.79 (CI 0.26 to 2.40) per 1000 h (see supplementary file 9).

3.8.4. Thigh, groin, and pelvic injuries

A total of 8 studies reported the incidence of thigh, groin, or pelvic injuries, including 6 studies on acute injuries and 4 studies on overuse injuries. The overall pooled incidence was 0.45 (CI 0.27 to 0.75) per 1000 h. For acute injuries, the pooled incidence was 0.43 (CI 0.29 to 0.62) per 1000 h and for overuse injuries, the pooled incidence was 0.31 (CI 0.20 to 0.47) per 1000 h (see supplementary file 10).

3.8.5. Torso and back injuries

A total of 11 studies reported the incidence of the torso and back injuries, including 9 studies on acute injuries and 7 studies on overuse injuries. The overall pooled incidence was 0.41 (CI 0.25 to 0.67) per 1000-h. For acute injuries, the pooled incidence was 0.20 (CI 0.08 to 0.51) per 1000 h and for overuse injuries, the pooled incidence was 0.24 (CI 0.15 to 0.38) per 1000 h (see supplementary file 11).

3.8.6. Upper extremity injuries

A total of 10 studies reported the incidence of upper extremity injuries, including 7 studies on acute injuries and 4 studies on overuse injuries. The overall pooled incidence was 0.26 (CI 0.17 to 0.41) per 1000 h. For acute injuries, the pooled incidence was 0.21 (CI 0.13 to 0.36) per 1000 h and for overuse injuries, the incidence was 0.19 (CI 0.08 to 0.44) per 1000 h (see supplementary file 12).

3.9. Sensitivity analysis

We performed a sensitivity analysis with only the highest-quality studies included, meaning that all RoB checklist items were properly addressed. Results from those analyses were like those observed from analyses with all studies, as the total pooled incidence of injuries was 2.8 (CI 1.38 to 5.7) per 1000 h (see supplementary file 13).

4. Discussion

This meta-analysis reported a pooled incidence rate of floorball

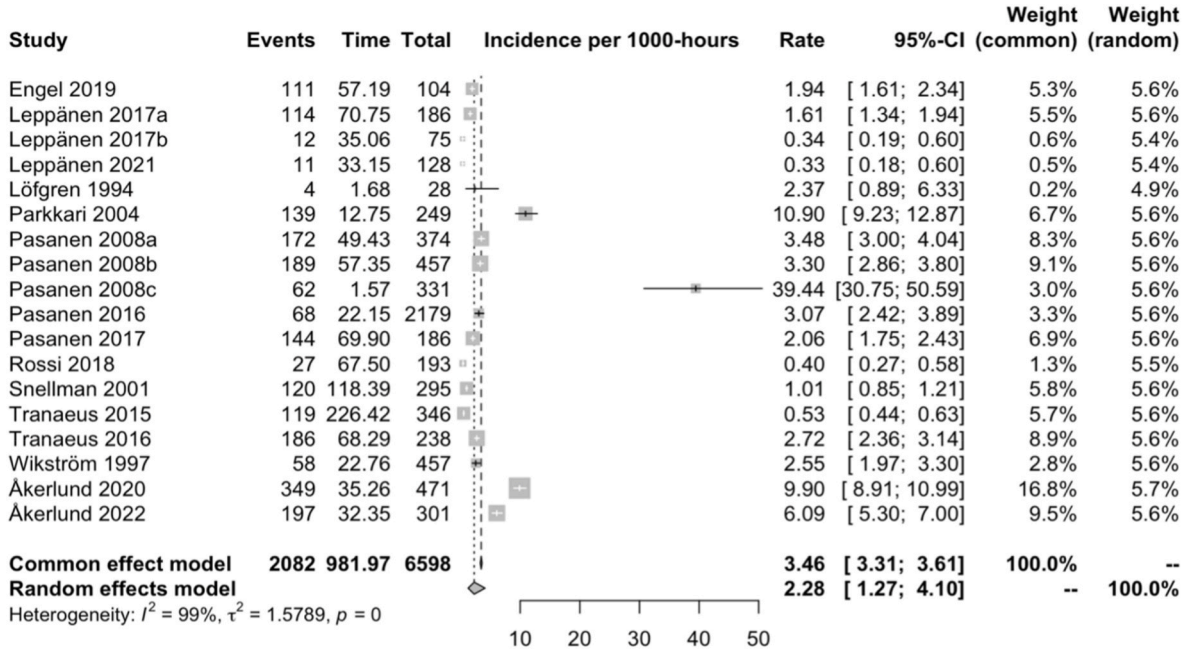

Fig. 2. The pooled incidence of floorball injuries.

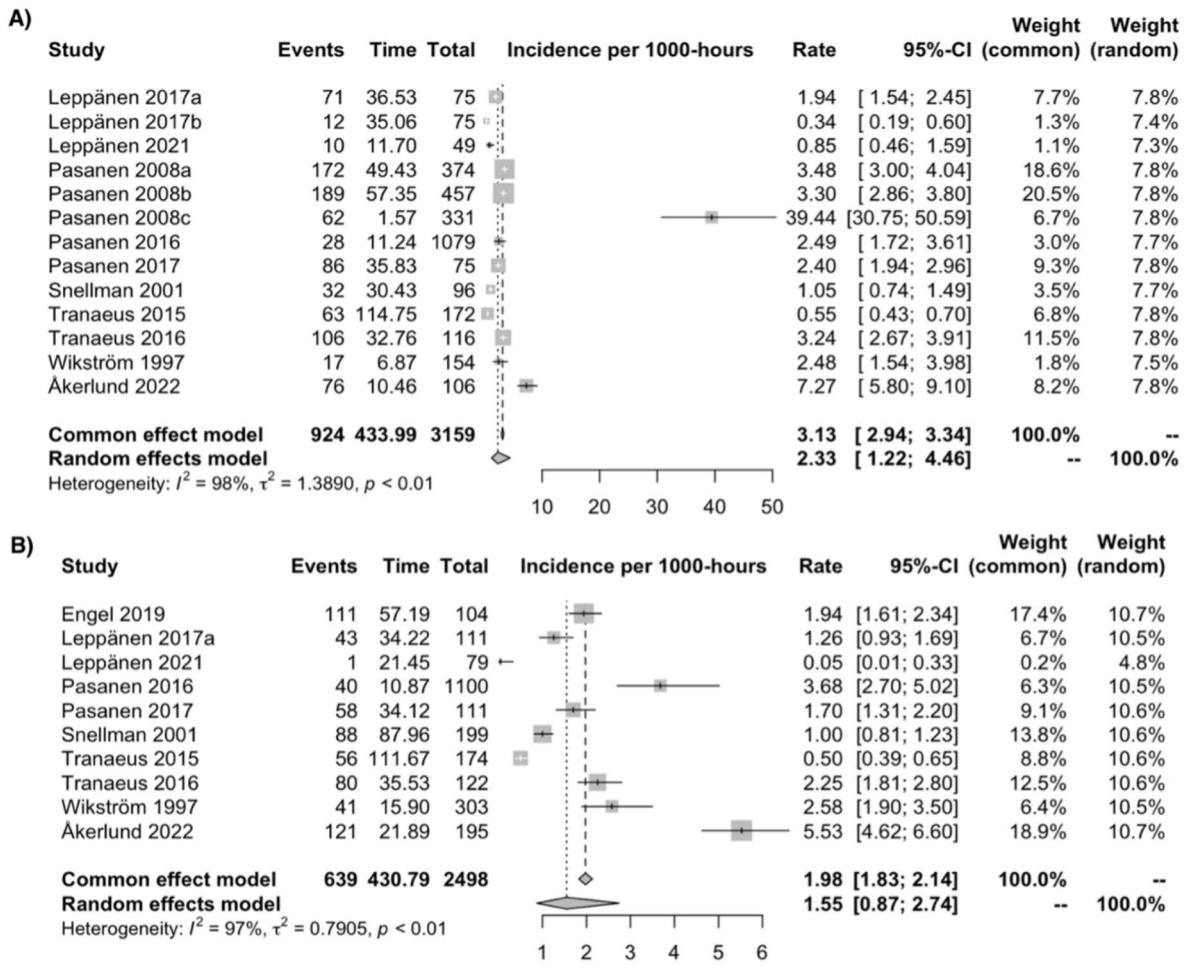

Fig. 3. The pooled incidence of floorball injuries, stratified by sex. A = Female, B = Male.

injuries as a result of this study. In addition to the sex- and age-stratified incidences, we examined both the anatomically stratified incidences and incidence separately for gametime and training injuries. Given the growing popularity of floorball, these pooled estimates serve as an important reference for future prevention strategies on floorball injuries.

Our review demonstrated a total pooled incidence of 2.28 injuries per 1000 h. No previous meta-analyses have reported pooled incidences of floorball injuries. Previous studies have examined the incidences of other sports, such as football and other Olympic sports (Ekstrand et al., 2011; Gimigliano et al., 2021; Junge & Dvořák, 2015; Parkkari et al., 2004; Pfirrmann et al., 2016). The incidence of football injuries among elite athletes has been reported to be 8 injuries per 1000 h, which is remarkably higher than our reported incidence (Ekstrand et al., 2011). As our study population was rather heterogenic, including both amateurs and professionals, adults and youths, our results are not perfectly compared on the generalized level.

In addition to higher overall incidence, the incidence of gametime injuries has also been reported to be high among football players, ranging up to over 50 injuries per 1000 h in international tournaments (Junge & Dvořák, 2015). In our study, the pooled incidence of gametime injuries was 12.21 injuries per 1000 h, which can be considered surprisingly low when compared to the previously reported incidence of football injuries. This difference might be due to the different nature of football, as the playing time is divided into two 45-min periods, and hence the intensity varies a lot, whereas, in floorball, the game is played in short shifts with very high intensity. However, as our study was based on a larger sample with various levels of athletes, our results should be interpreted as generalized pooled incidences. It is evident, that in high-speed sports, such as floorball and football, as the intensity of the game increases, so does the incidence of e.g., pivoting injuries. In addition to football, it has been previously reported that the incidence of field hockey injuries is ca. 29 injuries per 1000 gametime hours (Theilen et al., 2016). As field hockey is played with sticks and balls, it might compare better to our pooled incidences.

Previously, females have been reported to be at an increased risk of pivoting injuries, such as ligamentous knee injuries (Zech et al., 2022). Our review demonstrated a total pooled incidence of 2.33 per 1000 h for females, and for males, the corresponding incidence was 1.98 per 1000 h. As the most common injuries in our review were knee and ankle injuries, it might be possible that this slight difference in incidences can be due to the female's proneness to pivoting injuries (Montalvo, Schneider, Yut, & et al, 2019). However, as there is inevitably confounding in our results, more studies on the differences between sexes are warranted. In addition to the differences between sexes, we also observed a greater incidence of incidence among adults, than compared to youths. As floorball is a contact sport, this difference is most likely due to the higher intensity of play among adults, as we also reported a higher rate of acute injuries among adults compared to youths.

The higher intensity increases the forces affecting the joints, which leads to increased stress on ligaments, muscles, and other joint-supporting structures. If the intensity remains high for a long period, it can lead to increased cumulative stress, which might lead to overuse injuries (Bahr, 2009). Previously, the youths have been reported to be prone to overuse injuries, as bone maturation and growth are not completed and muscular imbalances may be present more often than within adult athletes (Launay, 2015). In our study, the pooled incidence

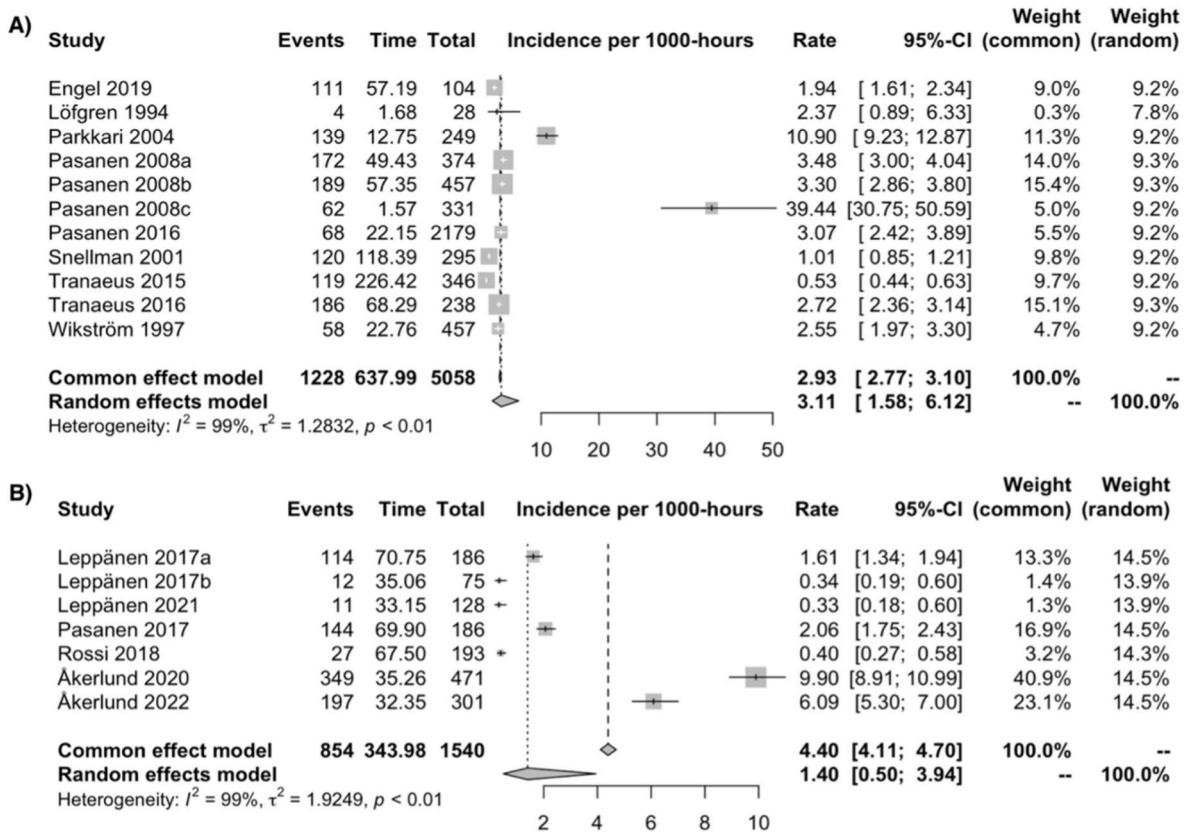

Fig. 4. The pooled incidence of floorball injuries, stratified by age. A = Adults, B = youths.

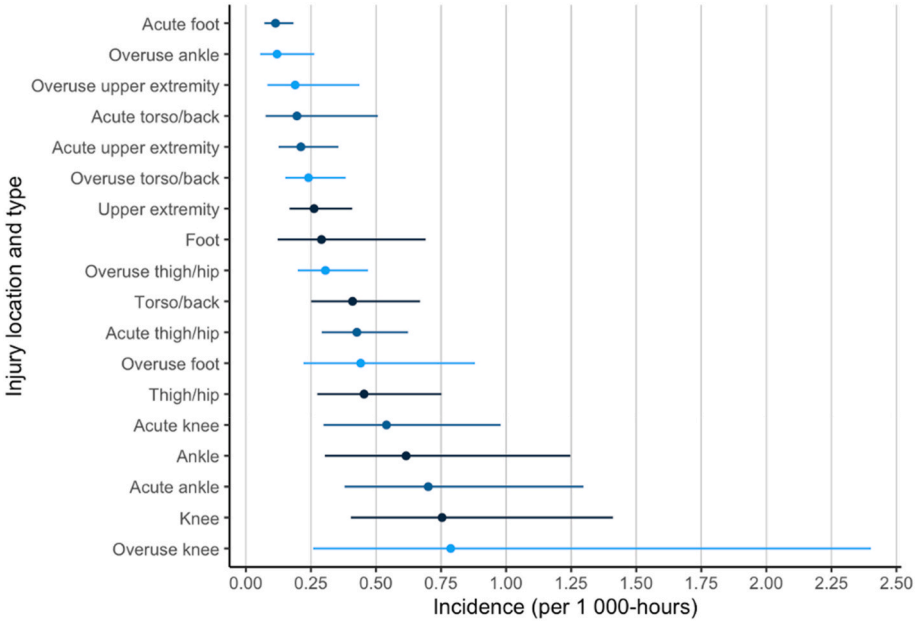

Fig. 5. Incidence of the floorball injuries, stratified by the location of the injury and type of the injury.

of overuse injuries was higher among adults than youths. The higher rate of overuse injuries among youths is a worrying finding, and prevention of these injuries should be focused on daily training. In addition to the overuse injuries, the higher intensity increases the momentary forces affecting the joints and hence might increase the risk of acute injuries within athletes. Our study revealed, that the pooled incidence of gametime injuries is over tenfold to training injuries; a phenomenon that has been reported previously among football players (Ekstrand et al., 2011; Pfirrmann et al., 2016).

Pivoting injuries, such as knee or ankle injuries, are common in high-speed sports. Especially the risk of suffering anterior cruciate ligament injuries is higher within pivoting sports when compared to non-pivoting sports (Montalvo et al., 2019a, 2019b). Accordingly, the results from our analyses were like the previous literature, as injuries of the knee and

ankle were the most common. Our robust estimates should serve as important references when assessing the effectiveness of future preventative measures.

Whereas our review may provide robust estimates of the incidences of floorball injuries, it also has a few limitations that should be addressed. The main limitation was the high heterogeneity rate among all the studies, which remained high even in the subgroup analyses. This is due to the small number of studies that share different study questions and cohorts. For example, in their study, Pasanen et al., 2008c reported much higher incidence than any other studies. To control the possible bias that the heterogeneity might have had on our results, we used the random-effects models and presented our results in subgroups, which are relevant to the sport. Moreover, as floorball is a growing sport, but the number of studies is still low, our results serve as an important reference for future research regarding this topic. The second limitation, that our study has, is that the definition of injuries was not similar in each of the studies, which might influence the overall pooled incidences. For example, if only the pooled incidence of all injuries were reported, it may have been misleading, as the incidence of injuries in different anatomical locations varied significantly. Therefore, we also presented the anatomically stratified incidences, which reduces the possibility of reporting bias among the original studies. Another limitation that our study has is that almost all the studies were from the Nordics, and therefore we were not able to present nation-stratified pooled incidences. However, as floorball is a growing sport, more studies on this topic are warranted.

To the best of the author's knowledge, this is the first study to date to report pooled incidences of floorball injuries. The main strength of this study is the comprehensive literature review among four different databases, which made the synthesis of the data possible.

5. Conclusions

The incidence of floorball injuries is high, especially among women, and the risk of knee and ankle injuries is high. When considering the growing popularity of floorball, these pooled incidences serve as a reference for future injury prevention programs. However, further studies on other countries are needed.

Statements

The authors do not have competing interests.

The authors have no financial support for this study.

The data collection form can be accessed via supplementary material. Any other material can be accessed by contacting the corresponding author.

Ethical statement

No ethics commitee was involved due to the study design.

Ethical approval

Not applicable.

Funding

None.

CRediT authorship contribution statement

Rasmus Liukkonen: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. **Matias Vaajala:** Conceptualization, Data curation, Investigation, Writing – review & editing. **Jeremias Tarkiainen:** Data curation, Investigation, Writing – review & editing. **Ilari Kuitunen:** Conceptualization, Formal analysis, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ptsp.2024.04.003.

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