# INJURIES IN HANDBALL

## FROM YOUTH TO SENIOR PLAYERS

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### INTRODUCTION

Handball is an extremely dynamic sport with direct contact between players, as well as a wide range of player movements, including rapid sprints, sudden stops, cutting, powerful throws, and frequent jumps, landing situations and falls. Although essential for performance, these entertaining attributes of the game cause a high burden of injuries in handball players. Handball is thus one of the pivoting team sports where players are mostly affected by injuries. In comparison to other sports, it can be found in the top 5 in terms of number and severity of injuries[27]. Nevertheless, research in handball medicine, and for instance a systematic recording of injuries as it is being increasingly practiced in other sports, is still under-developed.

In this context, this article aims to provide a narrative review of the wide spectrum of injuries in handball. An overwhelming majority of them is either of traumatic or overuse origin. Nevertheless, as for every other patient, healthcare practitioners do always need to keep in mind that even in a supposedly healthy population of athletes, potential life-threatening inflammatory diseases or neoplasms may occur. In these patients, delaying a diagnosis is not an option.

### EPIDEMIOLOGY

High injury incidence rates have been reported during both training and matches. Among senior/adult players, the incidence of time loss injuries was estimated to be between 11.2 and 14.3 per 1000 hours of handball match play, while it was quantified between 0.6 and 2.4 per 1000 hours of handball training[76,92,113]. Among youth players, injuries are also common. A prospective study in Norway reported an incidence rate of 8.3 and 10.4 injuries per 1000 hours of handball match practice in boys and girls respectively and with slightly lower rates during training[78]. Contact injuries (but not foul play) represent a majority of injuries, mainly at the head, hand, shoulder and ankle[60,76].

Between 5 and 36% of handball injuries are considered as "major", meaning that they can result in significant and prolonged absence from the field and that they may generate long-term health issues for the players[51,73,76,78,92,116]. A Brazilian study revealed that 31.7% of the injuries among elite handball players led to an absence of more than 7 days[32]. German data from the men's first and second division leagues showed that 10% of injuries had a duration of 8 to 21 days, while 9.3% resulted in a prolonged absence of more than 21 days[76]. Additionally, ankle, knee and head injuries were often the primary locations resulting in absence from the field[51]. Interestingly, non-contact injuries induced longer absences compared to contact injuries[51].

Knee, ankle and shoulder injuries are the most frequently reported locations (Table 1). This has been explained by the repetitive and high-impact actions inherent to handball, with pivots/cuttings for the lower limb and throws for the upper limb[16,66,92]. Knee injuries represent 7 to 27% of all severe injuries which includes ACL injuries, particularly important among female players[76,92]. Overuse knee injuries like patellar tendinopathy account for 16% of all overuse injuries[87,92,115]. Ankle injuries, and particularly ankle sprains, are the most frequently reported acute injuries (8 to 45%), often resulting from repetitive jumps and landings. The shoulder is also frequently affected with rotator cuff tendinopathies, shoulder impingement or labral tears[19,57]. In total, shoulder injuries represent 4 to 27% of all injuries, with the main part of them resulting from overuse[16,32,65,78,92]. Around 22 to 28% of handball players are concerned with shoulder symptoms in a season[22,31]. Myklebust et al.[72] assessed the prevalence and the consequences of shoulder pain in elite Norwegian female handball players,

## Table 1

| Anatomic location | Adult Male players | Adult Female players |
|---|---|---|
| Head and neck | 19.3% | 28.8% |
| Shoulder, arm and elbow | 11.1% | 11.8% |
| Hand and finger | 12.5% | 10.1% |
| Trunk | 10.5% | 16.2% |
| Legs (muscles) | 13.2% | 10.4% |
| Knee | 11.5% | 10.5% |
| Foot and ankle | 10.3% | 11.3% |

**Table 1:** Injury rate per location in elite male and female players in international competitions[40,41,51].

## Table 2

| | Modifiable risk factors | Non-modifiable risk factors |
|---|---|---|
| Intrinsic risk factors | Fitness level<br>Force<br>Flexibility<br>Fatigue<br>Joint stability<br>Biomechanical changes<br>Balance/proprioception<br>Core stability<br>Psychological factors | Age / maturity<br>Gender<br>Previous injury<br>Joint laxity<br>Bone morphology |
| Extrinsic risk factors | Rules and regulation<br>Coaching education<br>Playing time<br>Playing surface<br>Equipment | Type of sport<br>Weather<br>Level of play<br>Time of season<br>Sport context<br>Playing position |

**Table 2:** Injury risk factors in handball.

revealing that 57% reported either previous or current shoulder pain. The risk factors of injuries in handball are presented in Table 2.

CONCUSSIONS

Handball, recognized as one of the team sports with the highest incidence of injuries, demands significant attention to concussion prevention and management[4,38,90,101]. This is particularly true given the physical nature of the sport, which includes rapid movements, frequent jumps, and forceful physical contacts, which increase the risk of head injuries. In a cross-sectional study from Germany including 3000 athletes, the authors noted that 24% of the handball players previously experienced a concussion. Moreover, in a Swedish longitudinal study, Åman et al.[4] observed that concussions represented 22 to 28% of all the injuries reported. Recent testimonies from top-level players, such as the French goalkeeper Cléopâtre Darleux, who suffered from severe symptoms after several concussions and took 13 months to come back to competition, illustrate the personal and professional impact of these injuries.

However, despite this high incidence and the important consequences of sport-related concussions, research and preventive measures specific to handball are relatively rare compared to other contact sports like American football or ice hockey, which limits a full understanding of the problematic and the effectiveness of preventive measures. This gap underscores an urgent need for targeted studies and interventions that address concussion risks in handball.

Players, coaches, and medical staff must be educated about the symptoms and dangers of concussions, not only to reduce incidence, but also to manage the injuries effectively when they occur. Besides, initiatives could include the development of more rigorous protective measures, rule changes to minimize risky plays, and improved player training and conditioning programs focused on injury prevention. These strategies should aim to protect players by reducing occurrences of risky situations that could lead to head impacts[80,90,101].

UPPER EXTREMITY INJURIES

*Shoulder*

Given that the overhead throwing motion is a complex open chain movement, repetitive throwing and catching movements, frequent falls, as well as the use of the upper extremity in defensive actions put the shoulder at high risk of acute and overuse injuries. Acute injuries represent approximately 7% of all handball injuries, with very few data available on specific diagnostic entities[91]. Basically, the entire spectrum of traumatic shoulder injuries may occur, reaching from fractures, dislocations of the acromioclavicular or glenohumeral joints to acute injuries of the intra-or periarticular soft tissues.

Handball players perform up to 48,000 throws per year, with velocities around 130 km per hour[39], subjecting their shoulder to significant loads in different directions. Over time, these overhead activities and repetitive microtraumas can lead to functional changes in shoulder kinematics, including altered glenohumeral mobility, rotator cuff imbalances or scapular dysfunction, thus increasing the risk of injuries in those athletes. Indeed, a

hyperlaxity of the anterior capsule as well as a stiffness of the posterior capsule (resulting in a glenohumeral internal rotation deficit) has been reported in overhead athletes following practice[11,18,105], explained by the repetitive eccentric contraction of the posterior rotator cuff during the follow-through phase of throwing[111]. An increase in internal rotators strength at the expense of external rotators, as well as a scapular dyskinesis are also frequently observed in this population[20,22,26,47]. The different adaptations that occur following practice are not only functional but can also be structural. A study of Jost et al.[45] observed 93% of MRI abnormalities (osteochondral defects, partial rotator cuff tears, tendinopathy etc.) in the shoulder of professional handball players after an average of 10 years of practice at high level, of which 37% were asymptomatic.

Several intrinsic and extrinsic risk factors of overuse shoulder injuries have been reported in handball players (Table 3)[8,106]. While female athletes experience a higher risk of shoulder injuries than their male counterparts[9,72], the years of handball practice[5,22] or age[22] do not seem to have an influence on the shoulder injury burden. The influence of the level of play is controversially discussed. While Seil et al.[92] and Clarsen et al.[22] observed a significant relationship between this parameter and shoulder injury, Asker et al. were not able to obtain the same findings[9]. Isometrically assessed external rotator weakness has been associated with an increased risk of shoulder injuries in different studies[1,10,22]. Moreover, in an isokinetic assessment, Edouard et al.[26] demonstrated that youth female handball players with lower ratios of concentric external rotation to internal rotation strength at a speed of 240 degrees per second, and high ratios of eccentric IR to concentric ER strength at 60 degrees per second had a 2.5 times higher risk of experiencing a shoulder injury. According to Forthomme et al.[31], the maximal concentric strength of internal rotators at 240 degrees per second is a protective factor against traumatic shoulder injuries. Although controversially discussed in the scientific literature, alterations in glenohumeral joint mobility[5,10,22], an external rotation gain >7.5° or a glenohumeral internal rotation deficit (GIRD) of 7.5° may increase the risk of overuse injuries. Furthermore, having an obvious scapular dyskinesis or a decrease

**Table 3**

| *Risk factors* | *Category* | *Study* | *For (+) or against (-)* |
|---|---|---|---|
| *Intrinsic factors* | | | |
| *Muscle imbalances* | *Isokinetic evaluation*<br>▪ *ERconc/IRconc 240°/s*<br>▪ *IRecc/ERconc 60°/s*<br>▪ *IRecc 240°/s* | *Edouard et al. (2013)*<br>*Forthomme et al. (2018)* | +<br>+ |
| | *Isometric ER strength* | *Clarsen et al. (2014)*<br>*Andersson et al. (2018)*<br>*Achenbach et al. (2020)*<br>*Asker et al. (2020)* | +<br>-<br>+<br>+ |
| *Range of motion (ROM) imbalances* | ▪ *IR ROM deficit* | *Clarsen et al. (2014)*<br>*Moller et al. (2017)*<br>*Achenbach et al. (2020)*<br>*Asker et al. (2020)* | -<br>-<br>+<br>- |
| | ▪ *ER ROM gain* | *Clarsen et al. (2014)*<br>*Moller et al. (2017)*<br>*Achenbach et al. (2020)*<br>*Asker et al. (2020)* | -<br>-<br>+<br>- |
| | ▪ *Total ROM* | *Clarsen et al. (2014)*<br>*Moller et al. (2017)*<br>*Andersson et al. (2018)*<br>*Achenbach et al. (2020)*<br>*Asker et al. (2020)* | +<br>-<br>-<br>-<br>- |
| *Scapular dyskinesis* | ▪ *Dykinesis*<br>▪ *Obvious dyskinesis*<br>▪ *Decrease of upward rotation at 45° or 90° of abduction* | *Struyf et al. (2013)*<br>*Clarsen et al. (2014)*<br>*Andersson et al. (2018)*<br>*Achenbach et al. (2020)*<br>*Asker et al. (2020)* | +<br>+<br>-<br>-<br>+ |
| *History of injury* | | *Giroto et al. (2017)* | + |
| *Gender* | *Females > Males* | *Myklebust et al. (2013)*<br>*Asker et al. (2018)* | +<br>+ |
| *Playing level* | ▪ *Regional vs local league (Germany)*<br>▪ *Years of participation at elite level*<br>▪ *National vs regional (Sweden)* | *Seil et al. (1998)*<br>*Clarsen et al. (2014)*<br>*Asker et al. (2018)* | +<br>+<br>- |
| *Years of practice* | | *Clarsen et al. (2014)*<br>*Andersson et al. (2018)* | -<br>- |
| *Age* | | *Clarsen et al. (2014)* | - |
| *Extrinsic factors* | | | |
| *Workload* | ▪ *Increase Workload >60%*<br>▪ *Increase workload 20-60% + ER weakness*<br>▪ *Increase workload 20-60% + scapular dyskinesis* | *Moller et al. (2017)* | + |
| | ▪ *Playing an extra match per week* | *Giroto et al. (2017)* | + |
| *Player's position* | *Backcourt and wings players* | *Seil et al. (1998)*<br>*Forthomme et al. (2018)* | +<br>+ |
| *Context* | *Match vs training* | *Seil et al. (1998)* | + |

**Table 3:** Risk factors of upper extremity injuries in handball.

in scapular upward rotation at 45° and 90° of shoulder abduction increases the risk of future injuries[10,22,100].

Not surprisingly, the most important extrinsic injury risk factor is match and training load. Playing an extra match per week or an increase of more than 60% in training load is associated with an increased risk of injury[32,67]. Moreover, a moderate increase in training load (20-60%), particularly if it is associated with an external rotator weakness or a scapular dyskinesis enhances the risk of injuries[67]. Finally, playing position would significantly influence the risk of injury in handball players, with wings and backcourt players experiencing the highest risk among all the investigated teams[31,92].

*Elbow*

Two major epidemiological studies have found that elbow problems affect up to 51% of goalkeepers and 32% of field players in handball, with primarily medial-sided elbow pain[83,108]. They suggest that the prevalence of elbow problems in handball is comparable to that of other sports such as tennis, golf, and baseball, potentially due to the broad definition of elbow injury used. Field players mainly sustain injuries related to the repetitive throwing, with about 60,000 throwing movements per season at speeds of up to 130 km/h[84]. Goalkeepers, on the other hand, primarily sustain injuries from hyperextension trauma when blocking shots, with 75% experiencing elbow problems during their career[109].

*Hand and Wrist*

Injuries to the wrist, hand, fingers, and thumb, are common, significantly impacting centre backs and goalkeepers[15]. Goalkeepers are particularly at risk when catching balls thrown at over 140 km/h, where the thumb and the little finger play an important role in stabilizing and locking the ball. Injuries often result from direct impacts, contact with other players, or falls, especially in one-to-one situations, which accounted for 61.4% of cases during the world championship in Qatar in 2015[15]. Affected structures include bones such as the scaphoid, ligaments like the scapholunate ligament, joints, and tendons, with diagnostic imaging necessary for accurate assessment[52].

The incidence of finger, thumb, and wrist injuries was specifically documented in a study of the Brazilian National League in 2011, highlighting injuries to fingers in 9% of players, to the thumb in 6%, and to the wrist in 3% of them[32]. In a recent retrospective study including adolescent elite players, a high injury rate was observed for hand and wrist injuries (42% of the players), with the proximal interphalangeal joints and the thumb being the most commonly injured areas[63]. These data underscore the importance of direct injury mechanisms and the specific risk of handball in the occurrence of hand and wrist injuries. Gender-related injury prevalence in adult players revealed that hand, wrist and finger injuries represented 9 to 37% of the total injuries in female[28,51] and 6 to 20% in male players[44,76].

LOWER EXTREMITY INJURIES

*Hip and Groin*

Hip and groin injuries in handball have received less attention compared to other sports. Data from major elite tournaments, such as the Olympics and World Championships, consistently report an incidence of 1.5-4.0%, with a higher occurrence in Men's Handball (3.0-4.0%) compared to Women's Handball (1.5-2.0%)[13,33,35]. These low figures are different from full season studies suggesting that hip and groin injury rates may be higher than those reported in major tournaments. In elite senior handball, hip and groin injuries make up to 12.5% and 11.0% of all overuse and acute injuries, respectively[66]. However,

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**Illustration**

## Table 4

| *Clinical entities* | *Clinical symptoms and signs* |
|---|---|
| *Adductor-related groin pain* | *Adductor tenderness and pain on resisted adduction testing* |
| *Iliopsoas-related groin pain* | *Iliopsoas tenderness plus, more likely if pain on resisted hip flexion and/or pain on hip flexor stretching* |
| *Inguinal-related groin pain* | *Pain located in the inguinal canal region and tenderness of the inguinal canal. No palpable inguinal hernia is present. More likely if aggravated by abdominal resistance or Valsalva/cough/sneeze* |
| *Pubic-related groin pain* | *Local tenderness of the pubic symphysis and the immediately adjacent bone. No particular resistance tests to test specifically for pubic-related groin pain.* |

**Table 4:** Clinical entities as defined at the Doha agreement meeting 2014 (adapted from 43).

## Table 5

| *Differential diagnosis of knee pain in adolescents* |
|---|
| *Meniscus or chondral injury* |
| *Ligament injury (ACL, PCL)* |
| *Acute patellar dislocation* |
| *Acute fracture* |
| *Epiphyseal injury* |
| *Stress fracture* |
| *Prepatellar Bursitis* |
| *Osteomyelitis* |
| *Septic arthritis* |
| *Juvenile rheumatoid arthritis* |
| *Tumors* |
| *Osteochondritis dissecans* |
| *Popliteus cyst, Meniscal cyst* |
| *Discoid meniscus, lateral meniscus instability* |
| *Patellofemoral instability* |
| *Patellofemoral pain syndrome (anterior knee pain)* |
| *Osgood-Schlatter disease* |
| *Sinding-Larsen-Johannson disease* |
| *Mediopatellar plica syndrome* |
| *Patellar tendinopathy* |
| *Hemophilia* |
| *Referred pain from spine or hip diseases (i.e. femoral head epiphysiolysis)* |

**Table 5:** Differential diagnosis of knee pain and knee injuries, both in adolescents and adult players (adapted from 89).

significantly lower incidences have also been reported, with hip and groin injuries accounting for 0.9% and 7.6% of all acute injuries, and 1.3% and 0.0% of all overuse injuries, respectively[32]. In contrast to elite players, non-elite and young handball players experience lower proportions of hip and groin injuries, constituting 5.5% and 2.0-10.0% of all injuries, respectively[66,78,92]. The significant variation in the reported proportions of hip and groin injuries can be attributed to methodological differences in injury definitions and reporting.

Diagnostic cohort studies on athletes with hip and groin pain show that handball players represent up to 5% of those diagnosed with longstanding groin pain, mainly categorized as adductor- and iliopsoas-related groin pain[42,103]. In a prospective cohort study on acute groin injuries, handball players accounted for 11.0% and 3.0% of athletes with acute hip adductor or proximal hip flexor injuries, respectively[94,95]. Detailed data on hip injuries in handball players are lacking, but some authors report that intra-articular hip pathologies, such as femoroacetabular impingement syndrome (FAIS), are common among handball players[43]. The same authors reported that several factors are associated with an increased risk of groin injuries in athletes, with the most common being a history of previous groin injury[43]. Other factors include a higher level of play, decreased hip adduction strength, and lower levels of sport-specific training. A systematic review revealed that pain, lower strength on the adductor squeeze test, reduced hip internal rotation, and bent knee fall out were common findings in athletes with hip and groin pain[69]. In youth players before growth plate closure, apophyseal injuries of the pelvis may cause significant problems.

Terminology and classification of hip and groin pain in athletes have long lacked consensus. In 2015, the Doha agreement sought to address this issue. A global team of experts, including surgeons, physiotherapists, sports physicians, and radiologists, defined several entities based on a clinical classification system to cover the most common causes of groin pain. These entities include adductor-related, iliopsoas-related, inguinal-related, and pubic-related groin pain, aimed at improving diagnosis and treatment (Table 4)[118]. The entities also facilitate comparative research and

treatment outcomes. Similarly, the Warwick Agreement addressed the lack of consensus on FAIS terminology and diagnostic criteria, defining it as a motion-related hip disorder with specific symptoms, clinical signs, and imaging findings[37]. These agreements mark significant progress in the clinical understanding and research of hip and groin injuries, ultimately benefiting athletes. Their findings will need to be included in future handball-related injury research.

Otherwise, there is limited data on long-term hip osteoarthritis in former handball players. L'Hermette et al.[55] reported a higher rate of premature hip OA in retired handball players in comparison to a general population cohort. The risk was estimated to be 5 times higher in former elite male handball players as compared to former elite athletes from other sports[77,107,110].

*Knee*

Knee injuries in handball are common and have received most attention over the past decades, covering a large number of diagnoses (Table 5). They do often cause long-term issues and display extended recovery times.

Several studies highlight the prevalence of knee injuries in handball:

- Langevoort et al. (2007)[51] reported that knee injuries accounted for 13% of all injuries in major men's competitions.
- During the 2015 Men's Handball World Championship in Qatar, knee injuries comprised 11% of all injuries[16].
- Seil et al. (1998)[92] found that knee overuse symptoms represented 16% of all overuse injuries, following shoulder and lower back issues.
- Olsen et al. (2006)[78] noted that knee overuse injuries made up 12% of all overuse injuries.
- Moller et al. (2012)[66] identified the knee as the most common site for overuse injuries in adults and the second most common in youth players.
- Clarsen et al. (2015)[23] reported that knees were the second most frequent site of overuse injuries (20%), after shoulders (22%), but were the most common site for significant overuse injuries (8%).
- In elite Brazilian handball players, knees were the second most common site for overuse injuries (20%) after shoulders (33%)[32].
- In elite Icelandic handball players, acute knee injuries were most common (26%), whereas the knee was the 2nd most affected body region after low back/pelvic problems, at the same level as shoulder overuse injuries[85].

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**Illustration**

The most common severe knee injury in handball is an anterior cruciate ligament (ACL) tear[93]. Concerns about the high incidence of ACL injuries in handball emerged in the late 1990s[74,92]. ACL injuries occur at rates of 0.2-0.8 per 1,000 playing hours for male athletes and 0.7-2.8 for female athletes[74,73,92]. Data from Scandinavian ACL reconstruction registries indicate that 10.0-20.0% of ACL surgeries are performed on handball players, with women being 2-5 times more likely to undergo these procedures than men[33,34,35,58]. This gender discrepancy is attributed to anatomical and biomechanical differences[70,82].

Not all ACL injuries are surgically treated, so the total number of handball-related ACL injuries is unknown[91]. However, the severity of the injury, its impact on an athlete's career, the potential for recurrent surgeries, and the risk of osteoarthritis highlight the need for accurate statistics. Approximately 80% of ACL injuries in handball are non-contact, often occurring during landing or sidestep cutting, typically involving a valgus collapse around 40 milliseconds after landing[48,73,79]. ACL injuries can be partial or complete, and in less than 30-40% of the cases they are isolated. Very often they are accompanied by injuries to other knee structures, such as the posterior cruciate ligament, medial collateral ligament, menisci, or cartilage.

Risk factors for ACL injuries include intrinsic factors like family history, knee laxity, knee recurvatum, the width of the intercondylar notch, and the tibial slope[70,71,96,97,104]. Evidence suggests that modifying intrinsic risk factors through primary prevention exercises and neuromuscular training can reduce the number of severe knee injuries in sports like handball[73,114,117]. These exercises aim to

**Table 6**

| | Women | | | Men | | |
|---|---|---|---|---|---|---|
| | *Professional adult* | *Amateur adult* | *Youth* | *Professional adult* | *Amateur adult* | *Youth* |
| | | | *Foot and Ankle Injuries* | | | |
| *Prevalence* | *10%* | - | *25-35%* | *12-19%* | *8%* | *25-35%* |
| *Incidence* | - | - | *0.42-0.45/1000h exposure* | *2.7/1000h match and 0.2/ 1000h training* | *6/100 regional league players and 8/100 local league players* | *0.42-0.45/1000h exposure* |

**Table 6:** Foot and ankle injuries according to sex and level of play[2,7,16,64,85,92].

counteract the dynamic valgus position of the knee by strengthening the hip abductors and medial hamstrings[14,120,122]. Despite these preventive measures, screening players for ACL injury risk remains challenging and controversial[13,99,121].

ACL reconstruction is generally recommended for handball players who wish to return to the sport. The decision to undergo surgery should be carefully considered by the athlete and their support team, taking into account factors like seasonal timing, career goals, and the risk of secondary ACL injuries. Surgery should be performed when the knee is pain-free, swelling is reduced, and range of motion is restored. Post-surgery, most players can return to sports (RTS) after a 6-9 months rehabilitation period, although success is not guaranteed. In elite-level athletes, ACL reconstruction failure rates are below 5%, but among young players under the age of 20, 25-33% experience a secondary ACL injury in either the contralateral or the reconstructed knee.

Meniscus injuries are common in handball, though handball-specific data is limited. Generally, medial meniscus tears are more frequent than lateral ones. Differentiating between acute meniscus injuries (common after trauma) and degenerative lesions (more common in older players) is crucial for proper treatment. Reports on knee articular cartilage injuries in handball are limited. Giroto et al.[32] reported 9 (4%) meniscal/cartilage injuries. Røtterud et al.[88] analyzed 1392 handball players from the Swedish and Norwegian National Knee Ligament Registry, finding that 74 players (5%) developed grade 3-4 full-thickness articular cartilage lesions post-ACL reconstruction. Factors like time from injury, previous knee surgery, and age were independent risk factors. Male handball players operated within a year of injury had a twofold higher probability of developing these lesions compared to football players (OR=2.36, 95% CI 1.33-4.19). Granan et al.[36] examined 1548 handball players from two registries, finding 315 knee cartilage injuries (20%). Their probability of developing cartilage injuries was similar to football players (OR=0.99, 95% CI 0.84-1.16).

Medial collateral ligament (MCL) injuries are also prevalent in handball, either in isolation or in association with ACL injuries. They account for 7.9% of sports injuries across various disciplines[62]. Goalkeepers are particularly at risk[50]. The Norwegian knee ligament registry revealed that out of 1548 ACL injuries in handball players, 2.7% involved MCL injuries[36]. Additionally, 3.6% of handball injuries were multi-ligament, involving the ACL and at least one other ligament (e.g., PCL, MCL, or lateral collateral ligament).

Isolated LCL and PLC injuries are less frequent in handball compared to MCL injuries, but they are often underreported due to misdiagnosis. These injuries are more common when combined with other ligament injuries like ACL or PCL tears. Accurate diagnosis of knee injuries in handball is essential to prevent ineffective treatment and chronic instability, which can compromise an athlete's career. Neglecting lateral and posterolateral lesions can also lead to inferior outcomes of ACL or PCL reconstruction surgeries.

Quadriceps and patellar tendinopathy are common in athletes involved in jumping activities, more so in males than females. The prevalence is particularly high in volleyball players (40%). In handball, it affects 10% of female players and 30% of male players[56].

Patellar instability involves subluxation or dislocation, mostly in the lateral direction. Recurrent patellar instability is associated with specific risk factors. Acute patella dislocation accounts for 2-3% of all knee injuries[98], with recurrence rates between 15-60%[29].

Knee injuries, whether acute or due to overuse, are frequent in handball. Nevertheless, very few handball-and injury-specific data have been reported. Severe injuries like ACL/PCL tears, some posterolateral corner injuries, or quadriceps/patellar tendon ruptures often require 6 to 12 months for recovery. Meniscus tears can significantly affect a player's career if not treated correctly. Therefore, it is vital to accurately evaluate knee injuries using thorough clinical examination and imaging to ensure the best treatment and facilitate a return to sport at the same level.

*Foot and Ankle*

Ankle injuries are the most common injuries reported in handball (8–45%)[66,76,92], with a total incidence rate ranging from to 0.4 to 1.6 per 1000 hours of handball practice (Table 6). Among elite Brazilian players, Giroto et al.[32] showed that 19.4% of athletes had incurred an ankle injury during a 6 month-period. Similarly, during the 2017 Men world championship, the most affected body part was the ankle (19.3%)[102]. In the French championship, the ankle was the most frequently injured region (19.8% of the 78 147 reported injuries), representing 20.4% and 19.4% of all injuries in male and female players respectively[21]. The ankle is


**Illustration**

also commonly affected by overuse injuries, being the second most involved region (20.3%) in senior players[54]. Among all foot and ankle injuries, lateral ankle sprains (LAS) are the most common (13.5% of all reported injuries in handball)[30]. In senior male players, LAS was the most common injury, accounting for 33.3% of all injuries in adult male players[92] and 23% in young players[7]. During the 24th men's Handball World Championship 2015 in Qatar, a LAS was the most frequent specific diagnosis, accounting for 15.9% all injuries[15]. This has been recently confirmed among young players[7,64]. LAS are mainly non-contact injuries[15] which may occur during rapid change of direction, single leg landing or the push-off phase of a "jump-shot"[24]. Injury mechanism implies an excessive inversion of the ankle, combined with an internal rotation (i.e., adduction) of the foot. Recent investigations suggest that plantar flexion is less likely to occur during LAS, especially in handball[49,61]. Despite the absence of specific data on the burden of LAS, it has also been reported to be the most frequent time-loss injury[51,92].

Handball players are also frequently affected by high ankle sprains (34.7 per 100 000 athlete-exposures among male intercollegiate athletes)[112]. The contact nature of handball implies high constraints on the ankle syndesmosis, explaining why handball is one of the most affected sports concerning high ankle sprains. During side cutting maneuvers, the ankle complex is externally rotated with a forced ankle dorsiflexion that could further lead to the disruption of the anterior inferior tibiofibular ligament or interosseus ligament. To the best of the authors' knowledge, no study has specifically investigated the incidence rate or burden of syndesmotic injuries in handball players. Injuries to the metatarsophalangeal joint (such as turf toe or metatarsal fracture) are the most common injuries in the foot region, followed by midfoot sprains, which affect 4% of handball players each year[24]. The main reason why handball is one of the most injury-prone sports, particularly to the ankle/foot region[3], is the large number of changes of direction and one leg landing with contact. There is a lack of high-quality research on ankle injury epidemiology in handball, especially further studies are needed to evaluate the burden of chronic ankle instability among non-professional players.

INJURIES PER PLAYER TYPES

Research underscores that backcourt and wing players face an increased injury risk in comparison to other positions[44,53]. The multifaceted demands of wing play, including frequent jumps, falls, and intense contact situations, contribute to their elevated injury rates. Meanwhile, backcourt players endure substantial planting, cutting movements, and aggressive contacts, further amplifying their susceptibility to injuries. Wedderkopp et al.[115] demonstrated, in a cohort of young players, that female back players, had the highest incidences of both overall and acute noncontact lower-limb injuries in comparison to other positions. Similarly, a retrospective analysis by Piry et al.[81] during the 2008 Asian Handball Championships revealed a disproportionate injury distribution, with back players encountering 60.3% of injuries, compared to 12.7% and 11.1% for wing and line (pivot) players respectively. Moller et al.'s study on 517 elite Danish players confirmed these findings, indicating a higher injury prevalence in backcourt players, with wing players also significantly affected across genders and age groups[66]. Additionally, Myklebust et al. presented evidence

suggesting a heightened relative risk of Anterior Cruciate Ligament (ACL) injuries among back players[74,73]. In a longitudinal study including 186 male players among 16 senior German teams, Seil et al.[92] observed that wing and backcourt players faced 36% and 33% of the total injuries respectively, with the former exhibiting higher rates of serious injuries[7]. Besides, pivot players, though less frequently injured, showed increased susceptibility to head and neck injuries[119].

INJURIES PER PLAYER CATEGORY

Among adults, injury rates vary significantly depending on the study and the level of play. For instance, in the top divisions in Germany, the injury incidence reaches 77.7 injuries per 1000 match hours, with nearly 80% of players getting injured during a season (2015-2016)[59]. In major competitions, injury rates can increase to 89-129 injuries per 1000 match hours for men and 84-145 for women[51]. Conversely, among adolescent/young players, injury rates appear slightly lower but significant. It ranges from 8.9 to 14 injuries per 1000 match hours and 1.7 to 4.3 injuries per 1000 training hours[12,76]. Moreover, a prospective study in Norway on players aged 15 to 18 found an injury rate of 8.3 for boys and 10.4 for girls per 1000 match hours[78]. Finally, a study on elite Danish players showed injury rates during matches of 23.5, 15.1, and 11.1 injuries per 1000 match hours for seniors, under-18s, and under-16s, respectively[66]. An important difference in the type of injuries was reported from Denmark, with a significant proportion of adolescent/young players sustaining overuse injuries (37%), while among adults acute injuries were predominant[66]. Moreover, other studies suggest that players under 20 years of age have a significantly lower risk of injury than those over 20 years of age[25], although young players are still susceptible to severe injuries, as shown by a higher incidence of serious knee injuries in the control group of a study on an injury prevention program[25]. Finally, a higher incidence of apophyseal related injuries was found in immature youth players[68].

INJURIES BY GENDER

Studies have observed differences in injury profiles between male and female handball players, with females reporting more serious injuries[86] (Table 1). The research by Langevoort et al.[51] and Holdhaus[40,41] indicates notable disparities at this level, while other studies report minimal gender differences. However, when it comes to specific injuries such as anterior cruciate ligament (ACL) injuries, women have a 3 to 5 times higher incidence rate than men, highlighting a notable difference in susceptibility to ligament injuries in this sport[6,17,74,75]. Moreover, data from elite-level international competitions illustrate this injury frequency, with a particular focus on gender differences. In their cohort of 517 elite Danish players (senior, U-18, U-16), Moller et al.[66] found significant gender-related differences only in the U-18 group, indicating a 1.76 times higher injury rate in males. Another study on Brazilian elite players revealed a higher frequency of match injuries in men (17.9 per 1000 hours vs 23.5 per 1000 hours)[32].

CONCLUSIONS

Handball is a team sport where players frequently experience injuries[90]. Compared to other sports, handball ranks in the top five for both the number and severity of injuries. Elite players, participating in both national and international competitions, play up to 80 high-intensity matches per year, with plans to increase this number. Concussions are relatively common, as are acute joint injuries, primarily affecting the knee and ankle. Recent studies highlight the significance of overload and degenerative injuries, particularly in the shoulder, hip, and knee. This article summarizes the current knowledge on handball-related injuries and identifies several areas needing more comprehensive injury research which is essential to understand the extent of these issues, develop preventive measures, enhance medical support, and update guidelines on player safety and long-term health. Despite some high-quality studies involving handball players, the sport lags behind others in producing evidence-based medical and scientific insights.

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