EHF

COMPETENCE ACADEMY & NETWORK

INJURY PREVENTION MANUAL

CONTENT

Jesper Bencke
Matej Nekoranec
Tanja Sarenac

PROJECT MANAGER

Matej Nekoranec

VIDEO PRODUCTION

Tim Passgang

DESIGN & LAYOUT

Lara Novotny
Katharina Roth

EDITING

Simona Margetic
Joanne Harris

PUBLISHED BY

European Handball Federation
Baumgasse 60A, 1030 Vienna Austria

www.eurohandball.com

DISCLAIMER

The Injury Prevention Manual is provided for informational and educational purposes only. While reasonable care has been taken in its preparation, the EHF makes no representations or warranties, express or implied, regarding the completeness, accuracy, or applicability of the information contained therein. Implementation or reliance on the Injury Prevention Manual is solely at the discretion and risk of the user.

The EHF shall not be liable for any injuries, losses, damages, or other claims, whether direct, indirect, incidental, consequential, or otherwise, arising out of or in connection with the use of, reliance upon, or inability to use the Injury Prevention Manual.

Users are encouraged to seek appropriate professional advice and training and to exercise independent judgment when applying any recommendations or practices described in the Injury Prevention Manual.

ISBN: 978-3-9503311-9-6

PREWORD: PEDRO SEQUEIRA

Injuries are an inevitable part of any sport — but many of them are preventable. In handball, a fast-paced and high-contact game, the physical demands placed on athletes are immense. As coaches, we are not just tacticians or motivators. We are also responsible for ensuring our players are physically prepared, resilient, and protected against unnecessary risk. That responsibility starts with understanding injury prevention as a core part of performance.

This manual was born from a simple idea: if we can prepare our players better, we can protect them better. It brings together practical strategies, proven exercises, and a clear framework that coaches at all levels can apply in real-world training environments. It's not about adding complexity — it's about being intentional.

The role of the coach in injury prevention is often underestimated. Yet, the coaches are the ones who control the training load, design the weekly plan, create recovery windows, and shape player habits. Every drill, every warm-up, every cool-down — these are moments in which injuries can be either prevented or invited. That's the difference we can make.

This manual is not just a resource — it's a reminder. A reminder that preventing injuries isn't a side task; it's part of developing better, healthier, longer-lasting players. If this helps you reduce even one serious injury in your team, it has served its purpose.

Let's train smart, not just hard.

Pedro Sequeira
EHF Methods Commission Chairman

PREWORD: MARTIN HAUSLEITNER

The game of handball is charging forward — faster, fiercer and more physically intense than ever before. As the pace picks up and the demands on athletes increase, one thing is crystal clear: Injury prevention is not a luxury, it is a game changer. It is the foundation for a sustainable future in handball, where performance and endurance go hand in hand.

Here at the European Handball Federation, athlete health is a fundamental priority. To keep the players strong, resilient and ready to perform, we need a smart, science-backed strategy that meets the modern game head on. That is where this manual comes in — allowing us to take a bold leap forward in protecting the athletes and elevating the sport.

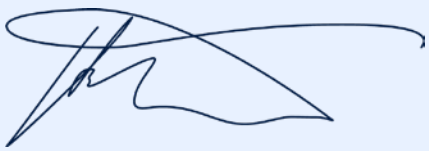
Built on cutting-edge research and developed with precision, this manual unites academic insight and real-world play. It is not just theory — it is practical, powerful and ready for the court. Coaches and players alike will find clear, actionable guidance with exercises and techniques presented in dynamic, cross-media formats that make learning and implementation seamless.

Every move, every drill, every recommendation is designed for accessibility. Whether you are training in a grassroots club or competing at the top level, the exercises require minimal equipment while giving maximum impact. This ensures that every team, regardless of resources, can access the benefits and build injury prevention into their daily routines.

This is not just a manual — it is a mission. A mission to empower coaches, energise athletes and future-proof the sport we love. With this resource in hand, teams can train smarter, play harder and stay healthier — season after season.

Let’s raise the bar, protect our players and keep the spirit of handball alive and thriving.

Yours in sport,

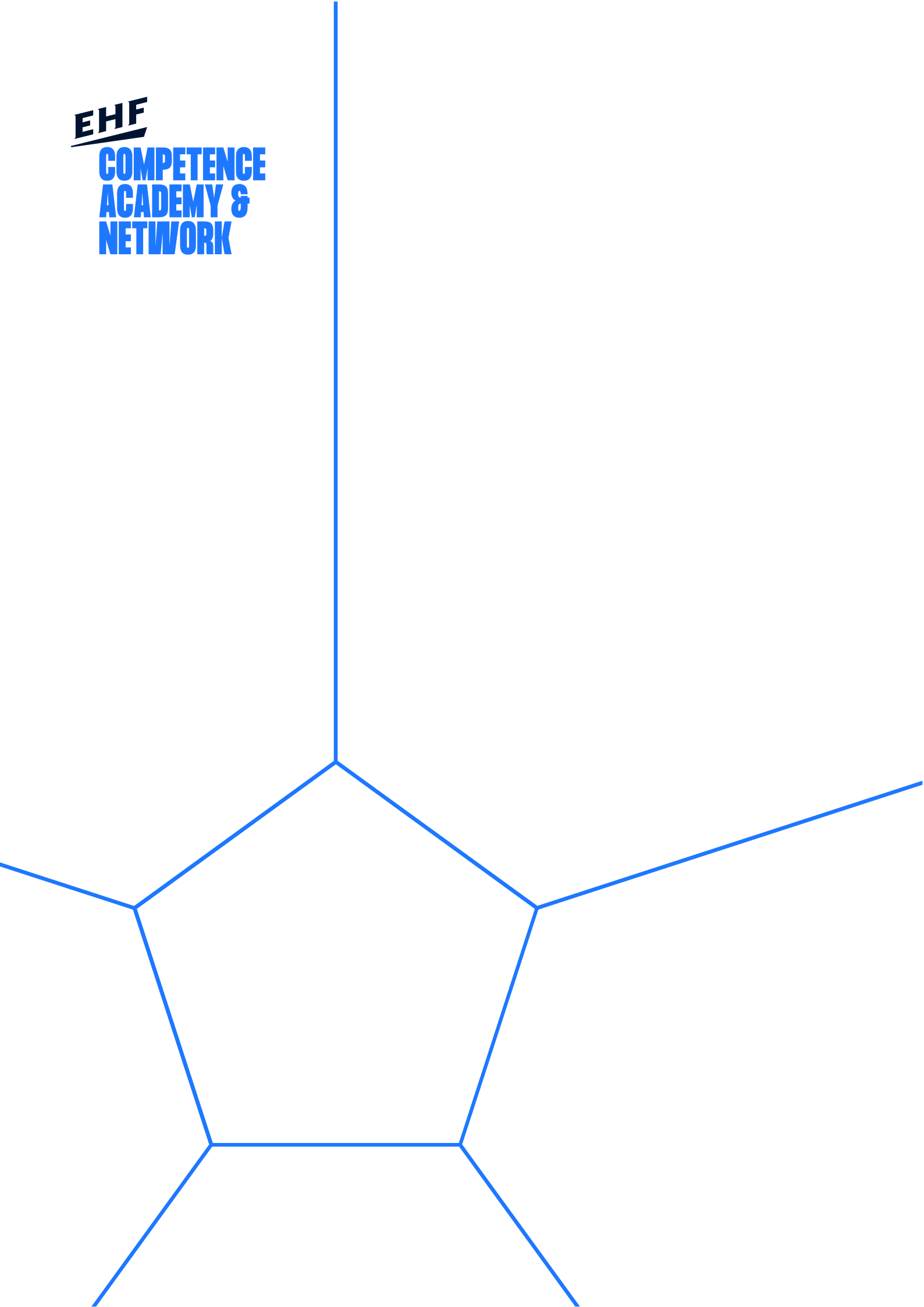


Martin Hausleitner
EHF Secretary General

CONTENTS

EHF

COMPETENCE ACADEMY & NETWORK



FOREWORD

HOW TO READ THIS MANUAL

Injury is the most feared opponent of every player who steps onto the court and every coach who has ever stepped into the sport of handball. Injury prevention isn't about a single moment, it's an ongoing process that starts long before anything goes wrong, with effects that often extend far beyond recovery. To manage injuries effectively, we need to see them as a process we can actively influence and control.

But reading alone isn't enough. It's equally important to see exactly what we want to do on the court. That's why the EHF team has prepared injury-prevention videos you can use anywhere, with minimal equipment, and designed specifically for handball. You'll find a large library of these videos at the end of the manual. We also reference specific videos throughout, showing you which exercises to use for respective injuries and purposes. Each video provides clear explanations of what to do and where to focus your attention.

The manual begins with an introduction to different types of injuries and how common they are in handball. This is essential to understand, because the type and frequency of injuries directly influence our prevention strategies and our approach to proactive management.

After that, we introduce the most common injuries in detail, with exact steps for how to handle them. In the final section, we explain how to structure a typical injury-prevention session within your weekly training plan, how to test for injury risk, and how to work with external specialists when needed. We've worked to make the manual engaging, visual, and accessible.

The main point we want you to take from this manual is that injury prevention doesn't need to be boring or done separately from handball training. It can be built right into regular practice. If it's done well, players won't even realise they're doing injury-prevention work; they'll just notice they're getting faster, stronger, and more resilient. **Let's get to work.**

THE AETIOLOGY, EPIDEMIOLOGY, AND RISK FACTORS OF INJURIES IN HANDBALL

This chapter aims to give an overview of the incidence frequency of the different common injuries in handball and also give a general introduction to the various types of injuries and injury definitions to ease the understanding of the differences between injuries and the subsequent difference in prevention measures.

1.1 EPIDEMIOLOGY

Handball is a high-intensity sport that combines rapid movements, frequent physical contact, and sudden changes in direction, making it inherently prone to injuries. As one of the most popular team sports in Europe, with a growing global presence, understanding the epidemiology of injuries in handball is necessary to understand the magnitude of the problem and enabling coaches and physical therapists and physical conditioning coaches to divide their attention between the various types of injuries with the highest impact on player's health and performance.

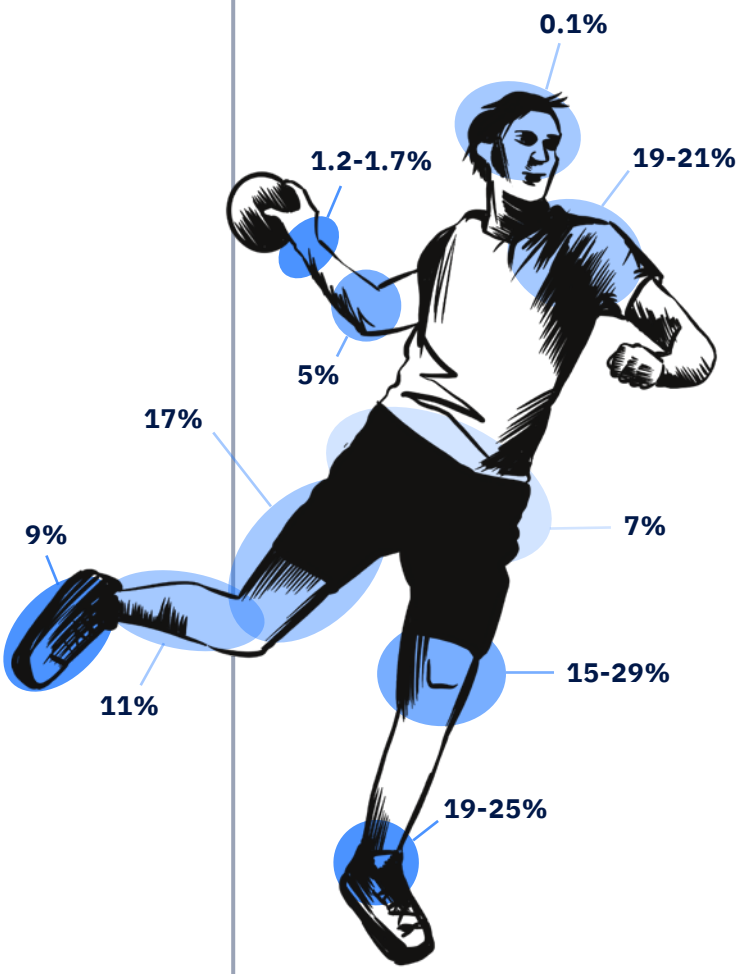
Injury rates in handball are notably high, as shown in many studies. Epidemiological studies consistently show that injury rates are markedly higher during match situations than during training sessions, with 15-23 injuries per 1,000 hours of match play, while the incidence of injury during training was calculated at around 1-4 injuries per 1,000 hours of training (1; 2; 3). These incidence rates vary significantly depending on age, gender, and playing level.

Some data from the men's Bundesliga in Germany and the Spanish first division league showed match play incidences of 78-84 per 1,000 hours (4; 5; 6). In other terms, in Germany each team sustained an average of 52 injuries per season (5). Comparing these incidence rates, a trend towards higher injury risk at the highest level and fewer injuries at lower level is seen; however, this playing-level dependent difference should be investigated further, especially for women.

Number of injuries	Setting	References
15-23/1,000 hours	Match	(1; 2; 3)
78-84/1,000 hours	Match	(4; 5; 6)
1-4/1,000 hours	Training	(1; 2; 3)

Figure 1. The table summarises reported injury incidences in different settings.

In general, male players tend to experience a higher frequency of contact injuries, while female players are more prone to non-contact injuries. However, the overall injury incidence rate is quite similar across all studies. At all levels, knee injuries are the most injury prone body part among women, especially injuries to the anterior cruciate ligament (ACL), while ankle injuries are the most frequent in men's handball (77).



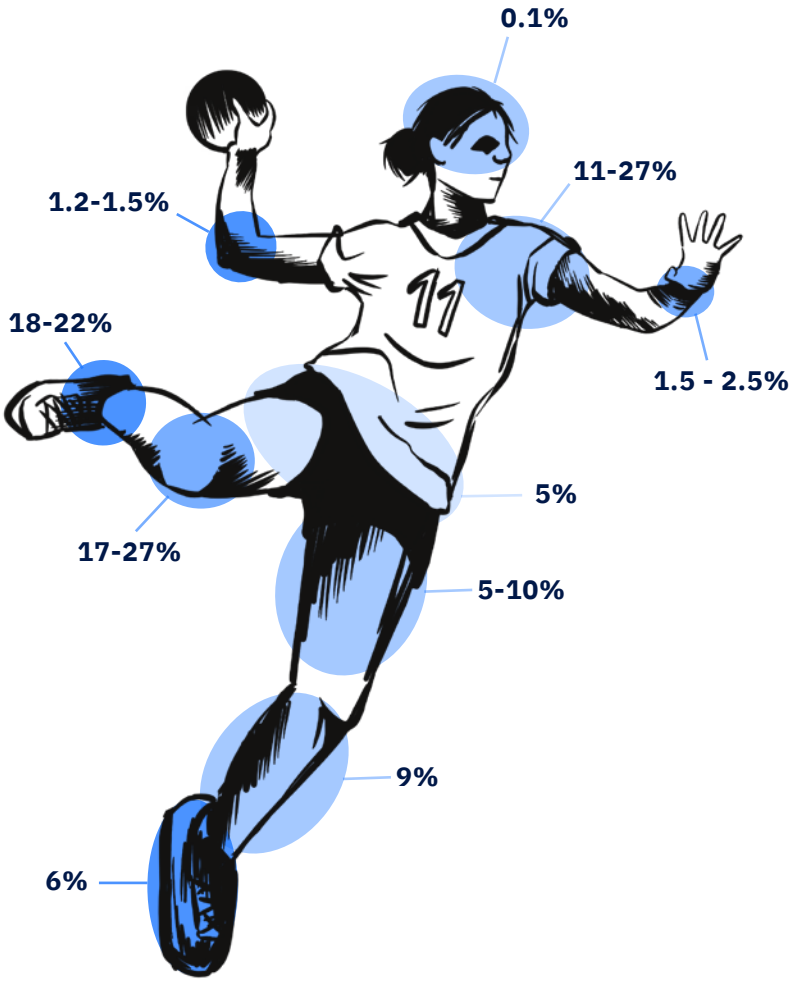


Figure 2. Based on the following studies: 1; 3; 14; 20; 44; 45; 77; 78.
The main key points are that when considering severity and frequency, the most important injuries are knee acute, shoulder overuse and ankle acute injuries. Graphics are intended solely for illustrative purposes to represent typical injury patterns. The numbers shown are drawn from various studies that employed differing injury classifications and research methods. No quantitative conclusions should be drawn from these figures.

Also in youth handball, ankle and knee injuries are the most frequent body parts to sustain injuries. However, the injury incidence rates are generally lower for adolescents compared to the above-described injury rates for adult elite handball, and even lower for children (6-13 years) (7).

1.2 ACUTE VS OVERUSE INJURIES

In handball, injuries can be broadly classified into two types: acute and overuse injuries.

ACUTE INJURIES

Acute injuries are those that occur suddenly as a result of a specific traumatic event, such as a collision, landing with high forces, or rapid accelerations. Common acute injuries in handball include sprains, strains, contusions, fractures, and dislocations. These injuries often result from the high-speed and high-contact nature of the game. For example, players frequently sustain ankle sprains from jumping and landing awkwardly, or shoulder dislocations may occur during falls or unlawful opponent contact. Concussion is also classified as an acute injury.

OVERUSE INJURIES

Overuse injuries, on the other hand, develop gradually due to overload or repetitive stress on particular body parts without adequate time for recovery. These injuries are often seen in bone or tendons and are more common in players who engage in intense training regimens without sufficient rest. Tendinitis, stress fractures, and chronic muscle strains are examples of overuse injuries commonly observed in handball players.

Unlike acute injuries, which are often immediately debilitating, overuse injuries can lead to long-term issues if not properly managed, potentially sidelining players for extended periods. These type of injuries occur often in the periods after a longer break, such as the start of the season, and if not treated carefully may develop into an almost chronic condition, and as such ultimately be career-threatening.

In handball, more acute injuries than overuse have been observed (42).

1.3 CATEGORIES OF INJURIES

Understanding the specific categories of injuries that commonly occur in handball is essential for developing prevention strategies and effective treatment protocols. This chapter is a brief overview of the categories of injuries that may happen in the different types of structures in the body. In chapter 2, the different injuries will be described in detail with risk factors and preventive measures.

MUSCLE INJURIES

Muscle injuries are prevalent in handball, often resulting from the sport's demands for explosive movements, such as sprinting, jumping, and sudden directional changes. Muscle injuries are predominantly acute injuries. The incidence of muscle injuries is high, particularly in the lower limbs, with the hamstrings, quadriceps, and calf muscles being most frequently affected. The severity of these injuries can vary, with mild strains potentially requiring only a few days of rest, while more severe tears may necessitate weeks or even months of rehabilitation.

TENDON INJURIES

Tendon injuries in handball can be both acute and overuse-related, with the latter being more prevalent. The commonly most affected tendons in handball players are the Achilles tendon, patellar tendon, and tendons of the shoulder muscles (9; 10; 72). These injuries can manifest in various locations, including within the tendon structure itself (e.g. Achilles tendinopathy) or at the bone attachment site (e.g. shin splints) (67).

The primary cause of tendon injuries is overloading relative to the tendon's capacity (67). Excessive jumping or running activities combined with insufficient recovery time can lead to painful overuse injuries. However, it is important to note that the risk of injury is relative to an individual's training status. Players with limited training history or those returning after extended rest periods may be more susceptible to tendon overuse injuries (67). Ignoring early warning signs of tendon overuse can result in the condition progressing and becoming chronic. These injuries may require prolonged recovery periods and, in severe cases, could potentially threaten an athlete's career (9; 10).

LIGAMENT INJURIES

Ligament injuries are another common occurrence in handball and are predominantly acute injuries. Almost all handball players have experienced a distortion of a finger, due to poor catching technique or in contact with an opponent, but often these injuries do not keep the player off the court for long. Other ligament injuries are more severe and may impact participation in the game for a longer duration, particularly in the knees and ankles, which bear the brunt of the sport's physical demands. Injuries to the important stabilising knee ligament, the ACL, are especially prevalent, often resulting from the rapid deceleration and cutting manoeuvres that are integral to handball. Such injuries have a severe impact for the athlete, typically requiring surgery and extensive rehabilitation for up to 12-14 months. They are therefore a major concern for players due to the set-back in handball development, but also the increased risk of future osteoarthritis.

BONE FRACTURES

Bone fractures happen in handball, often because of a fall or collision and typically affecting the nose, wrist, forearm, fingers, or foot metatarsals (12). Stress fractures, which develop gradually due to repetitive force on a bone, are also relevant in sports like handball, particular as an alternative manifestation of overuse and poor load management, and often located in the lower leg and foot.

CONCUSSION

Concussion in handball is a significant concern, with recent studies shedding light on its prevalence among players. A cross-sectional study from Germany involving 3,000 athletes revealed that 24 per cent of handball players reported experiencing a concussion at some point in their careers (13). This high percentage underscores the importance of addressing concussion risk in the sport.

In youth handball, the issue is equally pressing. A prospective study of Danish youth community handball players aged 11-17 found an overall concussion incidence of 0.94 per 1,000 playing hours (14). Notably, female athletes in this study sustained twice as many concussions as their male counterparts, highlighting a gender disparity in concussion risk, which is not readily explained.

Another study examining concussion across multiple sports found that 18 per cent of participants reported experiencing a concussion, with handball players showing a significantly higher rate at 24 per cent (13). This places handball among the sports with the highest concussion prevalence, alongside football.

These findings emphasise the need for targeted concussion prevention strategies and management protocols in handball, particularly given the physical nature of the sport which includes rapid movements, frequent jumps, and forceful physical contact (9). As research continues to unveil the short and long-term impacts of concussions, addressing this issue becomes crucial for player safety and the overall health of the sport.

1.4 PSYCHOLOGICAL AND SOCIOLOGICAL IMPLICATIONS: THE CIRCLE OF HANDBALL LIFE

The impact of injuries in handball extends beyond the physical domain, influencing both the psychological well-being of players and the sociological dynamics of teams.

PSYCHOLOGICAL IMPACT

Injuries can have a profound psychological impact on players, leading to feelings of frustration and sometimes outright signs of depression.

KEYPOINTS

- fear of re-injury and the uncertainty surrounding the recovery process
- loss of dentity when sidelined
- self-worth is sometimes tied to an athlete's handball performance.
- this can lead to a negative cycle, where mental distress hinders recovery, and increasing the risk of subsequent injuries.

SOCIOLOGICAL IMPLICATIONS

Injuries also affect the social dynamics within a team. An injured player's absence can disrupt team cohesion, particularly if the injured individual is a key player or leader. The pressure to return to play quickly can be intense, not just from the player themselves, but also from coaches, teammates, and even fans. This can lead to premature returns to competition, increasing the risk of re-injury and further complicating the recovery process.

In conclusion, injuries in handball are a multifaceted issue requiring a comprehensive understanding of their epidemiology, the nature of different injuries, and the broader psychological and sociological implications. In addition, more precise understanding of the risk factors of the specific injuries is also important for designing the right injury prevention exercises. By addressing these factors, stakeholders in the sport can work towards reducing injury rates and supporting the overall well-being of players.

PSYCHOSOCIAL VARIABLES AND INJURY RATE

Psychosocial variables are proven to increase the risk of injuries (47). Psychosocial variables can be defined as major and minor life events, personality factors, anxiety, stress susceptibility, basic psychological needs, and so on.

A large study from football (47) showed an association with injury risk:

- stress response
- history of stressors

Another football-focused study (48) went deeper into team-specific stressors and showed:

- players who perceive teammates as a source of stress have a greater risk of acute injury
- players who perceive the coach as a source of stress have a greater risk of overuse injury

There are recent data coming from handball showing that the deterioration in the coach-athlete relationship can increase the risk of injury (49). However, it only counts for players who perceive the deterioration; therefore, there are interindividual differences in the response.

The key implications are that coaches should be aware of the team's social and psychological dynamics, screen for any possible sources of psychological and sociological stressors and resolve conflicts in the team as quickly as possible.

COMMON INJURIES IN HANDBALL – WHY THEY HAPPEN AND HOW TO PREVENT THEM

Handball, with its fast pace and physical demands, presents numerous injury risks to players.

Fortunately, we now know from multiple studies that injury prevention works. As an example, focusing on the prevention of injuries to the ACL has been shown to be highly effective. Several systematic reviews and meta-analyses gathering an overview of all the existing studies on ACL injury prevention (16; 17) have shown that neuromuscular training (NMT) programmes resulted in about 50 per cent reduction in injury risk across different sports. But similar good results have been observed in adult and youth elite handball at different performance levels for ACL injuries and other acute knee injuries (18; 20: 19), as well as for shoulder injuries (20). These NMT programmes typically included various exercises such as strength training, plyometrics, and balance exercises.

The studies found that programmes incorporating more landing stabilisation exercises (e.g. drop landings, jump/hop and holds) and lower body strength exercises were particularly effective in reducing ACL injury risk. Similarly, specific strength, flexibility and neuromuscular control exercises for the trunk and shoulder reduced the risk of shoulder injuries (20).

The different studies also highlighted the importance of proper movement technique, including knee control during landing and other dynamic movements, or proper throwing technique, as key components of effective injury prevention programmes.

GENERAL COMPONENTS OF INJURY PREVENTION

STRENGTH TRAINING (IN THE GYM)

Increased muscle strength prevents injuries, however it is important that the programme is properly designed for the requirements in handball with regard to **both** performance enhancement **and** injury prevention. This includes:

- a balanced programme targeting both the front and back of the body adequately.
- targeting specific muscles identified as important muscles for injury prevention.
- include individual exercises targeting individual weaknesses determined through testing or clinical examination.

FUNCTIONAL STRENGTH TRAINING (ON COURT OR IN THE GYM)

A different kind of strength training incorporating more whole-body movements is sometimes better exercised on the handball court, and may in addition include aspects of technique and neurocognitive challenges. An example could be two-legged jumping with rubber bands around the knee. The rubber bands increase the load of hip external rotators, which are important muscles for knee injury prevention. The technical focus could be on avoiding heel strike landings and improving eccentric shock absorption, which also improve eccentric strength. By adding elements such as catching a ball, the extra neurocognitive challenge will enhance the transfer of correct landing strategy into a proper landing situation during a match.

TECHNICAL TRAINING (ON COURT)

Improving correct technique in throwing or side-cutting will reduce the risk of injury. The implementation of exercises on court, for example as part of a warm-up, could potentially improve the technical performance which will reduce acute loading on sensitive structures such as the ACL during side-cutting.

BALANCE AND PROPRIOCEPTIVE TRAINING

Elements of balance are often an integral part of many exercises or added to an exercise for progression to a more difficult level. Balance and the neuromuscular control of movement are controlled by the brain and are essential elements of technical training.

This control by the brain is a result of a fine interplay between the interpretation of incoming information about joint position, muscle or ligament tension, pressure senses, vision and more — proprioceptive feedback — and the outgoing pattern of nerve signals to the muscles, a 'motor programme', that is necessary to perform a motion such as a handball shot or a landing.

Therefore, improving technique in a movement, or improving the stability of a joint, will be enhanced by exercising the brain's ability to interpret the proprioceptive feedback in order to adjust motor programmes in a specific situation (69; 74).

Performing a movement like a stable landing is not only about having adequate strength, but just as much about adjusting the motor programme to position the foot correctly, and turn on the right muscles in right time to stabilise the joints. As a result, introducing both strengthening exercises and balance/control exercises are important. Increasing demands on stability and control (proprioception) by progressing from a leg press machine to free-weight squats is another example of this.

MOTOR LEARNING PRINCIPLES AND NEUROCOGNITIVE LOAD

A further progression of the above principle may be to add more mental load during a handball-specific exercise. For example, when performing a landing exercise alone on a handball court, it may be easy to focus on controlling your knee and landing with less load. But in a game situation the attention needs to be directed towards many other things, like the distance to the defender and catching the ball. If landing technique gets compromised because of external cognitive challenges the risk of injury will be higher. This may partly explain why more injuries happen during match play (64; 66). Therefore, injury prevention must also include training the ability to cope with external challenges, while maintaining safe technique. Adding cognitive tasks during technical exercises will enhance the transfer of correct landing strategy into a proper landing situation during a match, provided the player also strives to maintain proper landing technique, and will be an important progression from basic controlled exercises.

Recent advances at the intersection of neuroscience and sports science demonstrate that neurocognitive factors play a substantial role in reducing injury risk (62). When an athlete performs a motor task like jumping simultaneously with a cognitive task like catching a ball, a dual-task interference mechanism may arise, potentially increasing the risk of injury (58). Given that handball is played in a predominantly unpredictable and chaotic environment, it is essential to teach athletes correct movement patterns (e.g. landing, side-cutting) that can be executed automatically while performing typical handball actions such as tackling or shooting. Importantly, dual-task interference is further exacerbated following ACL injuries, underscoring the importance of addressing these aspects throughout the rehabilitation process as well.

An external focus of attention is particularly crucial for both rehabilitation and the automation of motor tasks. Research has consistently demonstrated its superiority for motor performance and learning (60; 61). For novice athletes, proximal external focus cues, closer to the body, are often most effective (63), for example: “Let your knee follow an imaginary line from your foot.”

As athletes advance, attention can be shifted toward more distal external focus such as adding ball to the exercise or emphasising outcomes of the action such as: “Twist and smash the ball through the wall.”

From a practical standpoint, exercise progression can be conceptualised along a continuum. At one end are simple, low-complexity tasks — like no-cognitive challenges such as ball catching — combined with proximal external cues to teach correct techniques. As the athlete moves along the continuum, we can add more complex, sport-specific tasks that direct focus outside the body and incorporate unpredictability, while still reinforcing the correct technical execution (59). In training science, this progression reflects a shift from linear methodologies — a focus on reps and sets — towards non-linear or differential pedagogical approaches, which prepare athletes to adapt to diverse and unforeseen motor contexts (61).

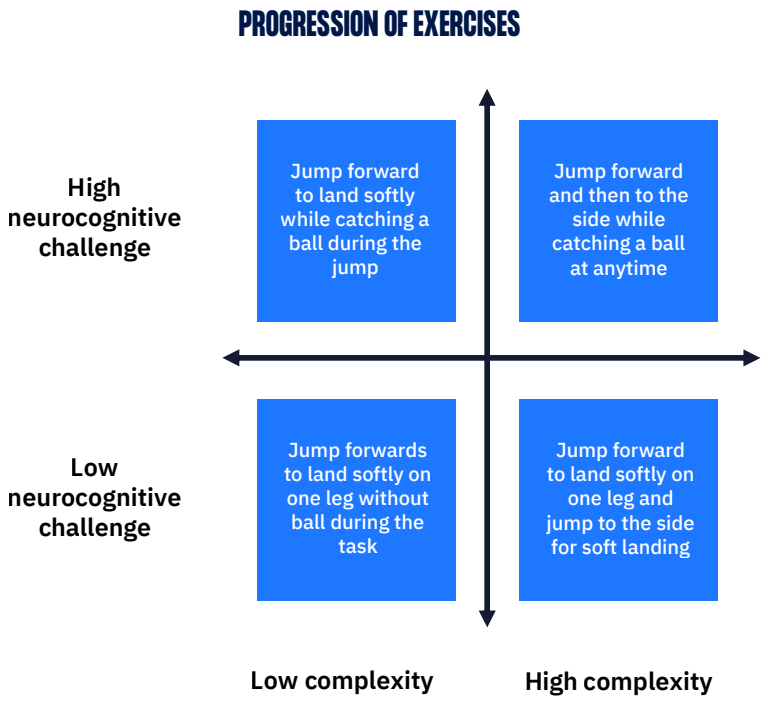


Figure 3. This diagram shows how jump tasks progress by combining movement complexity (left to right) and neurocognitive challenge (bottom to top). Simpler tasks focus on controlled landings and balance, while more complex ones add directional changes. As neurocognitive demand increases, tasks include elements like catching or reacting to a ball, requiring greater focus and coordination. The top-right corner represents the most advanced challenge, blending complex movement patterns with cognitive decision-making.

LOAD MONITORING

Overuse injuries, as the term indicates, are always to some extent a result of an increased load of specific body structures in relation to the capacity of the given structure. An obvious example could be that a sedentary person, who has not run for years, cannot just run a marathon without sustaining one or more overuse injuries. In handball, a typical example could be that starting even a moderate volume of jump training sessions will increase the load on the tendons of the knee and ankle joints. Some of the players in the team may not have had the time to build up the necessary strength capacity of their tendons, and thus they will likely begin to feel pain in the patella tendon or the Achilles tendon. Besides basically loading body structures more than their capacity allows, other factors may also add to the risk of overuse injuries. In the mentioned example it could be lack of hip muscle strength or control, which would induce poor alignment of the jumping leg, and therefore increase the load on, for example, the patella tendon, and therefore increase the risk in this person.

So, besides the above-mentioned modalities of injury prevention which may also influence overuse injury risk, monitoring the load of players may help prevention overloading.

MONITORING TRAINING LOAD

Monitoring overload is never straightforward. No perfect measurement method exists, but by applying a few structured principles, it is possible to make monitoring both practical and effective.

EXTERNAL AND INTERNAL LOAD

Training load can be thought of in two categories:

• **External load** describes what the athlete actually does. This could be the total distance run, the number of sprints, or high-intensity actions such as jumps, tackles, or rapid changes of direction. These measures can be tracked in simple ways by writing them down, using video review, or just counting repetitions. Even basic information, such as session duration and overall intensity, provides valuable insight.
• **Internal load** reflects how the athlete feels during training. A simple and widely used tool for this is the Session Rating of Perceived Exertion (sRPE). After training, each athlete gives the session an intensity score from 0 (very easy) to 10 (maximum effort). That score is then multiplied by the session duration in minutes:

> **Formula: sRPE Load = Intensity × Duration**
> **Example:** A 90-minute session rated as 6 → 90 × 6 **= 540 units**

KEEPING IT MANAGEABLE

Monitoring can quickly become overwhelming, particularly when focusing on external load. For this reason, it is best to start simple. Tracking just three things — **session duration, the sRPE score, and one basic external marker** (e.g. number of sprints or jumps) — already gives meaningful information. A spreadsheet or a free mobile app can help with recording and visualising trends.

In some cases, it is useful to distinguish between upper and lower-body load. For instance, a highly intense shooting session may increase upper-body strain but contribute little to lower-body fatigue.

CONSISTENCY MATTERS

For monitoring to be effective, data collection must be consistent:

- keep instructions clear and uniform
- record values after every session
- educate athletes on the importance of accurate and honest reporting.

MAKING SENSE OF THE DATA

Each week, review the collected information for both individuals and the team as a whole. Look for patterns, changes, or warning signs such as fatigue or declining performance. Even the best-designed training plan may need to be adjusted if the data suggests excessive strain.

A useful guideline is to watch for sudden increases in load. If the weekly load rises by **more than 20–30 per cent** compared to the average of the previous four weeks, the risk of injury rises significantly. In such cases, reducing session volume or intensity is advised.

FROM DATA TO DECISIONS

Once analysed, training load data should be used to actively shape practice. It can guide the scheduling of light versus heavy days, inform adjustments when players show signs of fatigue, and help manage demanding periods in the lead-up to competitions.

BUILDING A MONITORING CULTURE

The long-term success of monitoring depends on creating a culture where athletes see the value in participating. Emphasise that load tracking helps keep them healthy, improves their performance, and enables smarter training design.

If the budget allows, additional tools such as heart rate monitors, accelerometers, or free digital feedback apps may be useful. However, it is important to avoid common mistakes: only collect data that will actually be used and resist the temptation to believe that more data is always better.

2.1 LOWER EXTREMITIES

Most injuries in handball are related to the lower extremities. The sport's requirements for many rapid accelerations, forceful decelerations, jumping, and explosive changes of direction puts great load on muscles, tendons and joints. The challenging control of joint stability in these situations places high demands on a precise neuromuscular control of the muscles around especially the ankle and knee joint. Hip joint control and foot stability also play a role in both acute and overuse injuries in the lower extremities.

2.1.1 ACUTE JOINT AND LIGAMENT INJURIES (KNEE AND ANKLE)

RISK FACTORS

- Landing with extended hip/knee
- Landing with heel strike
- Poor alignment: body lean/rotation; lower leg rotated inwards; hip rotated inwards; landing knee with abduction

PREVENTION STRATEGIES

On-Court Training

- Softer landings
- Proper leg/body alignment
- Plyometric exercises
- Challenging landing stability

Gym-Based Training

- Quadriceps strengthening
- Hip external rotators
- Hamstring strengthening
- Medial hamstring activation

ANTERIOR CRUCIATE LIGAMENT (ACL) INJURIES

ACL injuries are particularly prevalent in handball and are a serious injury keeping the player off the court for 8-12 months. The injury most often occurs during the side-cutting movement, and the second most frequent risk situation is the single-legged landing, typically after a jump shot or the flight phase over the goal area. Other risk situations can be sudden stops, turning and for the goalkeeper also landing after a save. These movements place significant stress on the knee, particularly when the foot is planted, and the change of direction cause diminished control of the knee joint and the resulting ground reaction forces.

Around 85 per cent of ACL injuries happen without contact with others, or after slight contact during the flight time. Only a few ACL injuries in handball happen as a result of direct contact. Thus, focusing training on the risk movements specific for handball may reduce the injury risk.

RISK FACTORS:

Several studies have shown that the injury generally occurs very soon after the initial ground contact. This very fast injury mechanism, within 40-50 milliseconds after foot strike, demonstrates that the measures to prevent this injury should focus on preparation before landing, and absorption of landing ground contact through adequate body control. In essence, in a landing where high ground reaction forces are not well aligned around the knee joint — if the leg is planted in poor alignment of the hip-knee-ankle (see figure 4) — these forces may abduct and rotate the knee joint until the ACL ruptures. Muscle strength and proper activation patterns will protect the knee from these damaging forces, but landing properly in the first place would also reduce risk. Identifying the specific and more addressable risk factors, leading to these high and skewed forces, will help design preventive training interventions which, which may be readily implemented. These risk factors may be divided into subcategories of qualities necessary for control of movement:

RISK FACTORS RELATED TO HARD LANDING

- landing with more extended hip and knee (see figure 4)
- landing with heel strike

RISK FACTORS RELATED TO POOR ALIGNMENT

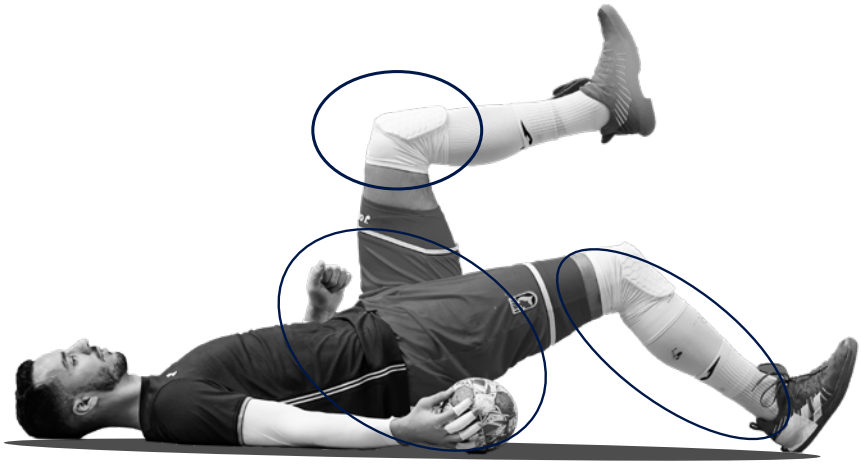
- landing with hip rotated inwards (see figure 4)
- landing with lower leg rotated inwards
- landing knee abduction (see figure 4)
- landing the leg far to the side (see figure 4)
- landing with body lean/rotation to the landing-leg side (see figure 4)

Landing with less hip and knee flexion, also with initial heel strike, will make it more likely that the landing will be harder, and therefore result in higher ground reaction forces.

Landing with knee abduction, the leg far to the side, body lean, and inward rotation of hip and knee will increase the risk of having the ground reaction forces poorly aligned with the leg, and therefore the forces will be driving the knee into rotations subsequently loading the ACL.

RISK FACTORS RELATED TO STRENGTH (MAY BE ADDRESSED IN THE GYM)

- poor hip external rotator strength
- poor eccentric quadriceps strength
- poor explosive strength of hamstrings
- muscle imbalance, particularly weak hamstrings relative to quadriceps



To reduce the high landing ground reaction forces, adequate eccentric quadriceps strength is required. Landing softly is crucial for reducing the high early impact of ground reaction forces.

During the landing, stabilising the knee to absorb potential rotational twisting forces is crucial, and the hamstrings are the optimal muscles for this. They must be strong and explosive to build adequate force in the short time after landing. Also, strong hip external rotators have been found to be crucial to help avoid the hip from rotating inwards and therefore preventing poor alignment.

LOW MEDIAL HAMSTRING ACTIVATION

Studies have shown that reduced activation of the medial hamstring before landing (pre-activation) is an important risk factor. Low activation would indicate low force production at the precise time where the ground reaction forces may induce knee abduction, one of the major mechanical reasons for ACL injury. Therefore, not only adequate strength, but high activation in optimal timing of the medial hamstrings, may reduce injury risk.

Having already sustained an ACL injury is a risk factor for sustaining another.

PREVENTION STRATEGIES:

ON COURT

- implementing exercises focusing on softer landings and proper alignment of the leg and body during side-cutting and landing
- exercises challenging landing stability (e.g., landing on BoSU or Airex)
- regularly incorporating plyometric exercises that simulate game movements in a controlled environment but with increased neurocognitive load, i.e. catching balls, making decisions on cutting direction, etc.

IN THE GYM

- eccentric strength training of quadriceps
- exercises for hip external rotators
- strength training for hamstrings
- exercises specifically targeting activation of the medial hamstring (e.g., kettlebell swing or landing on BoSU or Airex (21; 22; 23)).

EXERCISES

Principles of dynamic landing:

Watch Video

Landing exercises & change of direction:

Watch Video

Watch Video

Lower body strength:

Watch Video

Watch Video

Watch Video

EXAMPLARY POSES (FIGURE 4)

The arrow represents an estimation of the direction and magnitude of the force the ground pushes back into the body with each step, jump, or landing. The more aligned the vector is with the knee, the less twisting torsion will be induced around the knee. Therefore, good alignment of the force arrow with the knee and hip (seen from the front) will reduce stress on the joints and mitigate injury risk.

DO'S:

DON'TS:


FEET FAR AWAY FROM BODY CENTER: INCREASED RISK OF INWARD KNEE


EXCESSIVE HIP INTERNAL ROTATION, VALGUS KNEE, PATTERN TO BE AVOIDED


SHOULD BE AVOIDED: HEEL STRIKE, CONTACT POINT FAR AWAY FROM BODY CENTER

ANKLE SPRAINS

RISK FACTORS

- Landing on the forefoot
- Poor proprioception
- Poor peroneus muscle strength
- Previous ankle injuries

PREVENTION STRATEGIES

- Strengthening exercises
- Landing exercises
- Supportive gear: Spraino© shoes; Taping; Ankle braces

INJURY MECHANISM

- Landing on another player's foot
- Foot contact before direction change
- Ankle inversion and internal rotation

Ankle sprains are among the most frequent injuries in handball, typically occurring during foot contact before a sudden change in direction. However, the most frequent injury situation is when a player lands on another player's foot, causing the ankle to invert and internally rotate.

RISK FACTORS:

- landing on the forefoot, often in combination with slight inversion and internal rotation (24; 70; 25; 68)
- poor proprioception, or the body's ability to sense its position in space
- poor peroneus muscle strength and timing of activity (71)
- previous ankle injuries that may have weakened the ligaments and surrounding muscles and the proprioception function of these

PREVENTION STRATEGIES:

- incorporating dynamic proprioception exercises aiming to optimize landing motor program, such as single-leg landings on an unstable surface, into on-court training. These exercises should be progressed to involve cognitive challenges like catching a ball during exercises.
- strengthening the muscles around the ankle through specific resistance exercises and calf raises. Special focus on the lateral tibial muscle group (peroneus muscles), as they directly will resist the inversion which may cause the ligament damage.
- using ankle braces or taping for additional support, especially for players with a history of sprains. Also Spraino© shoes might reduce injury risk (27)

EXERCISES

Principles of foot mechanics:

Watch Video

Plyometrics & landing:

Watch Video

Watch Video

Calf strength:

Watch Video

2.1.2 ACUTE MUSCLE AND TENDON INJURIES (MUSCLE STRAINS AND TENDON RUPTURES)

Hamstring tears are common in handball and mostly a result of the explosive sprints, jumps, and for goalkeepers' high kicks or reaching into a split. There is not much knowledge about why hamstring tears occur, but they are often assumed to be related to small alterations of joint angles in the swing phase during sprinting, or the other movements provoking stretching of the hamstrings, such as long steps forward or to the side with forward flexion of the trunk.

RISK FACTORS:

- eccentrically weak hamstrings, particularly the lateral hamstring
- poor core muscle strength (28)
- fatigue, which can lead to poor technique and increased strain on muscles.
- inadequate warm-up, possibly leading to reduced muscle flexibility and elasticity.

PREVENTION STRATEGIES:

ON COURT

- implementing a comprehensive warm-up routine that includes dynamic stretching and sport-specific drills involving the hamstrings

IN THE GYM

- regularly performing eccentric strength training exercises that target lateral hamstring (Nordic hamstring (29; 30))
- incorporating plyometric training to enhance the hamstring muscles' ability to absorb and generate force
- core muscle strength training

EXERCISES

Hamstring strength: Watch Video

Plyometrics & landing: Watch Video

Core stability: Watch Video

MUSCLE CONTUSIONS

Muscle contusions are frequent in many sports involving body contact. Thigh muscle contusions are mostly occurring in contact with an opponent during tackles and breakthroughs. They are not easy to prevent except to play with safe distance to opponents, which, of course, is not always possible.

2.1.3 OVERUSE INJURIES OF TENDONS AND MUSCLES

KNEE OVERUSE INJURIES (JUMPER'S KNEE (PATELLAR TENDINOPATHY) OR PAIN UNDER THE KNEE CAP (PATELLOFEMORAL PAIN))

RISK FACTORS

- Repeated stress
- Inadequate recovery
- Reduced ankle dorsiflexion
- Poor lower body alignment: increased hip abduction; knee abduction in landings

PREVENTION STRATEGIES

- Eccentric strengthening: quadriceps exercise
- Adequate rest/ recovery
- Practice softer landings
- Practice correct alignment: proper ankle, knee and hip control

COMMON SYMPTOMS

- Pain during jumping/ running
- Severe cases: pain at rest; pain while walking down stairs
- Mild cases: pain later in training/ match

Jumper's knee is an overuse injury characterised by inflammation or degeneration of the patellar tendon, which connects the kneecap to the shinbone. Patellofemoral pain is related to the compression of the kneecap to the femoral bone. The player feels pain during jumping and running — in severe cases also when in rest or when walking down the stairs, while in mild cases, the pain will not present until later in the training or match. These injuries are common in sports that involve repetitive jumping, such as handball. Jumper's knee has been reported to have a prevalence of 13 per cent in handball (31).

RISK FACTORS:

- repeated stress from jumping and hard landings
- inadequate recovery between intense training sessions
- poor lower body alignment during landing displaying increased hip adduction and knee abduction in landings (32)
- reduced ankle dorsiflexion might also be a risk factor (32; 33)

PREVENTION STRATEGIES:

- regularly performing eccentric strengthening exercises for the quadriceps, such as slow, controlled single-leg squats
- ensuring adequate rest and recovery between training sessions to prevent tendon overuse
- practice correct alignment with proper ankle, knee and hip control (see ACL injury section for details)
- practice softer landing techniques (see ACL injury section for details).

EXERCISES

Lower body strength: Watch Video

Landing exercises: Watch Video

SHIN SPLINTS

RISK FACTORS

- Overtraining
- Poor footwear
- Foot mechanics: flat feet; overpronation
- High-impact activities: running; jumping

PREVENTION STRATEGIES

- Gradually increase intensity
- Wear supportive footwear
- Strength training: arch-supporting muscles; hip abductor muscles
- Examine running technique: shorten steps; increase step frequency; avoid hard landings

COMMON SYMPTOMS

- Pain along inner shinbone

Shin splints, also often called medial tibial stress syndrome, is an overuse injury characterised by pain due to inflammation along the inner edge of the shinbone. It is typically caused by repetitive impact on hard surfaces, especially when increasing load, for example after a holiday.

RISK FACTORS FOR SHIN SPLINTS:

- overtraining, particularly with high-impact activities like running and jumping
- flat feet or overpronation, which can increase stress on the shinbone
- poor footwear that does not provide adequate support or cushioning

PREVENTION STRATEGIES:

- gradually increasing training intensity to allow the body to adapt
- wearing well-cushioned, supportive footwear that is appropriate for both training and game play
- strength training of arch-supporting lower leg muscles
- strength training of hip abductor muscles
- examining running technique – hard landings increase risk and may be reduced by shortening steps and increasing step frequency
- an active lifestyle during childhood with daily sports activities or physical may build up resilience to overuse injuries by increasing strength of tendons. Tendons and ligaments increase volume slowly compared to muscle tissue.

EXERCISES

Foot mobility & strength: Watch Video

Hip abductors strength: Watch Video

ACHILLES TENDINOPATHY

RISK FACTORS

- Excessive changes in load of high-impact activities
- Poor footwear
- Playing on hard surfaces
- Poor core stability

PREVENTION STRATEGIES

- Proper load management
- Implement strength training of calf muscles
- Include appropriate warm-up and cool-down
- Avoid excessive play on hard surfaces

Achilles tendinopathy is a common overuse injury characterised by pain, swelling, and impaired performance of the Achilles tendon (35). Specific data on Achilles tendinopathy in handball is limited. The following recommendations are therefore based on information obtained in other sports.

The prevalence of Achilles tendinopathy in sports involving running and jumping activities like handball is significant, affecting up to 9 per cent of recreational athletes and potentially ending the careers of 5 per cent of professional athletes (35). Prevalence increases with age (>30 years) and body weight and is also higher for male athletes, according to an Oxford University Hospital leaflet. Preventing Achilles tendinopathy is important, and players with severe problems may have to pause their careers and do extensive rehabilitation for up to a year to overcome the problems (34).

RISK FACTORS:

- excessive changes in load of high-impact activities and training volume with inadequate recovery (35)
- weak or tight calf muscles (76)
- playing on hard surfaces (35)
- poor footwear (76)
- biomechanical abnormalities (e.g., hyperpronation, limited subtalar joint mobility) will increase risk when load is increased (35)
- poor core stability (76)

PREVENTION STRATEGIES:

- implement proper load management and gradual increase in training intensity (34)
- incorporate strength training for the calf muscles (34; 76)
- ensure adequate warm-up and cool-down routines (35)
- use appropriate footwear with good shock absorption (35)
- maintain a healthy body weight (76)
- improve core stability and lower limb biomechanics (76)
- vary training surfaces and avoid excessive play on hard courts (35)
- address any underlying biomechanical issues or muscle imbalances (35)
- recognise and address early symptoms promptly (34)

By understanding these risk factors and implementing appropriate prevention strategies, handball players and coaches can work towards reducing the incidence of Achilles tendinopathy and maintaining optimal performance. See references (76) or (34) for a more extensive overview of risk factors, prevention and rehabilitation.

EXERCISES

Calf strength: Watch Video

LOWER BACK PAIN

RISK FACTORS

- Previous episodes of low-back pain
- Reduced core and hip muscle strength
- Hyperextension of the lower back
- Increased training load

PREVENTION STRATEGIES

- Core training
- Exercises aimed at pelvic and spine mobility and flexibility
- Corrective exercise of poor pelvic control

Lower back pain is common in the general population but has also shown to be prevalent in handball players, albeit not to an extent different from the general population. In Norway a study showed almost 60 per cent of female handball players having experienced lower back pain within a year, but this was similar to an active control group (57). In Icelandic elite male handball players, 30 per cent experienced weekly lower back pain, but only 11 per cent reported substantial lower back problems (3). In Brazilian elite handball, a 4 per cent prevalence of lower back pain related to overuse was observed (1), while another study (73) found an increased prevalence of lower back pain in young female ball athletes compared to male. So in general, lower back pain is prevalent in handball players, but not more than the general population. However, besides being a problem which may impair performance and participation, lower back pain may also create a risk of shoulder injury (38; 41). Therefore, implementing exercises for prevention of lower back pain may be important for all handball players.

RISK FACTORS:

- previous episodes of low-back pain
- reduced core and hip muscle strength, especially the deep abdominal muscles, and flexibility, and impaired balance between opposing muscle groups (39; 40)
- hyperextension (hyperlordosis) of lower back. This may be related to:
    - o week abdominal muscles,
    - o tight hip flexors, and/or
    - o poor pelvic control
- increasing training load may enhance risk particularly if the above risk factors are present
- in adolescent athletes, there may be a period of increased risk during growth spurts due to higher risk of growth-induced muscular strength imbalances.

PREVENTION STRATEGIES:

- implement core training, including exercises for the deeper abdominal muscles (54; 55)
- implement exercises that improve and maintain pelvic and spine mobility and flexibility (56)
- observe and eventually correct poor pelvic control in case of hyperextension of lumbar back (55)

EXERCISES

Principles of hip mechanics: Watch Video

Lower body strength: Watch Video

Core stability: Watch Video

2.2 UPPER EXTREMITIES

Handball places significant demands on the upper body, particularly during throwing, blocking, and physical contact, leading to a range of injuries.

2.2.1 SHOULDER INJURIES (ACUTE AND OVERUSE INJURIES)

The shoulder is particularly susceptible to injuries in handball due to the repetitive overhead motions involved in throwing and blocking. Proper throwing technique and segmental coordination are critical in handball to prevent shoulder injuries.

The biomechanics of a hard throw impose high forces on the shoulder, particularly during the cocking and deceleration phases. These phases demand significant muscle strength, neuromuscular coordination, range of motion, and proximal segment stability. A stable shoulder blade, supported by thoracic stability, provides the necessary base for effective upper arm rotation and minimises injury risk. Core stability is foundational to maintaining this kinetic chain and reducing excessive shoulder loads (41). Poor technique or imbalances in these parameters increase the likelihood of shoulder overload and injury. Acute shoulder injuries may sometimes occur during contact situations in play or sometimes in the gym.

Principles of shoulder mechanics: Watch Now

ACUTE SHOULDER INJURIES

RISK FACTORS

- Improper warm-up
- Shoulder instability
- Poor throwing mechanics
- Foul play
- Reduced range of motion

PREVENTION STRATEGIES

- Improve landing technique
- Core training
- Technique & strength: proper warm-up, adequate range of motion, strengthen rotator cuff, practice proper trowing

These injuries often result from sudden impacts or falls or foul play, leading to dislocations, sprains, or strains.

RISK FACTORS:

- direct trauma from collisions or falls
- foul play, e.g. pulling the player's arm from behind
- reduced range of motion or instability in the shoulder joint and shoulder blade. This will also influence lifting technique in the gym, where, for example, the lack of correct shoulder blade positioning during bench press may increase risk of tenidinous injury
- improper warm-up
- poor throwing mechanics, leading to acute abnormal stress on the shoulder joint

PREVENTION STRATEGIES:

- improve landing technique to reduce risk of fall-related traumas.
- ensure proper warm-up before throwing at maximum speed
- ensure adequate range of motion of the shoulder joint and the shoulder blade
- strengthening the rotator cuff muscles and shoulder blade stabilizers through resistance training (see below)
- core training
- practice proper throwing techniques to reduce undue stress on the shoulder
- ensure correct lifting technique in the gym, especially during bench press
- observe correct playing conduct and avoid touching opponent's arm from behind

OVERUSE SHOULDER INJURIES

RISK FACTORS	PREVENTION STRATEGIES
■ Repetitive throwing without rest	■ Flexibility and mobility
■ Improper core strength	■ Load Control Methods: weekly load not >20% increase
■ Reduced range of motion	■ Core strengh and stability
■ Weak shoulder external rotators	■ Targeted strengthening: rotator cuff (external rotators); back side of shoulder; scapula exercises

Overuse injuries, such as rotator cuff tendinitis or impingement injuries, result from repetitive overhead motions that cause wear and tear on the shoulder joint, especially if the mobility and movement pattern of the shoulder and shoulder blade are compromised and throwing technique is not correct.

RISK FACTORS:

- repetitive throwing without adequate rest
- muscle imbalances or weaknesses, particularly weak shoulder external rotators
- reduced range of motion or instability in the shoulder joint and shoulder blade
- improper throwing technique compromising the kinetic chain
- improper core strength and stability
- low back pain may compromise core stability and influence the kinetic chain

PREVENTION STRATEGIES:

- strengthening exercises for the back side of the shoulder, particularly exercises involving the shoulder blade

- strengthening exercises for the rotator cuff, particularly the external rotators (42; 20)
- incorporating regular flexibility and mobility exercises into training (46)
- ensuring regular core strength and stability (43)
- load management to control load of the shoulder:
    - ensuring that the weekly shoulder load is not increased more than 20% compared to the preceding four weeks (42)
    - by adjusting training exercises the total number of high intensity throwing repetitions in practice may be controlled
    - having the players perform a home-based throwing program will reduce risk after longer periods with no handball and will mitigate the large fluctuations in loading (46)

EXERCISES

Shoulder blade strength & control:

Watch Video

Watch Video

Watch Video

Flexibility & mobility:

Watch Video

External rotators strength:

Watch Video

Core & shoulder stability:

Watch Video

2.2.2 ELBOW INJURIES

RISK FACTORS

- Repetitive throwing motions
- Improper technique
- Insufficient muscle strength of forearm and upper arm muscles

PREVENTION STRATEGIES

- Strengthen forearm/wrist
- Proper throwing mechanics
- Goalkeeper elbow position/not fully extended
- Load management

Elbow injuries, such as tendinitis (commonly known as tennis elbow) and ligament sprains, can occur due to the repetitive strain of throwing or direct impacts, particular for goalkeepers.

RISK FACTORS:

- overuse from repetitive throwing motions
- improper technique that places excess stress on the elbow joint, e.g., extended elbow when goalkeepers save a shot
- insufficient strength in the forearm and upper arm muscles, particularly elbow flexors

PREVENTION STRATEGIES:

- strengthening the forearm and wrist muscles through specific exercises like wrist curls and reverse curls
- ensuring proper throwing mechanics to minimize stress on the elbow.
- goalkeepers: Ensure proper, i.e. not fully extended, elbow position during saving shots
- load management.

2.2.3 WRIST INJURIES

RISK FACTORS	PREVENTION STRATEGIES
■ Repetitive motions/impact	■ Strengthen wrist/forearm
■ Falls or collisions	■ Proper falling technique
■ Weak wrist/forearm muscles	■ Proper hand positioning during catching and blocking
	■ Protective taping/guards

The wrist is prone to sprains, fractures, and tendinitis due to the frequent use of the hands for catching, blocking, and shooting.

RISK FACTORS:

- repetitive motions and impacts during catching or blocking
- falls or collisions that lead to direct trauma to the wrist
- weakness in the wrist and forearm muscles

PREVENTION STRATEGIES:

- strengthening the wrist and forearm muscles through resistance training
- proper falling technique reducing the risk of awkward loading of the wrist
- practicing proper hand positioning and technique during catching and blocking
- using protective taping or wrist guards to provide additional support

2.2.4 FINGER INJURIES

SYMPTOMS	PREVENTION STRATEGIES
■ Weak grip strength	■ Strengthen grip/finger muscles
■ Falls or collisions	■ Use buddy taping
■ Direct impacts from ball	■ Proper catching techniques

Finger injuries, including distortion, dislocations, and fractures, are very common due to the hand's role in catching and controlling the ball and the less controllable contact with the opponents during defence actions. Typically, distortion and pain are a result of a strained ligament, but in some cases also involve small avulsions where the ligament has pulled a fragment of the bone away. In such situations, medical attention is necessary to prevent long-term problems with the finger.

RISK FACTORS:

- direct impacts from the ball, particularly when catching at awkward angles
- falls or collisions that lead to trauma to the fingers
- weak grip strength or poor hand positioning

PREVENTION STRATEGIES:

- strengthening grip and finger muscles through specific exercises like squeezing a stress ball
- using buddy taping (taping two fingers together) to provide additional support during play
- practicing proper catching techniques to reduce the risk of awkward impacts

EXERCISES

Wrist strength: Watch Video

2.3 CONCUSSION

SYMPTOMS

- Headaches
- Dizziness
- Confusion
- Memory loss

PREVENTION STRATEGIES

- Penalise dangerous play
- Strengthening of neck muscles
- Reduce head impact from falls

INJURY MECHANISM

- Collisions with other players
- Falls resulting in head impact

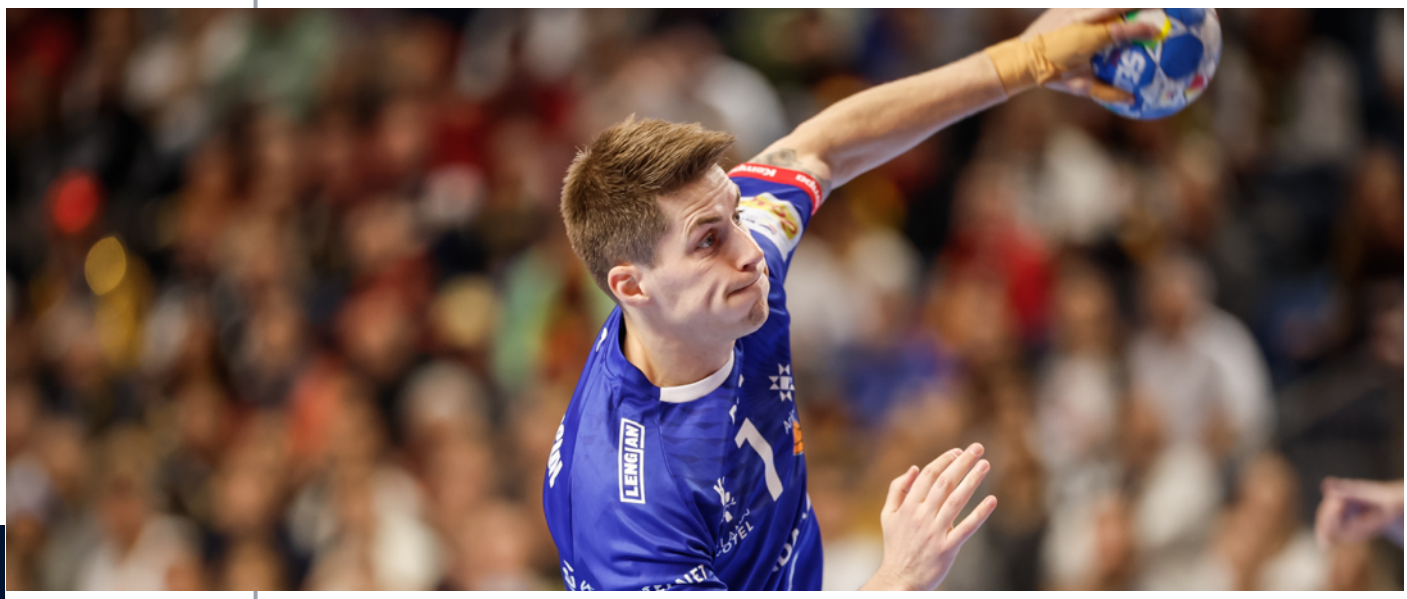
Concussions, while less common than other injuries in handball, are serious and can have long-lasting effects if not properly managed. A concussion is a type of traumatic brain injury that occurs when a blow to the head or body causes the brain to move rapidly within the skull.

SEVERITY OF CONCUSSION BASED ON LITERATURE

Studies in handball and other team sports have shown that concussions can lead to a wide range of symptoms, including headaches, dizziness, confusion, and memory loss. The serious long-term consequences of repeated concussions can include chronic traumatic encephalopathy (CTE), a degenerative brain disease. In handball, concussions typically occur from collisions with other players or falls that result in a head impact, and for goalkeepers a shot to the head, either directly or via the post, may result in a concussion.

PREVENTION STRATEGIES FOR MINIMIZING THE IMPACT OF CONCUSSIONS:

• **Education:** ensuring that players, coaches, and medical staff are well-informed about the signs and symptoms of concussion and the importance of reporting and managing them properly
• **Rule changes:** advocating for changes in rules to reduce the likelihood of head injuries, such as penalising dangerous play that increases the risk of head impacts
• **Strength interventions for head and neck training:** strengthening the neck muscles can help reduce the risk of concussion by increasing the head's stability during impacts. Exercises such as neck flexion, extension, and lateral flexion can be integrated into regular training programs to build neck strength and resilience. Regular resistance training that targets the cervical spine can also contribute to reducing the severity of concussions if they do occur
• **Technical interventions:** often uncontrolled landings result in harder impact of the body to the floor, and consequently a higher risk of head impact with the floor. Developing and improving proper landing technique will control the body contact with the floor, and most likely reduce the number of concussions related to falls
• **For goalkeepers:** introducing a head control strategy that stabilises the head and neck right before the shot by keeping the chin down and contracting the neck muscles will increase the stability of the head in case of a hit. Thus, the very fast and high acceleration resulting from a head impact will be mitigated and risk of concussion be reduced



2.4 SUMMARY

In conclusion, understanding the common injuries in handball, their risk factors, and how to prevent them is crucial for maintaining player health and performance. By implementing targeted prevention strategies, players can reduce their risk of injury and extend their careers in the sport. In general headlines, the following aspects should be considered:

BALANCING STRENGTH

Shoulder: strength in muscles on the backside controlling the shoulder blade, and particularly the external rotator muscles, is important, to balance the stronger frontside muscles creating the forceful throwing motion.

Core strength: abdominal muscles, back extensor muscles and lateral flexors should be strengthened along with the hip muscles controlling the pelvis. Particularly strong external rotators will reduce risk of ACL injury.

Knee: strong hamstrings are necessary for reducing hamstring strains, and particularly the medial hamstring to reduce risk of ACL injury. The knee extensors should be strong in the eccentric motion to enable softer landings to reduce ACL injury risk.

Ankle: strong peroneus muscles will be a prerequisite for prevention of ankle distortion, but also strengthening the deep shank muscles (e.g. tibialis posterior) to ensure proper foot posture and reduce risk of shin splints, patella-femoral pain and maybe ACL injuries.

DYNAMIC CONTROL – ALIGNMENT & OPTIMAL TECHNIQUE IN NEUROCOGNITIVELY CHALLENGED SITUATIONS.

Besides muscle strength, optimal activation of antagonist muscles is necessary to ensure joint stability if potentially damaging forces should occur.

To reduce risk of external forces creating excessive loading of the knee, a proper alignment of hip-knee-foot during landing is necessary. This includes proper knee and hip flexion, avoiding excessive internal rotation of hip and knee joint, as well as avoiding hip adduction and knee valgus.

The above should be automatised in the players so attention to the situations of the game like catching the ball, or avoiding a tackle, will not change the protective movement pattern.

LANDING TECHNIQUE

An automatic use of proper landing techniques will reduce hard impacts with the floor, and thereby reduce risk of acute impact injuries, but will also reduce risk of serious knee injuries and acute shoulder injuries.

LOAD MANAGEMENT

All overuse injuries are a result of a mismatch between the load-rest ratio and the physical capacity of the different body structures of the individual player. Controlling the load imposed on the players along with an understanding of the individual players' physical capacities will enable better dosage of physical load and reduce overuse injury risk.

3. INTEGRATION OF INJURY PREVENTION INTO HANDBALL PRACTICE AND S&C

In the next section, we will show how to apply injury prevention exercises. First, we will introduce a possible warm-up structure with videos. Next, we will present two micro cycles, which combine regular handball sessions with injury prevention exercises.

WARM-UP

Warm-up is based on the concept RAMP (51) and is divided into three sections: raise; activate and mobilise; and potentiate. Some of the exercises outlined in the activate and mobilise part of the warm-up can also fit at the end of handball sessions, especially when larger external loads are applied (see the micro-cycle examples). Furthermore, although the RAMP concept of the warm-up is advanced compared to the most common way most handball teams warm up, there are even more advanced approaches to the warm-up that also include mental and sensory functions.

RAISE	ACTIVATE & MOBILISE	POTENTIATE
The key focus of the raise phase is to increase body temperature, improve oxygen delivery, and prepare the cardiovascular system. The movements selected should mimic those used in the main session, with possible introduction of skill-based movements.	The key focus of this phase is to progressively increase the range of motion in fundamental movement patterns.	The key focus of the potentiate phase is to prepare the body for the demands of the main session, which includes high-intensity movements. This phase should mimic the session's main focus. For example, if the session focuses on defence, it may include high-intensity tackles. If the session focuses on offence, it might involve high intensity running or plyometrics.
Watch Video Watch Video	Watch Video Watch Video Watch Video Watch Video	Watch Video Watch Video

MICRO-CYCLE

In the following section, you can find two examples: the off-season/ pre-season micro-cycle and the in-season micro-cycle. It is important to note that every club will follow a different training structure due to logistics and time constraints. These examples represent an ideal scenario, but general principles can still be derived.

In the following examples, we have structured one training session consisting of three parts:

- warm-up,
- main handball part,
- and post-training, with corresponding videos attached

Important takeaways

Implementation of injury prevention programmes are not always successful in practice, especially if they are introduced as a package to perform rigidly and consistently. Implementing the different categories of exercises into different parts of the handball practice and physical conditioning may have greater success of acceptance and adaptation by the players. For example, hopping, landing and shoulder stability exercises may be implemented in the warm-up, replacing ordinary running and arm swings, and potentially also in technical exercises while introducing an increased cognitive load. Specific strength exercises for injury prevention may be introduced in the strength and conditioning parts, substituting ordinary squats or leg press for Bulgarian split squats with rubber bands, or leg curls for kettlebell swings or Nordics.

It is not necessary to perform all exercises; sometimes it is enough to select one exercise from the progression. Every warm-up can be built using the RAMP concept explained above. If time is limited, it can be shortened by choosing just a few exercises, as shown in the micro-cycles.

When there is a regular handball session, the warm-up can include complementary handball exercises focused on correct landing and joint alignment. This not only supports injury prevention but also increases overall skill development. When the training session includes strength-dominant exercises with heavier loading (especially eccentric work), it is necessary to reduce or adjust the intensity in the main handball part to prevent overloading.

OFF-SEASON/PRE-SEASON MICRO-CYCLE

DAY	WARM-UP PART	MAIN HANDBALL PART	POST TRAINING PART
Monday	Watch Video Watch Video	Regular handball training	
Tuesday	Watch Video Watch Video	Handball training (technical focus, less running intensity)	Watch Video
Wednesday	Watch Video Watch Video	Regular handball training	
Thursday	Watch Video Watch Video	Handball training (technical focus, less running intensity)	Watch Video

Friday	Watch Video Watch Video	Regular handball training	
Saturday	Rest Day		
Sunday	Rest day		

It is more than clear that dense and heavy competition season needs to be take into account when designing in-season micro-cycles.

The evidence from handball on how to structure micro-cycles is limited; however, we can infer general insights from football periodisation principles (52). The general principles regarding the volume/intensity periodisation within a micro-cycle are also supported by studies (53).

Due to the frequent nature of handball matches, there are a few principles that should be followed.

- include one rest day in a weekly micro-cycle, ideally 1-2 days after the match
- in the two days leading to the match, coaches should switch between easy and moderate days, not two moderate days in sequence
- the need for exposure to high intensity running, in the micro-cycle, which should be strategically microdosed. This is highly relevant for substitute players, or players coming from an off-season
- if you include strength-dominated work, it should be early in the week after the match, to minimise DOMS interference with the match

IN-SEASON MICRO-CYCLE

DAY	WARM-UP PART	MAIN HANDBALL PART	POST TRAINING PART
Monday	Watch Video	Regular handball training	
Tuesday	Watch Video Watch Video	Handball training (technical focus, less running intensity)	Watch Video

Wednesday	Watch Video	Regular handball training with inclusion of high intensity running	
Thursday	Day off	Day off	
Friday	Watch Video Watch Video Watch Video	Last training before match (activation)	
Saturday	Match day		
Sunday	Rest day or easy activity		

4. TESTING

WHY DO PHYSICAL TESTS?

Testing for performance has long been an integral part of pre-season preparation in elite handball, and often also in youth and sub-elite adult handball. The results of such endurance, strength or jumping tests may inform coaches and S&C coaches about individual conditioning levels, and consequently guide the dosage and priorities for the physical training in the following period.

Likewise, testing for physical weaknesses or technical shortcomings associated with increased injury risks may indeed be worth implementing in the pre-season test battery, and probably also in a mid-season test.

TESTING FOR MAJOR INJURIES

As described in chapter 2, there is now a list of evidence-based risk factors associated with specific injuries. However, this list is long and some of the risk factors are not easily tested in a standard club environment but would require laboratory settings or advanced equipment. With developing technology, some equipment might be more accessible, and many physiotherapists are already using technology to assist evaluating patients. As an example, video technology is now much more readily usable with current smartphone apps.

It may be reasonable to focus on testing risk factors for some of the major injuries as the consequence of sustaining these injuries are larger, both for the individual player and for the team.

SHOULDER INJURY RISK FACTORS

Besides the increased risk induced by the increased load, specific weaknesses or improper technique may further increase risk. For example, players with weak shoulder external rotators will have a more than four-times increased risk of shoulder injuries, when load is also increased. Therefore:

- if a strength measuring device is available, testing of shoulder external rotator strength is recommended
- testing strength for the back side of the shoulder (retraction of the shoulder blades)
- if experienced physiotherapist is available, scapula dyskinesia may be tested

KNEE INJURY RISK FACTORS

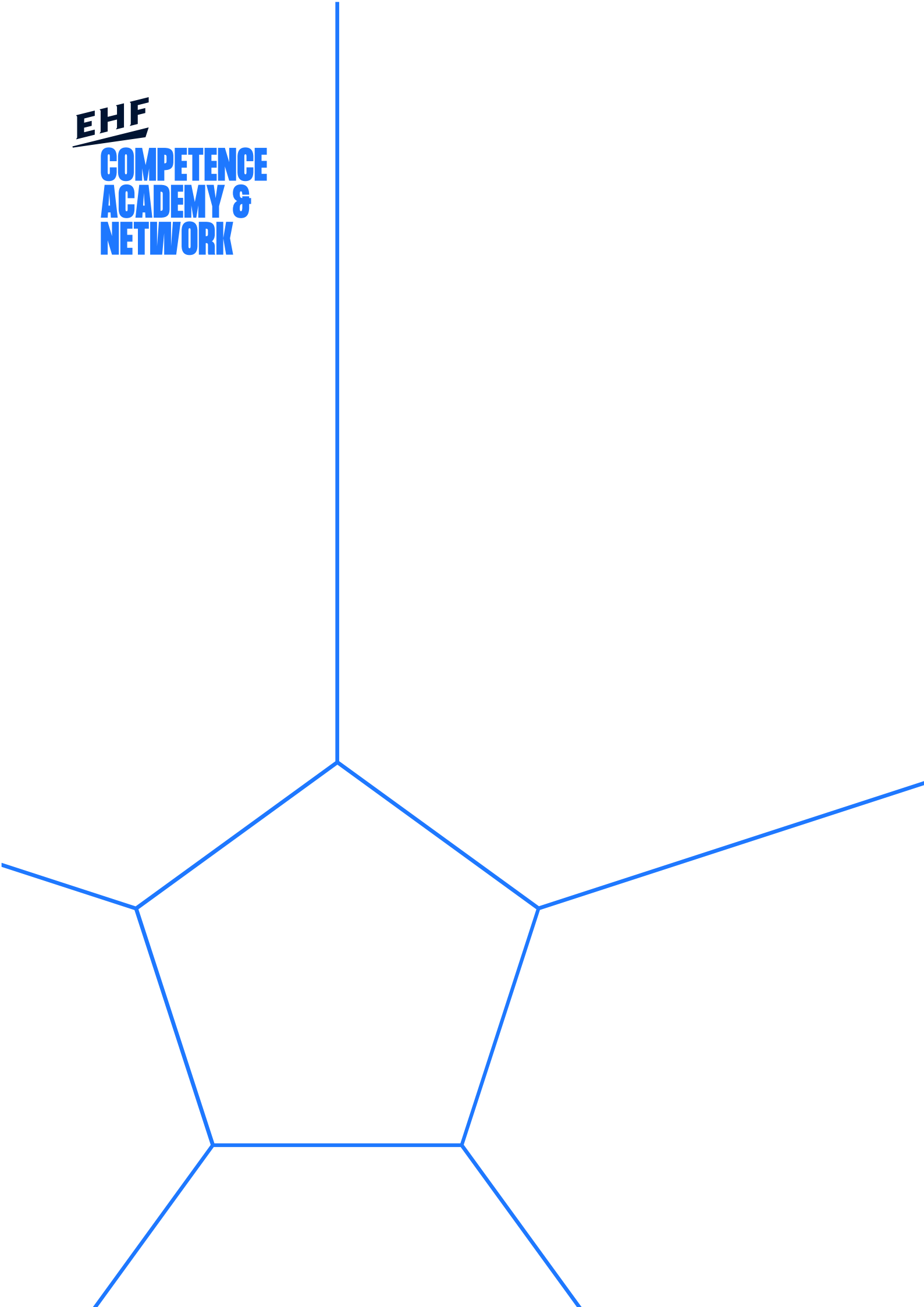
There is limited validity of tests performed outside a motion analysis laboratory, but some studies have used video in the frontal plane to estimate the alignment of trunk-pelvis-knee-foot during single-leg landings (75), and others have used video to analyse side-cutting movements (65). Although not highly valid, such video recordings may help identify individual players with poor alignment.

When analysing frontal plane video of side-cut movement or single-leg landing from a box —preferably when catching a ball right before landing — look for the following risk factors:

- foot placement far away from the body centre, either in front or to the side
- internally rotated foot or heel strike pattern
- hip internal rotation
- contra-lateral pelvic drop
- excessive trunk lateral flexion over the cutting leg
- lack of knee and hip flexion (if possible with a sagittal plane camera)
- hamstring strength measurements
- if a strength measuring device is available, measure hip external rotation strength (21; 23)

EHF

COMPETENCE ACADEMY & NETWORK



APPENDIX: VIDEO LIBRARY

DYNAMIC/HANDBALL SPECIFIC	
“S” Running	https://bcove.video/3Ivtmpl
“Z” Running Ball - “Z” Running with Dribbling	https://bcove.video/4pzA0vm
One Leg Landing “Z” Running with Side Bound and One Leg Landing Ball - “Z” Running with Side Bound and One Leg Landing and Ball Catch	https://bcove.video/3Vwsq6X
Ball - Running Forward and One Leg Stopping and One Leg Ball Control Ball - Running Forward and One Leg Stopping and One Leg Ball Control and 90° Turn	https://bcove.video/4nP7W5I
Partner - Running Forward and Two Legs Stopping with Tackle	https://bcove.video/4nIUv79
Ball - Jump Shot and Double Leg Landing	https://bcove.video/4nhQZAI
Double Leg Long Jumps - Continuous Ball - Double Leg Long Jumps - Continuous Band Resisted - Double Leg Long Jumps - Continuous	https://bcove.video/482kfa9
One Leg Side Hops (2 out - 1 in) to Jump Shot Motion Partner/ Ball / One Leg Side Hops (2 out - 1 in) to Jump Shot Motion after a Ball Catch	https://bcove.video/3IvtDbR
LOWER BODY	
Box - One Leg Squat to Touch Box / Band Pulling In - One Leg Squat to Touch	https://bcove.video/3KnPQZT
Box - Rear Foot Elevated Split Squat Box / Band Pulling In - Rear Foot Elevated Split Squat	https://bcove.video/4pwqqcB
Band Resisted - Swing - Hip Hinge Focus Band Resisted / KB - Two Arms Swing - Hip Hinge Focus KB - Two Arms Swing	https://bcove.video/4pKS7yv
KB - One Leg Standing - Around the Waist Rotations Band - Multidirection Ankle/Foot	https://bcove.video/4gyQNuq

One Leg “Romanian” Deadlift KB/DB - One Leg “Romanian” Deadlift Med Ball - One Leg “Romanian” Deadlift - Fast Eccentric Control	https://bcove.video/3K9Jr4D
“Nordic Curl”	https://bcove.video/48r67Hu
Band - Side Lying Hip External Rotations Band - One Leg Standing Hip External Rotations Band - One Leg Standing Hip External Rotations with Dribbling a Ball Band - Sitting Hip External Rotations	https://bcove.video/4omlTIO
One Leg Standing Heel Raises	https://bcove.video/46pIZ9y
UPPER BODY	
Band - Four Ways Shoulders’ Mobility	https://bcove.video/4nljgqi
Band – Y-W-Y press Partner Supported - “Falling Backward”	https://bcove.video/4nFYVuZ
DB - Standing - One Arm Overhead Press Inclined Bench / DBs - Reverse Sitting - Two Arms Overhead Press	https://bcove.video/498BG9A
Band - Standing - One Arm Shoulder External Rotation - 90° Shoulder Abduction DB - Standing - One Arm Shoulder External Rotation - 90° Shoulder Abduction Ball - Standing One Arm Shoulder External Rotation Catch - 90° Shoulder Abduction Ball - Standing One Arm Shoulder External Rotation Throw - 90° Shoulder Abduction	https://bcove.video/46PqPzs
“Scapula Push-up” Floor press with focus on Serratus Towel / Partner Assisted - Legs Elevated Front Pillar Bridge on Forearms - Floor Sweeping	https://bcove.video/4pDdlyh
DB/Stick - Multidirection Wrist Motion	https://bcove.video/4mvtDXd

CORE	
Lateral Pillar Bridge on Forearm with T-Spine Rotation and Arm Reach Lateral Pillar Bridge with T-Spine Rotations and Arm Reach with a Ball Throwing/Catching	https://bcove.video/482kyBP
Basic Crawling Position - Arm(s) / Leg(s) lift off and Balance Front Pillar Bridge on Hands - Arm(s) / Leg(s) lift off and Balance	https://bcove.video/46kAHkN
Med Ball - Two Arms Side Rotational Throw - Face Forward	https://bcove.video/3W7HXdy
Med Ball - Sit-up Throw	https://bcove.video/4nIJ92X
PRINCIPLES	
Principles of Dynamic Landing	https://bcove.video/3W1qDqH
Principles of Hip Mechanics	https://bcove.video/4mvtHpV
Principles of Foot Mechanics	https://bcove.video/47WNXgx
Principles of Shoulders Mechanics	https://bcove.video/4pD9S2y

REFERENCE LIST

1. Giroto, N., Hespanhol Junior, L. C., Gomes, M. R. C., & Lopes, A. D. (2017). Incidence and risk factors of injuries in Brazilian elite handball players: A prospective cohort study. Scandinavian Journal of Medicine & Science in Sports, 27(2), 195–202. https://doi.org/10.1111/sms.12636

2. Moller, M., Attermann, J., Myklebust, G., & Wedderkopp, N. (2012). Injury risk in Danish youth and senior elite handball using a new SMS text messages approach. British Journal of Sports Medicine, 46(7), 531–537. https://doi.org/10.1136/bjsports-2012-091022

3. Rafnsson, E. T., Valdimarsson, Ö., Sveinsson, T., & Árnason, Á. (2017). Injury pattern in Icelandic elite male handball players. Clinical Journal of Sport Medicine: Official Journal of the Canadian Academy of Sport Medicine. https://doi.org/10.1097/JSM.0000000000000499

4. Langevoort, G., Myklebust, G., Dvorak, J., & Junge, A. (2007). Handball injuries during major international tournaments. Scandinavian Journal of Medicine & Science in Sports, 17(4), 400–407. https://doi.org/10.1111/j.1600-0838.2006.00587.x

5. Luig, P., Krutsch, W., Nerlich, M., Henke, T., Klein, C., Bloch, H., Platen, P., & Achenbach, L. (2018). Increased injury rates after the restructure of Germany's national second league of team handball. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA, 26(7), 1884–1891. https://doi.org/10.1007/s00167-018-4851-4

6. Raya-González, J., García-Esteban, S., de Ste Croix, M., Manuel Clemente, F., & Castillo, D. (2021). Longitudinal differences in the injury profile of professional male handball players according to competitive-level. Research in Sports Medicine, 29(1), 90–102. https://doi.org/10.1080/15438627.2020.1800465

7. Achenbach, L., Loose, O., Laver, L., Zeman, F., Nerlich, M., Angele, P., & Krutsch, W. (2018). Beach handball is safer than indoor team handball: injury rates during the 2017 European Beach Handball Championships. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA, 26(7), 1909–1915. https://doi.org/10.1007/s00167-018-4907-5

8. Åman, M., Forssblad, M., & Henriksson-Larsén, K. (2016). Incidence and severity of reported acute sports injuries in 35 sports using insurance registry data: Incidence of acute sports injuries. Scandinavian Journal of Medicine & Science in Sports, 26(4), 451–462. https://doi.org/10.1111/sms.12462

9. Aspetar Sports Medicine Journal - INJURIES IN HANDBALL. (n.d.). Aspetar.com. Retrieved August 13, 2025, from https://journal.aspetar.com/en/archive/volume-13-targeted-topic-sports-medicine-in-handball/injuries-in-handball

10. Achilles tendinopathy. (n.d.). Fittoplay.org. Retrieved August 13, 2025, from https://fittoplay.org/body-parts/lower-leg/achilles-tendinopathy

11. Sharma, P., & Maffulli, N. (2006). Biology of tendon injury: healing, modeling and remodeling. Journal of Musculoskeletal & Neuronal Interactions, 6(2), 181–190.

12. Jørgensen, U. (1984). Epidemiology of injuries in typical Scandinavian team sports. British Journal of Sports Medicine, 18(2), 59–63. https://doi.org/10.1136/bjsm.18.2.59

13. Helmich, I. (2018). Game-specific characteristics of sport-related concussions. The Journal of Sports Medicine and Physical Fitness, 58(1–2), 172–179. https://doi.org/10.23736/S0022-4707.16.06677-9

14. Pedersen, L. L., Bjerg, M., Carstensen, S., Hartvigsen, J., & Møller, M. (2024). 3.23 Concussion incidence amongst danish youth handball players participating in the health and performance promotion in youth sport (happy) randomized controlled trial. Second Round Abstract Submissions.

15. Luteberget, L. S., Houtmeyers, K. C., Vanrenterghem, J., Jaspers, A., Brink, M. S., & Helsen, W. F. (2021). Load monitoring practice in elite women association football. Frontiers in Sports and Active Living, 3, 715122. https://doi.org/10.3389/

16. Petushek, E. J., Sugimoto, D., Stoolmiller, M., Smith, G., & Myer, G. D. (2019). Evidence-based best-practice guidelines for preventing anterior cruciate ligament injuries in young female athletes: A systematic review and meta-analysis. The American Journal of Sports Medicine, 47(7), 1744–1753. https://doi.org/10.1177/0363546518782460 fspor.2021.715122

17. Sugimoto, D., Myer, G. D., Barber Foss, K. D., Pepin, M. J., Micheli, L. J., & Hewett, T. E. (2016). Critical components of neuromuscular training to reduce ACL injury risk in female athletes: meta-regression analysis. British Journal of Sports Medicine, 50(20), 1259–1266. https://doi.org/10.1136/bjsports-2015-095596
18. Myklebust, G., Engebretsen, L., Braekken, I. H., Skjolberg, A., Olsen, O. E., & Bahr, R. (2003). Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. Scandinavian Journal of Medicine & Science in Sports, 13(4), 272–272. https://doi.org/10.1034/j.1600-0838.2003.00341.x
19. Olsen, O.-E., Myklebust, G., Engebretsen, L., Holme, I., & Bahr, R. (2005). Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. BMJ (Clinical Research Ed.), 330(7489), 449. https://doi.org/10.1136/bmj.38330.632801.8F
20. Asker, M., Hägglund, M., Waldén, M., Källberg, H., & Skillgate, E. (2022). The effect of shoulder and knee exercise programmes on the risk of shoulder and knee injuries in adolescent elite handball players: A three-armed cluster randomised controlled trial. Sports Medicine - Open, 8(1), 91. https://doi.org/10.1186/s40798-022-00478-z
21. Zebis, M. K., Skotte, J., Andersen, C. H., Mortensen, P., Petersen, H. H., Viskaer, T. C., Jensen, T. L., Bencke, J., & Andersen, L. L. (2013). Kettlebell swing targets semitendinosus and supine leg curl targets biceps femoris: an EMG study with rehabilitation implications. British Journal of Sports Medicine, 47(18), 1192–1198. https://doi.org/10.1136/bjsports-2011-090281
22. Zebis, Mette K., Andersen, C. H., Bencke, J., Ørntoft, C., Linnebjerg, C., Hölmich, P., Thorborg, K., Aagaard, P., & Andersen, L. L. (2017). Neuromuscular coordination deficit persists 12 months after ACL reconstruction but can be modulated by 6 weeks of kettlebell training: A case study in women's elite soccer. Case Reports in Orthopedics, 2017, 4269575. https://doi.org/10.1155/2017/4269575
23. Bencke, J., Strøm, M., Curtis, D. J., Bandholm, T., & Zebis, M. K. (2023). Differences in thigh muscle activation between standing and landing exercises for knee injury prevention and rehabilitation. International Journal of Sports Physical Therapy, 18(1), 102–112. https://doi.org/10.26603/001c.67829
24. Bagehorn, T., de Zee, M., Fong, D. T. P., Thorborg, K., Kersting, U. G., & Lysdal, F. G. (2024). Lateral ankle joint injuries in indoor and court sports: A systematic video analysis of 445 nonconsecutive case series. The American Journal of Sports Medicine, 52(6), 1572–1584. https://doi.org/10.1177/03635465241241760
25. Fong, D. T.-P., Ha, S. C.-W., Mok, K.-M., Chan, C. W.-L., & Chan, K.-M. (2012). Kinematics analysis of ankle inversion ligamentous sprain injuries in sports: five cases from televised tennis competitions: Five cases from televised tennis competitions. The American Journal of Sports Medicine, 40(11), 2627–2632. https://doi.org/10.1177/0363546512458259
26. Fong, D. T. P., Mok, K.-M., Thompson, I. M., Wang, Y., Shan, W., & King, M. A. (2023). A lateral ankle sprain during a lateral backward step in badminton: A case report of a televised injury incident. Journal of Sport and Health Science, 12(1), 139–144. https://doi.org/10.1016/j.jshs.2021.03.007
27. Lysdal, F. G., Bandholm, T., Tolstrup, J. S., Clausen, M. B., Mann, S., Petersen, P. B., Grønlykke, T. B., Kersting, U. G., Delahunt, E., & Thorborg, K. (2021). Does the Spraino low-friction shoe patch prevent lateral ankle sprain injury in indoor sports? A pilot randomised controlled trial with 510 participants with previous ankle injuries. British Journal of Sports Medicine, 55(2), 92–98. https://doi.org/10.1136/bjsports-2019-101767
28. Al Attar, W. S. A., & Husain, M. A. (2023). Effectiveness of injury prevention programs with core muscle strengthening exercises to reduce the incidence of hamstring injury among soccer players: A systematic review and meta-analysis. Sports Health, 15(6), 805–813. https://doi.org/10.1177/19417381231170815
29. Petersen, J., Thorborg, K., Nielsen, M. B., Budtz-Jørgensen, E., & Hölmich, P. (2011). Preventive effect of eccentric training on acute hamstring injuries in men's soccer: a cluster-randomized controlled trial: A cluster-randomized controlled trial. The American Journal of Sports Medicine, 39(11), 2296–2303. https://doi.org/10.1177/0363546511419277

30. Van der Horst, N., Smits, D.-W., Petersen, J., Goedhart, E. A., & Backx, F. J. G. (2015). The preventive effect of the nordic hamstring exercise on hamstring injuries in amateur soccer players: a randomized controlled trial: A randomized controlled trial. The American Journal of Sports Medicine, 43(6), 1316–1323. https://doi.org/10.1177/0363546515574057
31. Zwerver, J., Bredeweg, S. W., & van den Akker-Scheek, I. (2011). Prevalence of Jumper's knee among nonelite athletes from different sports: a cross-sectional survey: A cross-sectional survey. The American Journal of Sports Medicine, 39(9), 1984–1988. https://doi.org/10.1177/0363546511413370
32. De Bleecker, C., Vermeulen, S., De Blaiser, C., Willems, T., De Ridder, R., & Roosen, P. (2020). Relationship between jump-landing kinematics and lower extremity overuse injuries in physically active populations: A systematic review and meta-analysis. Sports Medicine (Auckland, N.Z.), 50(8), 1515–1532. https://doi.org/10.1007/s40279-020-01296-7
33. Sprague, A. L., Smith, A. H., Knox, P., Pohlig, R. T., & Grävare Silbernagel, K. (2018). Modifiable risk factors for patellar tendinopathy in athletes: a systematic review and meta-analysis. British Journal of Sports Medicine, 52(24), 1575–1585. https://doi.org/10.1136/bjsports-2017-099000
34. Silbernagel, K. G., Hanlon, S., & Sprague, A. (2020). Current clinical concepts: Conservative management of Achilles tendinopathy. Journal of Athletic Training, 55(5), 438–447. https://doi.org/10.4085/1062-6050-356-19
35. Li, H.-Y., & Hua, Y.-H. (2016). Achilles tendinopathy: Current concepts about the basic science and clinical treatments. BioMed Research International, 2016, 6492597. https://doi.org/10.1155/2016/6492597
36. Rafnsson, E. T., Myklebust, G., Bahr, R., & Árnason, Á. (2021). No relationship between a movement screening test and risk of overuse problems in low back, shoulder, and knee in elite handball players—A prospective cohort study. Translational Sports Medicine, 4(4), 481–487. https://doi.org/10.1002/tsm2.245
37. Yabe, Y., Hagiwara, Y., Sekiguchi, T., Momma, H., Tsuchiya, M., Kanazawa, K., Yoshida, S., Sogi, Y., Onoki, T., Suzuki, K., Takahashi, T., Itoi, E., & Nagatomi, R. (2021). Low back pain in young sports players: A cross-sectional study in japan. Spine, 46(17), 1154–1159. https://doi.org/10.1097/BRS.0000000000003978
38. Leroux, M., & Lagniaux, F. (2024). Relationship between shoulder pain, trunk and lower limb pain in overhead athletes: A systematic review with meta-analysis. International Journal of Sports Physical Therapy, 19(12), 1509–1520. https://doi.org/10.26603/001c.125882
39. Nadler, S. F., Malanga, G. A., Feinberg, J. H., Prybicien, M., Stitik, T. P., & DePrince, M. (2001). Relationship between hip muscle imbalance and occurrence of low back pain in collegiate athletes: a prospective study. American Journal of Physical Medicine & Rehabilitation, 80(8), 572–577. https://doi.org/10.1097/00002060-200108000-00005
40. Nadler, Scott F., Malanga, G. A., Bartoli, L. A., Feinberg, J. H., Prybicien, M., & Deprince, M. (2002). Hip muscle imbalance and low back pain in athletes: influence of core strengthening. Medicine and Science in Sports and Exercise, 34(1), 9–16. https://doi.org/10.1097/00005768-200201000-00003
41. Kibler, W. B., Press, J., & Sciascia, A. (2006). The role of core stability in athletic function. Sports Medicine (Auckland, N.Z.), 36(3), 189–198. https://doi.org/10.2165/00007256-200636030-00001
42. Møller, M., Nielsen, R. O., Attermann, J., Wedderkopp, N., Lind, M., Sørensen, H., & Myklebust, G. (2017). Handball load and shoulder injury rate: a 31-week cohort study of 679 elite youth handball players. British Journal of Sports Medicine, 51(4), 231–237. https://doi.org/10.1136/bjsports-2016-096927
43. Arnason, K., Asgeirsdottir, E., Arnarsson, U., Agustsson, A., & Briem, K. (2025). The association between internal and external shoulder load, pre-season strength and power, with shoulder problems in female handball play3ers. International Journal of Sports Physical Therapy, 20(8), 1203–1213. https://doi.org/10.26603/001c.142239
44. Choupeaux, R., Guegan, C., Edouard, P., Remy-Neris, O., & Picot, B. (2021). 287 Injury distribution analysis of the French handball championship using electronic game reports: a one-year longitudinal study among 323 628 players. In Poster Presentations (p. A111.2-A111). BMJ Publishing Group Ltd and British Association of Sport and Exercise Medicine.

45. Bayrak, A., & Enli, M. (2025). Epidemiological analysis of injuries in elite handball: insights from the 2023-2024 Turkish super league season. BMC Sports Science, Medicine and Rehabilitation, 17(1), 203. https://doi.org/10.1186/s13102-025-01224-0
46. Asker, M., Holm, L. W., Källberg, H., Waldén, M., & Skillgate, E. (2018). Female adolescent elite handball players are more susceptible to shoulder problems than their male counterparts. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA, 26(7), 1892–1900. https://doi.org/10.1007/s00167-018-4857-y
47. Ivarsson, A., Johnson, U., Andersen, M. B., Tranaeus, U., Stenling, A., & Lindwall, M. (2017). Psychosocial factors and sport injuries: Meta-analyses for prediction and prevention. Sports Medicine (Auckland, N.Z.), 47(2), 353–365. https://doi.org/10.1007/s40279-016-0578-x
48. Pensgaard, A. M., Ivarsson, A., Nilstad, A., Solstad, B. E., & Steffen, K. (2018). Psychosocial stress factors, including the relationship with the coach, and their influence on acute and overuse injury risk in elite female football players. BMJ Open Sport & Exercise Medicine, 4(1), e000317. https://doi.org/10.1136/bmjsem-2017-000317
49. Roux, V., & Trouilloud, D. (2025). Longitudinal associations between coach-athlete relationship quality and individual injury rate among young handball players: A variable and person-centered approach in intensive training centers. International Journal of Sports Science & Coaching, 17479541251334632. https://doi.org/10.1177/17479541251334632
50. Girginer, F. G., Seyhan, S., Açar, G., Bilici, M. F., Bilici, Ö. F., & Soylu, Ç. (2025). Acute effects of the RAMP warm-up on sprint and jump performance in youth soccer players. Frontiers in Physiology, 16, 1612611. https://doi.org/10.3389/fphys.2025.1612611
51. Jeffreys, I. (2017). RAMP warm-ups: more than simply short-term preparation. Professional Strength & Conditioning, 44, 17–23
52. Buchheit M, Douchet T, Settembre M, et al. The 11evidence-informed and inferred principles of microcycle periodization in elite football. Sport Perform Sci Rep2024; 218
53. Holm, P. A. T., & Randers, M. B. (2025). Internal and external training and match load quantification during in-season and pre-season in professional highly trained male team handball players. International Journal of Performance Analysis in Sport, 1–14. https://doi.org/10.1080/24748668.2025.2518889
54. Lee, S., Kim, H., Jung, J., & Lee, S. (2023). Immediate effects of sprinter-pattern exercise on the lordotic curve and abdominal muscle activity in individuals with hyperlordosis. Medicina (Kaunas, Lithuania), 59(12). https://doi.org/10.3390/medicina59122177
55. Shalamzari, M. H., Henteh, M. A., Shamsoddini, A., & Ghanjal, A. (2024). Comparison of the effects of core stability and whole-body electromyostimulation exercises on lumbar lordosis angle and dynamic balance of sedentary people with hyperlordosis: a randomized controlled trial. BMC Sports Science, Medicine and Rehabilitation, 16(1), 91. https://doi.org/10.1186/s13102-024-00879-5
56. Konrad, A., Močnik, R., Titze, S., Nakamura, M., & Tilp, M. (2021). The influence of stretching the hip flexor muscles on performance parameters. A systematic review with meta-analysis. International Journal of Environmental Research and Public Health, 18(4), 1936. https://doi.org/10.3390/ijerph18041936
57. Tunås, P., Nilstad, A., & Myklebust, G. (2015). Low back pain in female elite football and handball players compared with an active control group. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA, 23(9), 2540–2547. https://doi.org/10.1007/s00167-014-3069-3
58. Strong, A., Boraxbekk, C.-J., & Markström, J. L. (2025). Greater cognitive-motor interference among patients after anterior cruciate ligament reconstruction compared with controls. The American Journal of Sports Medicine, 53(5), 1041–1049. https://doi.org/10.1177/03635465251322947
59. Wilk, K. E., Ivey, M., Thomas, Z. M., & Lupowitz, L. (2024). Neurocognitive and neuromuscular rehabilitation techniques after ACL injury, part 1: Optimizing recovery in the acute post-operative phase- A clinical commentary. International Journal of Sports Physical Therapy, 19(11), 1373–1385. https://doi.org/10.26603/001c.124945

60. Chua, L.-K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618–645. https://doi.org/10.1037/bul0000335
61. Orangi, B. M., Ghanati, H. A., Basereh, A., Hesar, N. G. Z., & Jones, P. A. (2025). The effects of different focus cues and motor learning strategies on landing mechanics in male handball players. Scientific Reports, 15(1), 32206. https://doi.org/10.1038/s41598-025-17877-3
62. Moen, C., Myklebust, G., Munkvold, E., Hägglund, M., Bahr, R., Møller, M., Bjørndal, C. T., & Grindem, H. (2025). Why does it work? Proposed biomedical effect mechanisms of exercise-based injury prevention programmes in football (soccer) and handball: a scoping review of 104 studies. British Journal of Sports Medicine. https://doi.org/10.1136/bjsports-2025-109802
63. Singh, H., & Wulf, G. (2020). The distance effect and level of expertise: Is the optimal external focus different for low-skilled and high-skilled performers? Human Movement Science, 73(102663), 102663. https://doi.org/10.1016/j.humov.2020.102663
64. Buckthorpe, M., Pirli Capitani, L., Olivares-Jabalera, J., Olmo, J., & Della Villa, F. (2024). Systematic video analysis of ACL injuries in professional Spanish male football (soccer): Injury mechanisms, situational patterns, biomechanics and neurocognitive errors – A study on 115 consecutive cases. BMJ Open Sport & Exercise Medicine, 10, e002149.
65. Della Villa, F., et al. (2024). Kinematics of 90° change of direction in young football players: Insights for ACL injury prevention from the CUTtheACL study on 6008 trials. Knee Surgery, Sports Traumatology, Arthroscopy, 32, 2666–2678.
66. Gokeler, A., Tosarelli, F., Buckthorpe, M., & Della Villa, F. (2024). Neurocognitive errors and noncontact anterior cruciate ligament injuries in professional male soccer players. Journal of Athletic Training, 59, 262–269.
67. Maffulli, N., Khan, K. M., & Puddu, G. (1998). Overuse tendon conditions: Time to change a confusing terminology. Arthroscopy, 14, 840–843.
68. Mok, K.-M., Ha, S. C. W., Chan, Z. Y. S., Yung, P. S. H., & Fong, D. T. P. (2021). An inverted ankle joint orientation at foot strike could incite ankle inversion sprain: Comparison between injury and non-injured cutting motions of a tennis player. The Foot, 48, 101853.
69. Riemann, B. L., & Lephart, S. M. (2002). The sensorimotor system, Part II: The role of proprioception in motor control and functional joint stability. Journal of Athletic Training, 37, 80–84.
70. Stuelcken, M. C., Hiller, C. E., & Toohey, L. (2024). Mechanisms of lateral ankle ligament sprains in professional netball: A systematic video analysis. Physical Therapy in Sport, 69, 8–14.
71. Suda, E. Y., Amorim, C. F., & Sacco, I. C. (2009). Influence of ankle functional instability on the ankle electromyography during landing after volleyball blocking. Journal of Electromyography and Kinesiology, 19, e84–e93.
72. Vila, H., Barreiro, A., Ayán, C., Antúnez, A., & Ferragut, C. (2022). The most common handball injuries: A systematic review. International Journal of Environmental Research and Public Health, 19, 10688.
73. Yabe, Y., et al. (2021). Low back pain in young sports players: A cross-sectional study in Japan. Spine, 46, 1154–1159.
74. Yılmaz, O., Soylu, Y., Erkmen, N., Kaplan, T., & Batalik, L. (2024). Effects of proprioceptive training on sports performance: A systematic review. BMC Sports Science, Medicine and Rehabilitation, 16, 149.
75. Dingenen, B., Malfait, B., Nijs, S., Peers, K. H. E., Vereecken, S., Verschueren, S. M. P., & Staes, F. F. (2015). Can two-dimensional video analysis during single-leg drop vertical jumps help identify non-contact knee injury risk? A one-year prospective study. Clinical Biomechanics (Bristol, Avon), 30(8), 781–787. https://doi.org/10.1016/j.clinbiomech.2015.06.013
76. Reid, H., & Wood, S. (2015). Nhs.uk. https://www.ouh.nhs.uk/media/0svhhdqk/86720achilles.pdf
77. Martín-Guzón, I., Muñoz, A., Lorenzo-Calvo, J., Muriarte, D., Marquina, M., & de la Rubia, A. (2021). Injury prevalence of the lower limbs in handball players: A systematic review. International Journal of Environmental Research and Public Health, 19(1), 332. https://doi.org/10.3390/ijerph19010332

78. Aspetar Sports Medicine Journal - INJURIES IN HANDBALL. Aspetar.com. Retrieved October 9, 2025, from https://journal.aspetar.com/en/archive/volume-13-targeted-topic-sports-medicine-in-handball/inj<uries-in-handball

EHF

COMPETENCE ACADEMY & NETWORK