

Markus Wurm, Leonard Achenbach,
and Lior Laver

67.1 Introduction and Characteristics of the Sport

At the beginning of the twentieth century, handball was played outdoor on large fields (90–100 m × 55–65 m) as they were used for soccer games. To date, handball has become mainly an indoor sport (40 m × 20 m) and is played in the majority of cases on hardwood floors or artificial surfaces. Each team consists of 6 field players and 1 goalkeeper (a total of 7 players), and the game length is set to 2 × 30 min (a total of 60 min) with a 15 min break. Since 1972 (men) and 1976 (women), handball is an Olympic sport and has gained popularity worldwide. European and World Championships are played in alternating intervals of 2 years with several continental club competitions taking place every year (i.e., the

European Champions League). Due to recent years' rule changes, handball has become a much faster and physically as well as mentally demanding sport, especially at the elite level.

Handball is characterized by fast changes between offensive and defensive play while all players can participate in defense and offense except the goalkeeper and unlimited substitutions are allowed at all times at senior level, with no interruptions. Apart from set offense against set defense, fast break situations are quite common in the game. Pace changes such as acceleration and deceleration as well as one-on-one situations are frequent and accompanied by passing and throwing moves with or without body contact. Throwing is often contested with contact, which is allowed and is an integral part of the game. The free substitutions contribute to the high speed over the full duration of the matches. As contact is allowed and is an integral part of the game with less restrictive rules regarding contact, punishment is subjective to referee decisions while severe fouls can be punished with a yellow card, a 2-min suspension, or direct red card. Protective gear is not commonly used in handball, apart from selected braces and mouth guards. There is no limit for foul play, yet after sanctioned fouls and the three 2-min suspension by the same athlete, the athlete is automatically suspended with a red card for the rest of the game.

M. Wurm

Department of Orthopedic Sports Medicine,
Klinikum rechts der Isar, Technical University
Munich, Munich, Germany

L. Achenbach (✉)

Department of Trauma, Hand, Plastic and
Reconstructive Surgery, University Medical Centre
Wuerzburg, Wuerzburg, Germany
e-mail: leonard@dr-achenbach.eu

L. Laver

Department of Orthopedics and Traumatology,
The Royal Orthopedics Hospital—NHS Trust,
Birmingham, UK

67.2 Physiological and Biomechanical Demands on Athletes

Strength, excellent physical conditioning, agility, optimal muscle activation, control, and good throwing technique are the main components for today's elite handball player. In addition, well-trained cognitive and also tactical skills are consequential requirements in order to compete at a high level (Fig. 67.1). Handball is characterized by rapid changes of game speed, and therefore, athletes have to be well trained in both aerobic and anaerobic areas to be able to compete over 60 min. Male athletes show moderate to high blood lactate values post-match which shows the demand on the anaerobic energy system. Furthermore workload during matches are up to 70–80% VO₂-max.

67.3 Epidemiology of Injuries

Due to the less restrictive rules in terms of contact compared to many other team ball sports, athletes in handball are in frequent contact with opponents in both offense and defense. Only a few longitudinal epidemiologic studies have been performed and, in most cases, only over a period of 1 year at most. These studies reveal an estimated injury rate of 11.2–14.3 injuries/1000 h of exposure (game time) compared to 0.6–2.4/1000 h exposure (training). New data from the mandatory German insurance program (VBG—Verwaltungs-Berufsgenossenschaft), which includes all registered injuries over a season in the two highest divisions of male handball players, shows even higher injury rates with 77.7/1000 h of game play over the 2016/2017 season. Overall, in the reported period, the VBG

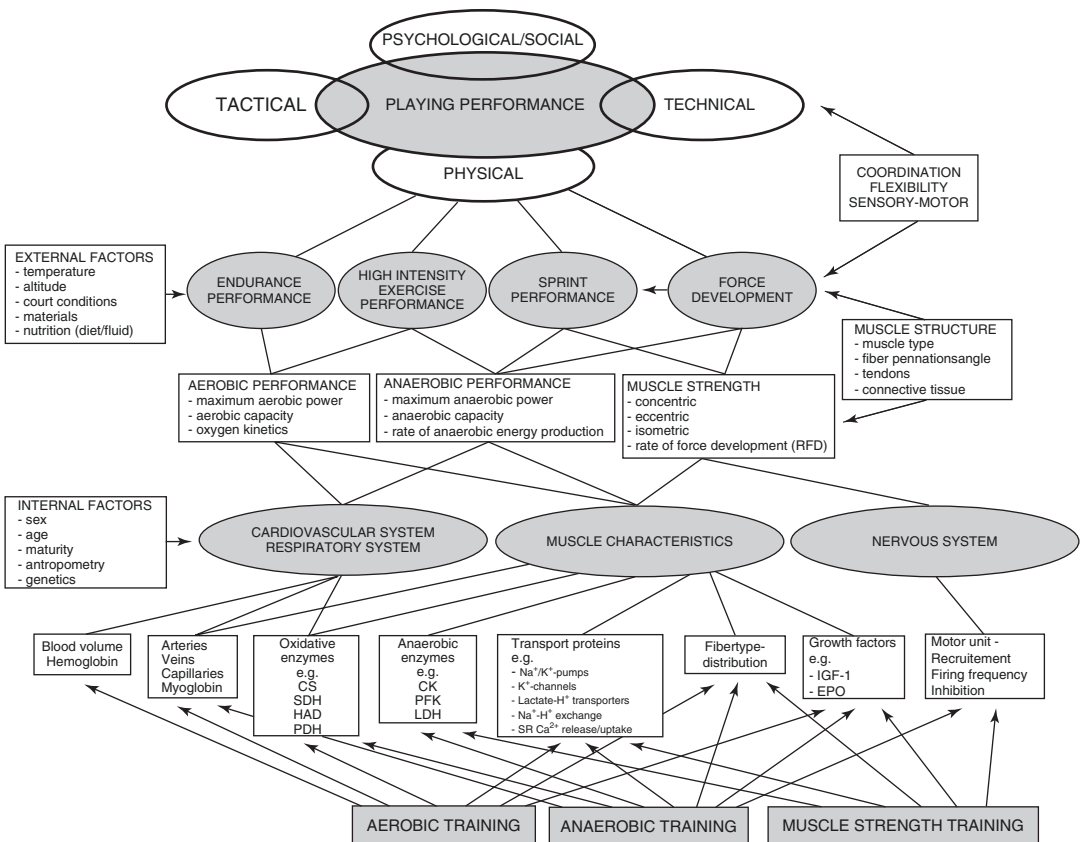


Fig. 67.1 Model with influencing and interacting factors in team handball. (From “Handball Sports Medicine; Basic Science, Injury Management and Return to Sport”, Chapter 2, Springer, 2018)

data has revealed an incidence of 52 injuries per team per season (2.7 injuries per player per season) with each player who played at least one game missing an average total time of 30 days per season. Injury data from European and World Championships reveal alarmingly high rates with 89–129 injuries/1000 match hours (men) and 84–145 injuries/1000 h game play (women).

Injuries during matches occur in a significantly higher frequency (75–92%) compared to training injuries (7.4–24.7%). Several reports have highlighted the fact that the highest amount of injuries occur in the second part of each half, with some highlighting the last 10 min of each half as being more injury prone. Most injuries occur during offense play of a team (52–86%) while overall, most injuries are sustained in the central shooting zone between the 6 and 9 m lines.

Several issues exist when comparing acute injuries data from various studies as different studies have used different injury severity definitions. Another aspect which should be considered in handball epidemiology relates to “stay and play” situations which are not uncommon in the game. In the context of sports traumatology, the term “stay and play” refers to situations where treatment provided by the medical staff on field enable injured players to stay in the match or practice session. Despite the frequent occurrence of these situations in handball, their true incidence has yet to be reported.

The body sites most frequently, severely, and acutely injured are the knee, hand, shoulder, and ankle. For each body site, a distinct injury mechanism could be identified. Ligamentous injuries of the knee, such as anterior cruciate ligament tears, occur most frequently during non-contact, side-cutting maneuvers or landings. Metacarpal and finger fractures are sustained mainly through collision with opponents or direct trauma from the ball. Acute shoulder injuries, such as dislocation or AC joint injuries, occur due to pulls from opponents or direct falls onto the shoulder after contact. Ankle sprains are common due to frequent landings and direction changes as well as high friction between the shoe and the playing surface, while foot-to-foot contacts are also common.

Apart from acute trauma, overuse injuries are also frequent in handball. The upper extremities are frequently affected with the throwing shoulder and goalkeeper’s elbow often requiring attention by the medical staff. Fifty percent of elite senior athletes complain of throwing shoulder problems during one season. Furthermore structural abnormality in the throwing shoulder in over 90% of elite athletes were found who competed 9 years at an elite handball level. Additionally, high susceptibility of goalkeepers for elbow injuries were found, which most likely arise from repeated hyperextension trauma.

Osteoarthritis is another burden for the handball players which has to be kept in mind especially over a long career span. Due to the combination of excessive jumping and landing loads in training and matches as well as with the high incidence of injuries, the lower extremities are at risk to early osteoarthritis.

67.4 Specific Rehab and Return to Play

The main criteria for a successful return to sport following acute or chronic injury should be the ability to perform high risk and handball-specific maneuvers, such as side-cutting, landing, tackling, defending, catching, and throwing the ball.

In case of discontinuation of handball due to injury, specific rehabilitation and later, return-to-play protocols for each joint and body site should be used with the handball-specific adaptations. Typical examples include rehabilitation after shoulder overuse injury or return-to-play protocols after ankle sprain injury. While no systematic evidence exists specifically for handball, it may be assumed that for lower extremity injuries, emphasis has to be put on cutting, change-of-direction maneuvers, and landing.

67.5 Specific Aspects in Different Subpopulations

The limited published data suggest that for ACL injuries, while the injury pattern is similar for

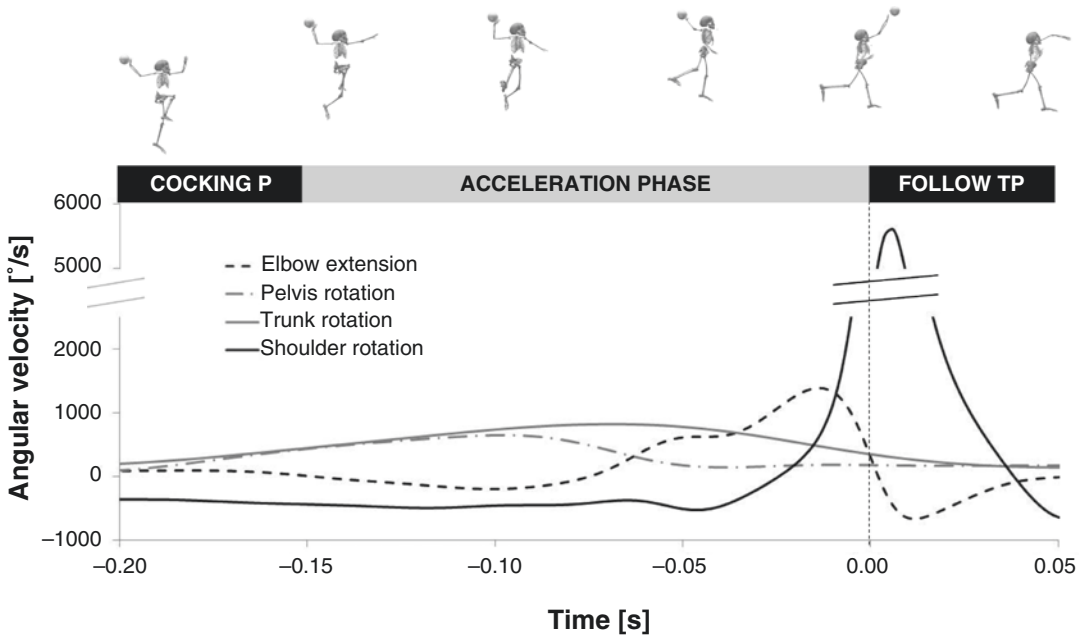


Fig. 67.2 Maximum joint angular velocities in various experienced handball players. (From “Handball Sports Medicine; Basic Science, Injury Management and Return to Sport”, Chapter 6, Springer, 2018)

men and women, women have a higher susceptibility for these injuries. There is a five times higher risk for ACL tears in females compared to males. Young female handball players have the highest risk for this type of injury. Apart from anatomical factors, neuromuscular factors and hormonal factors also contribute to a higher risk of ACL injuries in females. Ligaments and tendons are affected in females, and the entire metabolic system undergoes various changes throughout the menstrual cycle. Tendon fascicle in women ruptures earlier compared to male tendon fascicles and the fact that oral contraceptive users have a lower risk on ACL tears highlight the importance of this aspect.

Youth handball players may be particularly vulnerable to injury due to growth-related factors such as during the growth spurt period, susceptibility of the growth plate, and differing physiological response after training and match load. The more frequent and intensive training and competition of young elite handball players may create conditions under which these potential risks can more readily exert their influence. Sport-specific adaptations occur early and may

predispose to acute and overuse injuries. Late-developers are probably more susceptible prepubescent while early-developers have a higher injury risk during and post-pubescence. Youth handball players may have particularly vulnerable phases with increased risk of injury. Figure 67.2 reveals the maximal joint angular velocities in less experienced up to elite athletes. This shows the importance for accurate throwing techniques. Maximum training and match load especially on adolescent athletes has to be kept in mind due to overload and overuse injuries. These phases comprise the preseason period with sudden increases of physical load, the transitions into a higher league or better playing team, from junior to senior sports, and to a secondary sport school.

67.6 Prevention Strategies

Knowledge and evidence regarding prevention of acute lower extremity injuries have improved substantially in the last two decades. By means of addressing and reducing previously identified risk

factors, injury risk has been shown to be reducible by implementing regularly neuromuscular injury prevention exercises into practice and warm-up routines before matches. Randomized control trials in the last two decades have clearly shown the effectiveness of injury prevention programs. By means of strengthening exercises, such as the Nordic hamstring exercise, and plyometric oriented neuromuscular exercises, the injury incidence of noncontact ACL tears can be reduced to at least 50%. Another identified risk factor is artificial surface and a 2.4 times higher risk for ACL injuries. Narrow cutting techniques, and soft landings are found to be techniques that decrease the likelihood for ACL tears.

Shoulder overuse pain was shown to be reduced when implementing a neuromuscular training program that involved external rotation strengthening, posterior glenohumeral shoulder stretching, and scapular muscle control exercises. Results from elite youth athletes revealed higher injury rates due to an increase of handball load. Players who were tested preseason with low external rotational strength and signs of scapular dyskinesia were susceptible at lower increase of training loads compared to their peers.

Young handball players need special consideration from all team personnel. Implementation of good warm-up habits and injury prevention exercises, correct technique teaching, and optimal management of training in regard to load and recovery are key factors for injury prevention in the youth team handball setting.

Further prevention strategies include the implementation of training and match load monitoring and adapting individual training exercises and match actions for each player. Training workloads are applied to athletes with the goal of inducing positive physiological changes and maximizing performance. Various biological adaptations induced by (appropriate) training increase the athletes' capacity to accept and withstand load and may thus provide protection from injuries. The aim of load management is thus to optimally configure training, competition, and other load to maximize adaptation and performance with a minimal risk of injury. Load management therefore comprises the appropriate

prescription, monitoring, and adjustment of external and internal loads.

67.7 Equipment and Protection Considerations

Protective gear is not frequently used in handball. Mouth guards have been used in recent years due to an increased rate of tooth injuries. They have to be transparent and single-colored. Other gear such as masks or helmets are not permitted. Glasses and goggles are permitted yet only with special sports headbands, solid plastic lenses made of silicon or other elastic materials. Elbow and knee pads are allowed to absorb loads following direct contact but must be made out of soft and thin materials. If knee protectors are used, they have to be covered with foam. Ankle joint protectors and/or soft/hard stabilizers are permitted yet they also have to be covered with foam or bandages. The International Handball Federation (IHF) regularly provides updates of their guidelines about allowed protective gear during gameplay and which are subject of change within or after each season why it is important for teams and team officials to stay up to date.

67.8 Other Health Aspects and Diseases

There is a lack of sufficient information with regard to illness in handball. During the World Championships 2015, 10.9% of athletes were affected by a disease or illness. About 31 of 42 recorded cases showed signs of an inspiratory tract infection as the most common reason. Overtraining (increased level of stress hormones as well as intrinsic and extrinsic stressors) can be responsible for illness in today's athletes. Another important issue is the psychological factor. Long seasons and increased load due to additional national team obligations can become stressors to the players. In addition, public pressure due to bad performance is other potential stressor and depicts the necessity of psychological assistance in modern athletes.

67.9 Match Rules with Medical Importance

Counter-attacks by means of a long pass to a single attacking player carry a high risk if the opposing goalkeeper tries to intercept the long pass or provoke an attacking foul. The rules were therefore changed to decrease the rate of collisions. Goalkeepers will now face immediate red card by any kind of contact with the attacking player in such situations.

To decrease the rate of concussions and head injuries, stricter sanctions (2-min suspension instead of yellow card or no punishment) have been installed in situations where a defending player generates contact with the head or face of an opponent. In addition, an immediate and direct red card suspension is warranted for any player who throws the ball from a controlled situation into the face of an opponent. This includes a 7-m throw into the face of a goalkeeper or a free-throw (9 m) into the face of one of the opponents trying to block the ball.

67.10 Fact Box

- Acute injuries are most common in handball, and the body sites most frequently injured are the knee, ankle, hand, and shoulder.
- Overuse injuries are also very common in handball with the most common anatomic sites include the shoulder as well as the knee and ankle.
- Injury prevention programs have been shown successful to reduce the rate of ACL, and shoulder overuse injuries.
- Coaches and teams should be aware of the injury prevention programs and such programs should be taught and implemented in adolescent players.
- Load monitoring and management should be an integral part of injury prevention strategies and better education and awareness of this aspect is necessary.

Recommended References

1. Achenbach L, Krutsch V, Weber J, Nerlich M, Luig P, Loose O, Angele P, Krutsch W. Neuromuscular exercises prevent severe knee injury in adolescent team handball players. *Knee Surg Sports Traumatol Arthrosc* 2017;26(7):1901–08
2. 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 Surg Sports Traumatol Arthrosc* 26(7):1884–1891
3. Myklebust G, Engebretsen L, Braekken IH, Skjølberg A, Olsen OE, Bahr R (2003) Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. *Clin J Sport Med* 13(2):71–78
4. Andersson SH, Bahr R, Clarsen B, Myklebust G (2017) Preventing overuse shoulder injuries among throwing athletes: a cluster-randomised controlled trial in 660 elite handball players. *Br J Sports Med* 51(14):1073–1080
5. Möller M, Nielsen RO, Attermann J, Wedderkopp N, Lind M, Sorensensen H, Myklebust G (2017) Handball load and shoulder injury rate: a 31-week cohort study of 679 elite youth handball players. *Br J Sports Med* 51(4):231–237