VBG Sports Report 2017–
Analysis of accidents in German men’s professional team sports leagues: basketball, hockey, soccer, and handball.

Including the key issue of craniocerebral injuries
Dear Readers,

The consistently positive responses to the first VBG Sports Report proved to us that we are closing an important gap with this publication. VBG as a statutory accident insurance provider offers a unique analysis of accidents in the two top leagues for the most popular sports in Germany. We have dedicated ourselves to prevention in cooperation with these sports, because around eight out of ten athletes playing in the top two men’s leagues in Germany once again sustained injuries in the 2015/16 season. Each of them sustained 2.5 injuries on average. These two figures confirm the unchanged high risk of injury that players in professional team sports are exposed to.

Players were out of commission due to injuries for almost one month on average in the past season. This means the clubs were permanently lacking one-twelfths of their manpower for achieving their objectives in sports. Downtime of this magnitude is likely to present major business management challenges for the sports clubs in question as well.

These numbers are particularly critical from the perspective of the affected players, since injuries can have a negative impact on being selected for the representative teams or on pending contract extensions. The best possible injury prevention should also be practiced in view of quality of life after the end of an athlete’s career.

This second edition of the VBG Sports Report once again delivers numerous insights intended to offer starting points for prevention and rehabilitation in the clubs and associations. The analyses that are presented prove that the myth of injuries due to “bad luck” has limited basis in fact. Just the fact that only every fifth competitive injury is due to an opposing foul is indicative of the prevention potential.

This year we placed special emphasis on the problem of craniocerebral injuries. Concussions and the related short and long-term consequences have been intensively discussed in the North American professional leagues for some time now. Recently however, known individual cases in Germany have also sparked the debate surrounding one of the most commonly trivialized diagnoses. But reliable figures for Germany had been lacking to date. We intend to close that gap with this year’s key topic of craniocerebral injuries.

The VBG as a sports partner considers itself responsible, now and in the future, for supporting sports organizations in maintaining the health of their players through innovative, practical, and resource-conserving prevention and rehabilitation offerings. Because sports accidents are not dictated by fate.

You will find information, media, and helpful tools, especially for prevention, on the VBG sports page under www.vbg.de/sportvereine.

Sporty greetings

Angelika Hölscher  Prof. Bernd Petri  Dr. Andreas Weber
Chairperson  Member of Management  Director of Prevention
VBG – your statutory accident insurance provider
The VBG is a statutory accident insurance provider with around 36 million insurance contracts in Germany. Persons insured by the VBG are employees, voluntarily insured entrepreneurs, volunteers, and many more. The VBG includes more than one million companies in over 100 industries – from architectural offices to temporary employment agencies.

Further information: www.vbg.de
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<td>Injuries in hockey</td>
<td>44</td>
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<td>8</td>
<td>Injuries in soccer</td>
<td>62</td>
</tr>
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<td>9</td>
<td>Injuries in handball</td>
<td>80</td>
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</table>
2 Methodology – approach, definitions, and concepts

Observed leagues and players

The analysis of accidents included all players in the respective top two men’s leagues in

**Basketball:**
easyCredit Basketball-Bundesliga  
(in the following: BB1)  
ProA 2. Basketball-Bundesliga (BB2)

**Hockey:**
Deutsche Eishockey Liga (EH1)  
Deutsche Eishockey Liga 2 (EH2)

**Soccer:**
Bundesliga (FB1)  
2. Bundesliga (FB2)

**Handball:**
DKB Handball-Bundesliga (HB1)  
2. Handball-Bundesliga (HB2)

who, in the 2015/2016 season during the period from 1 July 2015 to 30 June 2016 (observation period), played in at least one official game in national or international competitions for their club.

→ **Total population**
Recorded variables: including age, league, playing position

**Promoter license/dual play right/club change**
Players who, during the observation period, played in both the first and second leagues due to a promoter license, dual play right, or club change are included in both league collectives in the comparison of the leagues (for example prevalences and incidences). In the analysis of the sport as a whole on the other hand, they are statistically considered as only one person.
Injury analysis

For the analysis of injuries in general, only those injuries were considered that took place during the 2015/2016 season, that is in the observation period from 1 July 2015 to 30 June 2016.

All insured events that led to financial benefits (treatment and compensation for lost remuneration) paid by the VBG and/or to the incapacity for work of a player were included.

We counted the number of injuries in our analysis. Some accidents also caused two or more injuries.

→ Injury collective
(Data as of: 9/2016) Recorded variables: including the injured body region, type of injury, treatment costs, incapacity for work.

The data were retrieved from the VBG data warehouse about three to four months after the close of the respective season as of 15 September 2016.

Thus the benefits reported for treatments and compensation for lost remuneration only include benefits paid by the VBG until 15 September 2016. It therefore must be noted that this is merely an excerpt of the total benefits as of the aforementioned cut-off date for the analyses.

The duration or expected duration of the incapacity for work was also examined as of the data retrieval date of 15 September 2016.

This approach enables a longitudinal comparison of the collected data in the future.

The benefits and incapacity for work are also used as indicators for the severity of injury under consideration of the identified restrictions.
Analysis of the causes of injury

For the systematic video analysis of the causes of injury, only moderate and severe match injuries that caused an incapacity for work lasting 7 days or more and/or benefits paid by the VBG in the amount of EUR 1,000 or more were included, provided they could be identified in the available video material.

Video collective
(Data as of: 1/2017) Recorded variables: including place and time of the injury, game situation, movement sequence, game action, injury mechanism, cause of injury

The limits of 7 days (primary) and EUR 1,000 (secondary) were chosen since current studies in the field of sports injury research show that the identification rate of less serious injuries in sports video material drops considerably. Moderate and severe injuries also have a higher relevance for prevention due to their severity of damage and the associated more serious personal, sports-related, and economic consequences.

Since insured events from the beginning of the season are further back in time upon data retrieval, so that they are more likely to exceed the EUR 1,000 limit where applicable, one can assume that the video collective tends to under-represent the insured events from the end of the season. The data analysis however showed that this effect can be disregarded since the proportion of the cases selected from the injury collective in reference to the time in the season was statistically insignificant.
Definitions and concepts

**Injuries**
An injury is defined as any event in training or competition that either leads to treatment costs or to an incapacity for work of the player for future training and/or game sessions. Pain or chronic injury that is not of a post-traumatic nature as well as illnesses or mental impairments are excluded in this context.

**Benefits**
Benefits are defined as all payments by the VBG for treatment costs and compensation for lost remuneration up to 15 September 2016 for injuries sustained by the players observed in this study in the observation period of 1 July 2015 to 30 June 2016. VBG benefits that go beyond this date are disregarded for the purpose of standardization and year-on-year comparability.

**Prevalence**
Prevalence means the proportion of the observed players (total population) who suffered at least one injury in the observation period.

**Incidence**
Incidence means the number of injuries sustained in relation to the exposure time of the observed players. The following types of incidence are used:
- Season incidence: Number of injuries per player and season
- Competition incidence: Number of match injuries per 1,000 hours of competition

**Contact injury**
A contact injury means any injury caused by a direct external application of force by another person (such as a fellow player, opposing player, or referee) or an object (such as a ball, puck, stick, goal, boards, or basket) to the injured and/or adjacent body regions.

→ Example: Ankle injuries after an opposing player kicks the ankle or lower leg.

**Indirect contact injury**
An indirect contact injury means any injury involving the application of force by another person or an object directly before or during the injury that does not cause the injury directly, but influences the player’s natural motion sequence and therefore indirectly leads to the situation that causes the injury.

→ Example: Ankle injuries after twisting the ankle upon landing after an impact to the upper body in the airborne phase.

**Non-contact injury**
A non-contact injury is any injury that is caused without the application of force by another player, play equipment, or playing field equipment.

→ Example: Ankle injuries after twisting the ankle during a fast direction change.
## 3 Fact check – overview of the 2015/2016 season

<table>
<thead>
<tr>
<th></th>
<th>Basketball</th>
<th>Hockey</th>
<th>Soccer</th>
<th>Handball</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of injuries per active player</td>
<td>1.9 injuries</td>
<td>2.7 injuries</td>
<td>2.5 injuries</td>
<td>2.7 injuries</td>
</tr>
<tr>
<td>Proportion of active players who sustained an injury</td>
<td>67 %</td>
<td>82 %</td>
<td>80 %</td>
<td>80 %</td>
</tr>
<tr>
<td>Average number of injuries per team</td>
<td>28 injuries (Range: 6–101 injuries)</td>
<td>68 injuries (Range: 35–206 injuries)</td>
<td>63 injuries (Range: 23–224 injuries)</td>
<td>52 injuries (Range: 12–168 injuries)</td>
</tr>
<tr>
<td>Average total downtime due to injury per active player</td>
<td>18 days</td>
<td>24 days</td>
<td>24 days</td>
<td>30 days</td>
</tr>
<tr>
<td>Average VBG benefits per injury</td>
<td>970 €</td>
<td>1,340 €</td>
<td>1,310 €</td>
<td>1,320 €</td>
</tr>
<tr>
<td>Distribution of injuries – training vs. competition</td>
<td>50:50</td>
<td>21:79</td>
<td>53:47</td>
<td>52:48</td>
</tr>
<tr>
<td>Month with the most injuries – training vs. competition</td>
<td>Training: August, competition: January</td>
<td>Training: August, competition: October</td>
<td>Training: January, competition: April</td>
<td>Training: Juli, competition: October</td>
</tr>
<tr>
<td>Most frequently observed diagnosis</td>
<td>Ankle sprain</td>
<td>Distortion of the cervical spine</td>
<td>Muscle strain of the thigh</td>
<td>Ankle sprain</td>
</tr>
<tr>
<td>Proportion of an opposing foul as a contributing cause¹,²</td>
<td>12 %</td>
<td>32 %</td>
<td>19 %</td>
<td>23 %</td>
</tr>
<tr>
<td>Most common injury situation¹</td>
<td>One-legged landing on the foot of a fellow or opposing player after rebound or throw</td>
<td>Side (board) check by opposing player during or after passing the puck</td>
<td>Structural overloading while sprinting in a race with another player or running for the ball</td>
<td>One-legged landing on the foot of a fellow or opposing player after a jump shot</td>
</tr>
<tr>
<td>Most dangerous playing position¹</td>
<td>Center players and power forwards</td>
<td>All field players</td>
<td>Back and midfield players</td>
<td>Back court and pivot players</td>
</tr>
<tr>
<td>Most dangerous zone on the playing field¹</td>
<td>Offense zone under the basket</td>
<td>Left offensive zone – close to the boards</td>
<td>Central offensive midfield</td>
<td>Offense – central free throw zone</td>
</tr>
</tbody>
</table>

¹ Based on the video analysis of moderate and severe match injuries 2010–2016 (n = 1,122)  
² Official referee decision
4 Comparison of injuries between different sports

General overview

Distribution of active players (%)

Basketball: 18.1 %
- BB1: 9.7%
- BB2: 8.1%

18.1 %

Handball: 25.8 %
- HB1: 12.1%
- HB2: 13.5%

25.8 %

Soccer: 31.6 %
- FB1: 16.1%
- FB2: 15.4%

31.6 %

Hockey: 24.5 %
- EH1: 12.6%
- EH2: 12.5%

24.5 %

1 Due to promoter licenses, dual play rights, and/or changing clubs during the season, the sum for the leagues is not identical to the overall proportion.

Around 2,900 players who played in at least one official game in one of the eight observed leagues during the 2015/16 season were included in this study in total. The total population that was included is therefore somewhat smaller compared to the prior year, which is mainly due to better data about the actual games played by the players.

This decrease has to be taken into account in the absolute number of injuries, and for the injuries and the associated downtime and VBG benefits.

Soccer with nearly one third of all players represents the largest sub-population, as it did in the previous season.

It is followed by handball (25.8%) and hockey (24.5%). The smallest player cohort in this report at 18.1% was observed in basketball, mainly since the teams are much smaller as a rule.

»Clubs have to expect an average of 2.5 injuries and 25 days of downtime due to injuries per player and season!«
Prevalence
Proportion (%) of injured players in the 2015/16 season [± 95% confidence interval, ± % year-on-year change]

Cumulative season incidence
Number of injuries (n) per player in the 2015/16 season [± 95% confidence interval, ± n year-on-year change]

Viewed across all sports, nearly 80% of all included players sustained at least one injury in 2015/2016. Nearly 7,200 injuries were observed overall. Thus each active player sustained 2.5 injuries on average. The prevalence and cumulative season incidence have therefore stagnated at close to the same high level of the previous year.

Downtime added up to more than 70,000 days in the four sports that were observed. Furthermore, the VBG had already paid more than EUR 8.5 million in treatment costs and compensation for lost remuneration by the analysis cut-off date (15 September 2016).

Basketball had much lower prevalences and cumulative season incidences compared to the other three sports. The proportion of injured players at 67.2% was almost 15 percentage points below hockey as the front runner (81.8%). With 1.9 injuries per player, basketball was also around 0.6 injuries below the overall average. Furthermore, a slight statistically provable decrease of this indicator compared to the previous year could be observed exclusively in basketball.
Training and match injuries
Proportion (%) of training and match injuries in the 2015/16 season

<table>
<thead>
<tr>
<th>Sport</th>
<th>Training</th>
<th>Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>50.1 %</td>
<td>49.9 %</td>
</tr>
<tr>
<td>Hockey</td>
<td>21.4 %</td>
<td>78.6 %</td>
</tr>
<tr>
<td>Soccer</td>
<td>53.3 %</td>
<td>46.7 %</td>
</tr>
<tr>
<td>Handball</td>
<td>52.4 %</td>
<td>47.6 %</td>
</tr>
<tr>
<td>Total</td>
<td>44.1 %</td>
<td>55.9 %</td>
</tr>
</tbody>
</table>
Injuries during home and away games

Competition incidence (injuries per 1,000 hours of competition) in the 2015/16 season [± 95% confidence interval]

Training and match injuries

The lower number of injuries in basketball however is probably mainly due to the overall lower competition exposure, in particular because of the shorter game duration in official games. At least this is indicated by the competition incidences that were identified, where basketball with 99.1 injuries per 1,000 hours of official game exposure is still considerably ahead of soccer (40.9 injuries/1,000 hours) and handball (77.7 injuries/1,000 hours). Hockey leads the field here as well with 132.1 injuries per 1,000 hours.

Interestingly the risk of injury in soccer was statistically higher during away games compared to home games. 43.7 injuries per 1,000 hours were observed for away games. In the own stadium, the competition incidence was only 35.9 injuries per 1,000 hours. Whether and to what extent poorer game preparation for away games, for example due to travel or unfamiliar field conditions – the field size and surface characteristics for instance are much more variable in soccer compared to other sports – could be responsible for this remains speculative. Psychological aspects, for example reduced fan support or special game tactics during away games, could also play a role here.

In basketball, soccer, and handball, the injuries are distributed almost evenly between training and competition, while considerably more match injuries at nearly 80% were observed in hockey as in the prior year.

Some peculiarities of hockey have to be mentioned in this context. The highest overall playing dynamics can be assumed in hockey due to the given speeds on the ice. Safety equipment notwithstanding, this leads to the conclusion that the mechanical effects on body structures will be the most severe in the course of collisions. This theory is supported by the highest proportion of contact injuries in hockey games at 73.1%. Hockey is nearly 20% above the overall average for all sports in this regard.

Due to the much higher game density in hockey league operations, an overall training-competition ratio shifted towards competition can also be expected from the outset. In conclusion, it must be noted that a comparatively higher proportion of hockey training takes place off the ice, typically without the duels and contact situations that are specific to hockey.

»The risk of injury in soccer is higher during away games than home games!«
Injury mechanisms and fouls

1,122 game scenes of moderate and severe match injuries were analyzed as the basis for the statements on the causes of injury and accompanying aspects of injuries in this report.

When all sports are considered together, there was a contact situation, meaning a direct external application of force by another person or an object on the injured and/or directly adjacent structure, as the injury mechanism in somewhat more than half of all cases (54.2%). This is followed by injuries with indirect contact at 24.2%, meaning injuries where a physical disruption before or during the injury event influenced the natural motion sequence of the player in a way that favored the occurrence of the injury. In the remaining 21.6% of the injuries there was a non-contact mechanism, meaning an injury situation with no physical application of force by other persons or objects. These are typically injuries where players have to respond to changed game conditions (cognitive perturbation) and where movement sequences are changed – for example when avoiding opposing players, switching to a different game phase, or highly intensive, often eccentric load situations, for example while sprinting.

When fouls are considered as possible causes or contributing causes of injuries based on the situation assessed by the referees, it turns out that only every fifth injury (20.8%) was associated with an opposing foul. The great majority of injuries (71.3%) occurred with no foul, another 7.9% due to an own foul or after a foul by a fellow player. In general the referees in the observed leagues deserve

Based on the video analysis of moderate and severe match injuries 2010–2016 (n = 1,122)

1 Injury mechanism by sport
Proportion (%) of contact, indirect contact, and non-contract injuries

<table>
<thead>
<tr>
<th>Sport</th>
<th>Contact</th>
<th>Indirect Contact</th>
<th>Non-Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>56.2%</td>
<td>19.5%</td>
<td>24.3%</td>
</tr>
<tr>
<td>Hockey</td>
<td>73.1%</td>
<td>20.8%</td>
<td>6.1%</td>
</tr>
<tr>
<td>Soccer</td>
<td>49.9%</td>
<td>27.4%</td>
<td>22.7%</td>
</tr>
<tr>
<td>Handball</td>
<td>52.3%</td>
<td>21.9%</td>
<td>25.8%</td>
</tr>
<tr>
<td>Total</td>
<td>54.2%</td>
<td>24.3%</td>
<td>21.6%</td>
</tr>
</tbody>
</table>

1 Based on the video analysis of moderate and severe match injuries 2010–2016 (n = 1,122)
Foul¹ as the cause of injury, by sport
Proportion (%) of injuries by no, own and opposing foul

<table>
<thead>
<tr>
<th>Sport</th>
<th>No foul</th>
<th>Own foul</th>
<th>Opposing foul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handball</td>
<td>69.5%</td>
<td>22.7%</td>
<td>7.8%</td>
</tr>
<tr>
<td>Hockey</td>
<td>69.9%</td>
<td>11.5%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Hockey</td>
<td>81.7%</td>
<td>5.9%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Basketball</td>
<td>67.7%</td>
<td>18.6%</td>
<td>31.5%</td>
</tr>
</tbody>
</table>

¹ Based on the video analysis of moderate and severe match injuries 2010–2016 (n = 1,122)
² Official referee decision

A compliment: Agreement with the video analysis considerably exceeded 90%, not only in regards to the decision but also regarding the applicable penalty. Only in EH2 did this proportion drop below 80%, in particular for the evaluation of head injuries. The fact that the three-person system is still being used in a large proportion of the main round games, while there are generally four referees for a game in EH1, could definitely play a role here.

Aside from the proportion of contact injuries already discussed above, the relative number of injuries after an opposing foul at 31.5% in hockey was also statistically significantly higher than in the other three sports. Basketball did best in this regard with only 12.4% of injuries after an opposing foul.

»Fouls only make a small contribution to the high rate of injuries.«
5 Key issue – craniocerebral injuries

Head and craniocerebral injuries
Proportion (%) of head injuries in general and proportion (%) of head injury types

**Head injuries in basketball:**
- Contusions: 7.6%
- Fractures: 6.3%
- Other injuries: 7.6%
- Craniocerebral injuries: 5.1%

**Thereof:**
- Lacerations: 31.6%
- Contusions: 26.2%
- Fractures: 22.8%
- Dental injuries: 17.5%
- Other injuries: 2.8%

**Head injuries in hockey:**
- Contusions: 25.8%
- Lacerations: 41.8%
- Fractures: 4.9%
- Dental injuries: 17.5%
- Other injuries: 2.8%

**Thereof:**
- Lacerations: 26.2%
- Contusions: 16.8%
- Fractures: 4.9%
- Dental injuries: 17.5%
- Other injuries: 2.8%

**Head injuries in soccer:**
- Contusions: 36.2%
- Fractures: 22.8%
- Other injuries: 3.4%
- Craniocerebral injuries: 16.8%

**Thereof:**
- Lacerations: 41.8%
- Contusions: 39.9%
- Fractures: 14.0%
- Dental injuries: 9.1%
- Other injuries: 2.0%

**Head injuries in handball:**
- Contusions: 14.0%
- Lacerations: 23.1%
- Fractures: 18.1%
- Other injuries: 9.1%
- Craniocerebral injuries: 11.9%
Head injuries in basketball: 7.9%
Head injuries in hockey: 17.0%
Head injuries in soccer: 6.6%
Head injuries in handball: 7.0%
Prevalence
Proportion (%) of players with craniocerebral injuries in the 2015/16 season [± 95% confidence interval]

Season incidence
Number of craniocerebral injuries per player in the 2015/16 season [± 95% confidence interval]

Craniocerebral injuries in competition
Competition incidence (craniocerebral injuries per 1,000 hours of competition) in the 2015/16 season [± 95% confidence interval]
General overview

Craniocerebral injuries pose a major challenge for players, athletes, clubs, and the attending health professionals in several ways. For one thing, diagnosing minor craniocerebral injuries that are also often referred to in a somewhat trivializing manner as concussions is very difficult. Especially on the sidelines when a decision regarding continued participation of the player in the game has to be made within a few minutes. Obvious symptoms such as unconsciousness or vomiting are seen relatively rarely, which is why many minor craniocerebral injuries are not perceived and treated as such by the player nor the medical personnel. Nevertheless even minor collisions, especially those with a head rotation component, can lead to diffuse axonal injuries to the brain. Cognitive and motor deficits can occur here in addition to a possible edema. Insofar it is no wonder that having suffered a craniocerebral injury can increase the general risk of subsequent sports injuries in other body regions by up to 50%, as shown by a study of male professional soccer players.  

There is also intensive scientific discussion regarding the considerable increase in the likelihood of chronic-degenerative processes in the brain due to repeated, minor craniocerebral injuries, some of which may only manifest years later as clinical pictures. The high estimated number of unreported craniocerebral injury cases is likely to be a major problem in this context.

Furthermore, numerous players return to competition much too soon after diagnosed minor craniocerebral

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1 Based on the video analysis of craniocerebral injuries in competition 2010–2016 (n = 42)
Foul\textsuperscript{1,2} as the cause of injury, by sport

Proportion (%) of injuries by no, own, and opposing foul

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{Proportion (%) of injuries by no, own, and opposing foul}
\end{figure}

\textsuperscript{1} Based on the video analysis of craniocerebral injuries in competition 2010–2016 (n = 42)
\textsuperscript{2} Official referee decision

Injuries or do not take any time off at all. Even though an international consensus regarding the return-to-competition after craniocerebral injuries has been established for several years, stating that a return to competition is recommended on the sixth day at the very earliest\textsuperscript{4}, downtime for the few craniocerebral injuries reported to the VBG shows that the time off falls short of this recommendation in many cases. This applies to soccer and handball in particular.

Even minor craniocerebral injuries should not be downplayed as trivial due to the aforementioned aspects. Awareness among all stakeholders and also the players themselves needs to be improved here. That is why the VBG recently published an algorithm for the practical diagnosis and treatment of sports-related craniocerebral injuries in paid sports, based on the established procedures from the international consensus and expanded with neuropsychological recommendations (see information on page 25).

«The risk of suffering craniocerebral injuries is highest in hockey!»
Craniocerebral injury algorithm

Against the background of the problem outlined in this key issue, the VBG in cooperation with neurology and neuropsychology experts, accident insurance consultants, team doctors, and sports scientists has developed an algorithm for handling craniocerebral injuries in sports. The goal was to present the relevant diagnostic and therapeutic processes as well as the interfaces between the participating professions in a practical framework, and to provide recommendations for treatment options depending on the injury severity. Among other sources, you will find the algorithm as a handy pocket card under www.vbg.de/sportvereine, or you can simply scan the QR code provided here.

Epidemiology and etiology of craniocerebral injuries

Nearly 130 craniocerebral injuries were diagnosed and reported in the observed players in the 2015/2016 season overall. The prevalence across sports was 3.6% and the cumulative season incidence was 0.04 craniocerebral injuries per active player. Depending on the sport, the proportion of craniocerebral injuries out of all head injuries was between 5% and 23%.

Against the background of the previously discussed estimated number of unreported craniocerebral injuries however, one should discuss to what extent severe cranial contusions or fractures in the cranial and facial region should at least be classified as suspected cases without diagnosis. According to defensive estimates, this would increase the number of potential craniocerebral injuries to about 500 cases per year in the observed population. This however does not yet include the incidents that are not perceived by players and health professionals as injuries in any form.

Considerable differences were noted between the sports. The risk of suffering a craniocerebral injury during an official game is 10 to 20 times higher in hockey than in the other three sports. 5.6 craniocerebral injuries per 1,000 hours of play were recorded in hockey. Soccer (0.6 injuries/1,000 hours), handball (0.5 injuries/1,000 hours) and basketball (0.2 injuries/1,000 hours) exhibit significantly lower incidences. The prevalence and cumulative season incidence were also considerably higher in hockey. In the interpretation of these figures however, one should consider that better diagnostics and therefore increased reporting may play a role in hockey due to many years of experience with craniocerebral injuries and the data from the North American professional leagues.

In regards to the causes of craniocerebral injuries, the different sports are much closer again. The video analysis of 42 craniocerebral injuries showed that nearly 85% of the cases were caused by direct contact to the head, and another 15% by indirect contact, typically due to falling on the head, after a preceding body contact with the opposing player. At more than 40% across sports, the proportion of opposing fouls is considerably overrepresented for craniocerebral injuries compared to other types of injuries. Only in soccer does this proportion appear to be significantly lower at 12.5%. However, it is too soon to make a final statement here since the number of cases from analyzed videos of craniocerebral injuries currently remains low.

Typical sport-specific injury patterns in head injuries are found in the following four sections on the different sports.
## Injuries in basketball

### General overview

**Injuries by competition**

Competition incidence (injuries per 1,000 hours of competition) in the 2015/16 season [± 95% confidence interval]

<table>
<thead>
<tr>
<th>Competition</th>
<th>Incidence (per 1,000 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 1</td>
<td>111.5</td>
</tr>
<tr>
<td>BB 2</td>
<td>82.0</td>
</tr>
<tr>
<td>National cup</td>
<td>100.0</td>
</tr>
<tr>
<td>International cup</td>
<td>104.3</td>
</tr>
<tr>
<td>Total BB</td>
<td>99.1</td>
</tr>
</tbody>
</table>
Around 520 players in Germany’s top two men’s professional basketball leagues played in an official club game during the 2015/16 season and were included in this study.

67.2% of all active players sustained at least one injury in the 2015/16 season. Each active basketball player sustained 1.9 injuries on average. These two indicators have therefore declined slightly compared to the prior year.

One thing that stands out is that significantly fewer players were injured in the second league (55.6%) than in the premier league (76.6%), which was also the case in the previous season. The number of injuries per player differs considerably as well. There were 0.9 more injuries per player on average in the premier league than in the second league.

Overall the risk of sustaining an injury therefore appears to be considerably higher in BB1 than in BB2. In reference to the overall prevalence and the cumulative season incidence, this is largely due to the in part up to 50% higher competition exposure in BB1. The larger league (18 versus 16 teams) and especially also the European competitions play a major role here. Presumably the noticeably higher proportion of match injuries in BB1 has to be viewed in this context as well.
»Power forwards and center players get injured more often!«

However, this cannot be considered the sole cause since a higher injury frequency was also observed with regard to competition incidences in championship games for BB1 compared to BB2. To what extent more physical play in BB1 or a poorer regeneration state due to the greater game and training density could be responsible for this is speculative and should be examined in the future.

The higher number of short term intra-seasonal transfers from abroad to the premier league may also play a role. Very often the mainly American players have short preparation and adaptation times before their first game, and their state of health and fitness is in part unknown as well. This could mean a greater susceptibility to injuries.
Influence of the playing position

Prevalence by playing position
Proportion of injured players in the 2015/16 season [± 95% confidence interval]

Cumulative season incidence by playing position
Number of injuries (n) per player in the 2015/16 season [± 95% confidence interval]

Compared to the previous season, the playing positions of shooting guard and small forward as well as power forward and center were combined for analysis purposes, since a high rate of player rotation to these positions is observed due to similar requirement profiles so that clear differentiation is not always possible.

As in the previous season, no statistical differences between the playing positions were noted regarding the prevalence in the 2015/16 season. Accordingly the proportion of injured players is comparable for all playing positions within the scope of statistical variations.

In regards to the cumulative season incidence however, power forwards and center players sustain noticeably more injuries at an average of 2.2 than point guards (1.8 injuries) and shooting guards/small forwards (1.7 injuries).

This result affirms that the risk of injury – as already observed in the previous season – tends to be higher for the tall “post players” who spend the most time in the zone, both for defense and offense, and therefore in the most risky areas of the court. Power forwards and centers also typically engage in the most shot block and rebound activities, which have been identified as risky play activities.
Ankle injuries are seen considerably more often in training!«

Distribution of the injuries

As in the previous season, nearly one third of all training injuries once again occurred in the two preparation months of August and September. This high proportion is remarkable even though the highest training volume can surely be expected here. Comparably high values can only be found in hockey, the second North America-driven sport. At the very least a look should be taken here at training management in the commonly short preparation phase, but also at the fitness level of the players during the summer break.

The first four months of the season are also overrepresented in regards to match injuries. Additional strain placed on the BB1 clubs by European competitions, which decreases in the course of the season, likely plays a role here as well among other factors.

The ankle continues to be the most frequently injured body region in basketball by far, followed by knee and thigh injuries where a noticeable increase was seen compared to the prior year.

Distribution of injuries in the course of the season

Proportion (%) of training and match injuries by month
Ankle injuries are noticeably overrepresented in training (23.1%, competition: 16.1%), knee injuries on the other hand in competition (19.6%, training: 13.5%). In regards to ankle injuries, a lower frequency of wearing ankle stabilization orthoses or tapes is a possible explanation. The average number of jumps with landings that typically lead to ankle injuries is presumably higher in training than in competition as well.

In regards to the league, playing position, or time in the season, no further peculiarities could be found for the injured body regions in 2015/2016.
Downtime and costs

When the downtime and costs caused by basketball injuries are examined as indicators for the possible severity of injury in addition to the frequency itself, ankle and knee injuries are revealed as the main injuries in basketball which is the same as in the previous season. A noticeable increase in downtime was observed as well due to the considerably increase in knee injuries.

Knee and ankle injuries accounted for 36.3% of all basketball injuries in the 2015/16 season. However, they accounted for 57.2% of the days missed and 48.6% of the benefits.

Thigh and lower leg injuries, typically consisting of muscle and tendon injuries, followed at a considerably distance in this regard.

These injury “hot spots” that are especially relevant for prevention will be illustrated in greater detail on the following pages these along with their causes and injury mechanisms.

Head injuries are also included in the hot spots in this edition due to the key issue of craniocerebral injuries. These are subsequently analyzed in more detail, even if they would otherwise not have been included in the hot spots based on frequency or downtime and costs.

»Ankle and knee injuries remain uncontested in first and second place, followed by thigh and lower leg injuries.«
<table>
<thead>
<tr>
<th>Lower leg</th>
<th>Hand</th>
<th>Back</th>
<th>Shoulder</th>
<th>Hip</th>
<th>Elbow</th>
<th>Wrist</th>
<th>Chest</th>
<th>Forearm</th>
<th>Abdomen</th>
<th>Upper arm</th>
<th>Neck</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.0</td>
<td>0.8%</td>
<td>1.4%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>1.4%</td>
<td>0.9%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>1.2%</td>
<td>0.4%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

**Basketball**

[Image of basketball players]
Injury “hot spots”

Head injuries in basketball:
- 7.9%

Thereof:
- 41.8% Lacerations
- 24.6% Ruptures
- 16.5% Other injuries

Thigh injuries in basketball:
- 13.2%

Thereof:
- 47.5% Contusions
- 33.1% Muscle strain
- 16.5% Other injuries

Knee injuries in basketball:
- 16.6%

Thereof:
- 42.7% Contusions
- 32.9% Distorsions
- 13.4% Ruptures

Ankle injuries in basketball:
- 19.7%

Thereof:
- 73.3% Distorsions
- 22.6% Ruptures
- 4.1% Other injuries

Lower leg injuries in basketball:
- 6.1%

Thereof:
- 47.5% Contusions
- 9.8% Distorsions
- 9.8% Muscle strain

Other injuries 7.6%
5.1% Craniocerebral injuries
31.6% Contusions
Fractures 6.3%
7.6% Dental injuries
11.0% Other injuries
13.4% Ruptures
32.9% Distorsions
4.1% Other injuries
22.6% Ruptures
73.3% Distorsions

VBG Sports Report 2017

Ankle injuries in basketball:
- 19.7%

Thereof:
- 73.3% Distorsions
- 22.6% Ruptures
- 4.1% Other injuries

Lower leg injuries in basketball:
- 6.1%

Thereof:
- 47.5% Contusions
- 9.8% Distorsions
- 9.8% Muscle strain

Other injuries 7.6%
5.1% Craniocerebral injuries
31.6% Contusions
Fractures 6.3%
7.6% Dental injuries
11.0% Other injuries
13.4% Ruptures
32.9% Distorsions
4.1% Other injuries
22.6% Ruptures
73.3% Distorsions

VBG Sports Report 2017
Causes, mechanisms, and injury situations in basketball

Injury location on the playing field
Proportion (%) of the injuries

<table>
<thead>
<tr>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defense 50.8%</td>
</tr>
<tr>
<td>0–5.0</td>
</tr>
<tr>
<td>5.1–10.0</td>
</tr>
<tr>
<td>10.1–15.0</td>
</tr>
<tr>
<td>15.1–20.0</td>
</tr>
<tr>
<td>&gt; 20.0</td>
</tr>
</tbody>
</table>

1 Video analysis of match injuries 2014–2016 (n = 169)
Overall the injuries were evenly divided among the offensive (49.2%) and defensive (50.8%) halves of the game. However, nearly 60% of all injuries occurred directly under the baskets in the restricted areas. Here the offensive zone stands out. Every third injury occurs under the offensive post.

This result is not entirely unexpected, since the most risky game actions such as lay-ups, rebounds, and shot blocks typically occur in these zones. Landing after jumps, regardless of the basketball-specific game action, was by far the most common movement sequence triggering an injury.

It appears that the frequency of injury is higher in the second and fourth quarters, that is in the second part of the respective half. For statistical purposes however this result narrowly fails to pass the significance test. If this trend is confirmed in the next year, the extent to which acute fatigue processes may also play a role in the occurrence of injuries will have to be considered.

Even though half court defense was the game phase with the most injury events, about 10% more injuries were observed overall in the offensive compared to the defensive game phases. Point guards sustained injuries considerably more frequently in the fast break than all other playing positions. This does not seem entirely surprising since they are involved in initiating and also completing the fast break much more often.
»Point guards often sustain injuries in the fast break!«
More than two thirds of all injuries occurred in direct situations with the ball. Here the player in control of the ball was affected most often, followed by the direct opponent. So it is no wonder that one-on-one situations are the most common basketball-specific actions at the time of injury, even ahead of rebounding.

Block defense in particular is increasingly seen as a game action causing injury in defensive game phases. Defensive players often injure themselves during collisions with blocking attackers who are anticipated late or not at all.

The proportion of contact injuries did decrease slightly compared to the prior year. Nevertheless more than half of all injuries (56.2%) are due to a direct contact event. Another quarter of the injuries was also indirectly associated with a preceding contact.

»Every third injury occurs under the offensive board!«
**Game action of the injured player at the time of injury**
Proportion (%) of the injuries

**Injury mechanism by injured body region**
Proportion (%) of contact, indirect contact, and non-contract injuries
Insofar it seems essential from a preventive perspective to athletically, technically, and mentally prepare players for the basketball-specific contact situations, especially in the airborne phase and the landing of jumps. Considering in particular that only every eighth injury occurs in the context of an opposing foul, notwithstanding the high number of direct and indirect contact injuries, a high prevention potential can definitely be assumed.

Basketball with only 12.4% opposing fouls is also the fairest of the four sports that were analyzed. Only head injuries and injuries in the fast break are more frequently linked to a foul by an opposing player. Here the injury mechanisms vary considerably depending on the injured body region. When the “hot spots” are examined, injuries of the thigh and lower leg in particular, typically muscle-tendon injuries, were observed in typical non-contact situations such as starts, sprints, landings, and direction changes.

Indirect contact was determined to be the injury mechanism in many knee injury cases. Here the players received light contact on the upper body during a one-on-one or in the airborne phase during shots and rebounds, and then twist the knee on landing or during the next step.

Ankle injuries on the other hand are very often contact injuries, but typically with no foul, during landings on the foot of the fellow or opposing player after rebounds, shots, or shot blocks.

See the table on page 43 for other typical injury situations in basketball.

### Foul as the cause of injury, by injured body region

<table>
<thead>
<tr>
<th>Injury Region</th>
<th>No Foul</th>
<th>Own Foul</th>
<th>Opposing Foul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>57.1%</td>
<td>100.0%</td>
<td>88.8%</td>
</tr>
<tr>
<td>Thigh</td>
<td>5.6%</td>
<td>10.0%</td>
<td>80.0%</td>
</tr>
<tr>
<td>Knee</td>
<td>8.5%</td>
<td>4.3%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>5.6%</td>
<td>10.0%</td>
<td>87.2%</td>
</tr>
<tr>
<td>Ankle</td>
<td>14.3%</td>
<td>28.6%</td>
<td>12.4%</td>
</tr>
<tr>
<td>All Injuries</td>
<td>81.7%</td>
<td>87.2%</td>
<td>81.7%</td>
</tr>
</tbody>
</table>
»High prevention potential in basketball – only every eighth injury is due to an opposing foul.«
### Typical injury situations in basketball

<table>
<thead>
<tr>
<th>Body region</th>
<th>Type of injury</th>
<th>Mechanism</th>
<th>Foul</th>
<th>Cause</th>
<th>Movement pattern</th>
<th>Game action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Craniocerebral injury, facial fracture</td>
<td>Contact</td>
<td>Frequent</td>
<td>Opposing player impact (with upper limbs, mainly elbows)</td>
<td>Airborne phase, standing</td>
<td>Lay-up/dunking, rebound</td>
</tr>
<tr>
<td>Shoulder</td>
<td>AC joint separation, AC joint contusion</td>
<td>Contact</td>
<td>Occasional</td>
<td>Opposing player collision (shoulder-shoulder collision)</td>
<td>Running</td>
<td>Block defense</td>
</tr>
<tr>
<td>Thigh</td>
<td>Muscle strain, ruptured muscle fibers</td>
<td>Non-contact</td>
<td>No</td>
<td>Structural overload</td>
<td>Running, sprinting, landing</td>
<td>Not specific</td>
</tr>
<tr>
<td></td>
<td>Muscle contusion</td>
<td>Contact</td>
<td>No</td>
<td>Opposing player collision (knee-thigh collision)</td>
<td>Running</td>
<td>One-on-one, block defense</td>
</tr>
<tr>
<td>Knee</td>
<td>Partial or total rupture of the collateral ligaments</td>
<td>Contact</td>
<td>No</td>
<td>Opposing/fellow player collision (knee-knee collision, fall onto the knee)</td>
<td>Running, sprinting, landing</td>
<td>Not specific</td>
</tr>
<tr>
<td></td>
<td>Knee joint distortion, partial or total rupture of the anterior cruciate ligament</td>
<td>Indirect Contact</td>
<td>Occasional</td>
<td>Opposing player collision + twisting</td>
<td>Running, landing</td>
<td>One-on-one, rebound</td>
</tr>
<tr>
<td></td>
<td>Non-contact</td>
<td>No</td>
<td>Twisting</td>
<td></td>
<td>Running, landing</td>
<td>One-on-one, rebound</td>
</tr>
<tr>
<td>Ankle</td>
<td>Partial or total rupture, distortion of the collateral ligaments</td>
<td>Contact</td>
<td>No</td>
<td>Opposing/fellow player collision (foot-on-foot collision)</td>
<td>Landing</td>
<td>Lay-up/dunking, shot block, shot</td>
</tr>
</tbody>
</table>
General overview

Injuries by competition

Competition incidence (injuries per 1,000 hours of competition) in the 2015/16 season [± 95% confidence interval]

<table>
<thead>
<tr>
<th></th>
<th>EH 1</th>
<th>EH 2</th>
<th>CHL*</th>
<th>Total EH</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH</td>
<td>141.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td></td>
<td>122.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHL*</td>
<td></td>
<td></td>
<td>162.0</td>
<td></td>
</tr>
<tr>
<td>Total EH</td>
<td></td>
<td></td>
<td></td>
<td>132.2</td>
</tr>
</tbody>
</table>

* Champions Hockey League
Around 700 players in Germany’s top two men’s professional hockey leagues played in an official club game during the 2015/16 season and were included in this study.

82% of all active players – around 5% more than in the prior year – sustained at least one injury. Each active hockey player sustained 2.7 injuries on average.

No statistically significant differences were found between the leagues in regards to the overall prevalence, although slightly fewer players appear to sustain injuries in EH2 (77.6%) than in EH1 (80.4%). The high number of players with promoter licenses, who sustained injuries during play in both EH1 and EH2, explains why the overall prevalence in hockey for 2015/16 is actually slightly higher compared to viewing the leagues individually. It would therefore be interesting for future analyses to take a closer look at this special player group with potential double burdens and to analyze what effect this status has on a player’s frequency of injury.

A significant difference is however noted in the number of injuries per active player when comparing the two leagues. Thus a higher number of injuries per player was recorded in EH1 (2.8 injuries) than in EH2 (2.4 injuries).

As in the prior year, the proportion of match injuries in hockey is considerably overrepresented in comparison to the other three sports examined in this study. Around 79% of all injuries were sustained in official games or tryouts. While this proportion was once again higher in EH1 than in EH2 in the prior year, the difference between the two leagues is only minimal this season.
Goalies have a considerably lower risk of injury than field players!«

When the individual competitions in hockey are examined, the risk of injury during competition in EH2 (122.2 injuries/1,000 hours) tends to be somewhat lower than in EH1 (141.1 injuries/1,000 hours), which is consistent with the prior year. As with the comparison to the Champions Hockey League however (162.0 injuries/1,000 hours), the difference fails to pass the statistical significance test by the narrowest margin.

This tendency was already noted in the prior year. Whether the somewhat more dynamic or more physical play in the DEL could play a role here is speculative. Monitoring this should however continue.
Injuries in hockey differentiated by playing positions are essentially the same as in the prior year.

The prevalence and cumulative season incidence are significantly lower for goalies than for all other field players. In particular, the number of injuries per player with 1.2 injuries for goalies was considerably below the cumulative season incidence for the field players (2.6–3.0 injuries), where more than one additional injury was observed on average.

This is surely due mostly to the overall lower dynamic of the requirements profile specific to the goalie, and here in particular to the lower exposure to risky game actions such as opposing checks for example. The goalies also benefit from the considerably higher level of protection offered by the protective equipment that is specific to them.

Statistically significant differences between the individual field player positions on the other hand could not be observed.
»More than two thirds of all training injuries occur in the first half of the season!«

**Distribution of the injuries**

The proportion of training injuries in the preparatory month of August is still the highest at 17.1%, but on the other hand has dropped considerably compared to the prior season. While nearly two thirds of all training injuries occur in the first five months of the season, a steady decrease in training injuries can be seen from the month of December to the end of the season.

The head continues to be the most frequently injured body region in hockey by a wide margin, a slight decrease notwithstanding, followed by thigh and shoulder injuries that switched places compared to the prior season.

Significantly fewer shoulder injuries occurred in EH1 (7.8%) than in EH2 (10.9%), which could be due to the use of flexible board systems in some EH1 arenas or to the somewhat less dynamic but slightly more combative manner of play in EH2.

Thigh injuries, consisting mostly of typical non-contact muscle injuries, occurred considerably more often in training (13.2%) than in competition (8.5%). This higher proportion should be examined, especially under consideration of the requirements in on and off-ice training. Neck (2.7%) and shoulder injuries (5.6%), typically contact injuries, were seen less often in training and this can be viewed as an indication that...
Distribution of injuries by body regions

Proportion (%) of injuries by affected body region

<table>
<thead>
<tr>
<th>Body Region</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>17.0%</td>
</tr>
<tr>
<td>Thigh</td>
<td>9.5%</td>
</tr>
<tr>
<td>Shoulder</td>
<td>9.2%</td>
</tr>
<tr>
<td>Knee</td>
<td>9.1%</td>
</tr>
<tr>
<td>Hand</td>
<td>7.9%</td>
</tr>
<tr>
<td>Neck</td>
<td>6.7%</td>
</tr>
<tr>
<td>Back</td>
<td>6.5%</td>
</tr>
<tr>
<td>Foot</td>
<td>5.4%</td>
</tr>
<tr>
<td>Hip</td>
<td>5.3%</td>
</tr>
<tr>
<td>Ankle</td>
<td>5.1%</td>
</tr>
<tr>
<td>Chest</td>
<td>5.0%</td>
</tr>
<tr>
<td>Wrist</td>
<td>4.1%</td>
</tr>
<tr>
<td>Lower leg</td>
<td>3.0%</td>
</tr>
<tr>
<td>Elbow</td>
<td>2.5%</td>
</tr>
<tr>
<td>Forearm</td>
<td>2.0%</td>
</tr>
<tr>
<td>Abdomen</td>
<td>1.0%</td>
</tr>
<tr>
<td>Upper arm</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

»Goalies and field players have very different injury profiles.«

Reduced body contact and less contact with the boards may occur during training.

Clear shifts in the distribution of the injuries were also seen in reference to the different playing positions. Goalies suffered significantly more knee (17.4%) and thigh injuries (20.9%) but fewer head (9.3%) and shoulder injuries (3.5%). On the one hand, this may be due to the movement requirements that are typical for the positions of the goalies, such as the butterfly technique or the crouching position. On the other hand, goalies are involved much less often in contact situations with opposing players.

No connection between the month in which an accident occurred and the injured body region could be found.
Downtime and costs

When the downtime and benefits caused by hockey injuries are examined as indicators for the possible severity of injury in addition to the frequency as such, shoulder and knee injuries in addition to head injuries (see key issue) emerge as the central injury focal points in hockey, as already seen in the previous season. These three body regions accounted for 35.3% of the injuries in the 2015/16 season. However, they accounted for 56.0% of the days missed and 55.5% of the benefits. Thigh and ankle injuries followed at a considerable distance for 2015/16 in this regard.

These injury “hot spots” that are especially relevant for prevention will be illustrated in greater detail on the following pages along with their causes and injury mechanisms.

»Head, shoulder, and knee injuries remain uncontested in the top spots, followed by thigh and ankle injuries.«
Dental injuries 17.5%
Hockey

Injury “hot spots”

Head injuries in hockey:
- Contusions: 25.8%
- Craniocerebral injuries: 22.8%
- Dental injuries: 17.5%
- Fractures: 4.9%
- Other: 2.8%

Shoulder injuries in hockey:
- Contusions: 45.2%
- Dislocations: 24.9%
- Lacerations: 15.8%
- Distorsions: 8.6%
- Other: 8.5%

Thigh injuries in hockey:
- Contusions: 34.6%
- Muscle strain: 44.5%
- Other: 6.6%
- Dislocations: 8.6%

Knee injuries in hockey:
- Contusions: 29.7%
- Distorsions: 37.7%
- Ruptures: 24.0%
- Other: 8.6%

Ankle injuries in hockey:
- Contusions: 30.3%
- Distorsions: 36.4%
- Fractures: 8.1%
- Ruptures: 21.2%
- Other: 4.0%

Dental injuries: 17.5%

Other injuries: 2.8%

Ankle injuries:
- Thereof: 5.1%

Shoulder injuries:
- Thereof: 9.2%

Thigh injuries:
- Thereof: 9.5%

Knee injuries:
- Thereof: 9.1%

Head injuries:
- Thereof: 17.0%

Cranio-cerebral injuries: 22.8%

Lacerations: 26.2%

Distorsions: 15.8%

Muscle strain: 5.6%

Other: 8.5%
Causes, mechanisms, and injury situations in hockey

Injury location on the playing field
Proportion (%) of the injuries

<table>
<thead>
<tr>
<th>Zone</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defensive</td>
<td>48.5%</td>
</tr>
<tr>
<td>Neutral</td>
<td>14.6%</td>
</tr>
<tr>
<td>Offensive</td>
<td>36.9%</td>
</tr>
</tbody>
</table>

- 3.1% 6.2% 0.8% 4.6% 12.2% 3.1% 8.5% 10.7% 0.8% 1.5% 8.5% 4.6% 10.0% 10.0% 2.3% 4.6% 5.4% 3.1% >20.0

1 Video analysis of match injuries 2014–2016 (n = 130)
Significantly more injuries occurred in the first period than in the other two periods. Direct physical and cognitive preparation for the game (for example through specific and individualized warmup routines) has to be questioned here as a possible cause. Another possible explanation might be that players who are still slightly off-color are sent onto the ice and then get injured early in the game. Somewhat more combative head to head action, especially in the first period, in order to earn the respect of the opposing team would also be conceivable.

Almost half of all injuries (48.5%) occurred in the defensive zone. At the time of injury, the injured player was in possession of the puck most often (43.1%) followed by the direct opposing player (20%). Defensemen in particular got injured more even in direct possession of the puck.

»Most injuries occur during the first period!«
» Every third injury and almost every second injury in hockey is due to an opposing foul! «
Regardless of the hockey-specific game action, gliding was by far the most commonly occurring movement pattern at the time of injury. In over 70% of all cases, the injured player was no longer engaged in a highly dynamic action (gliding, standing, stopping). Forwards on the other hand got injured more often while starting, that is at the beginning of an explosive action, while injuries while standing were overrepresented for goalies as expected. More than two thirds of all injuries occurred during a generally forward-directed movement.

Nearly three quarters of all analyzed injuries are due to direct contact as the injury mechanism. Furthermore, nearly every third injury is related to a foul by an opposing player. This high proportion of fouls is remarkable in particular because hockey, compared to other sports, already has the highest proportion of contact situations that comply with the rules.

The injury mechanisms vary considerably depending on the injured body region. Examining the hot spots reveals that head injuries in contact situations, knee injuries in indirect contact situations, and thigh injuries in non-contact situations are overrepresented.
Game action of the injured player at the time of injury
Proportion (%) of the injuries

Injury mechanism by injured body region
Proportion (%) of contact, indirect contact, and non-contact injuries
Thigh, ankle, and knee injuries in particular very rarely result from direct contact with an opponent or material, or from a foul. This emphasizes that there is in fact prevention potential even in the contact-dominated sport of hockey.

The recorded head injuries on the other hand were entirely due to a direct contact mechanism, in particular opposing checks with the shoulder and elbow. Accordingly nearly every second head injury was also considered a foul by the referees. When the situation that led to an injury involved a foul, this was always perpetrated by the opposing player with the exception of a few shoulder injuries. Here the injured player was more often in possession of the puck or gave it up shortly before.

The second-highest proportion of contact situations was observed for shoulder injuries (75.0%), with a large proportion once again resulting from non-anticipated checking by opposing players. However, the proportion of head to head action in compliance with the rules is considerably higher than for head injuries. Insofar the general question of appropriate head to head action and preparatory contact/head to head training must be raised here, especially for players in EH2. Converting all facilities to flexible board systems could also prove helpful, since shoulder injuries in particular are found in situations with board contact.

The position-specific injury profile reveals high prevention potential for goalies in particular, whose injuries occur less often in contact but more frequently in non-contact situations. This is presumably also due to their better protection and the protected goal space. In reference to the game phase, a large proportion of non-contact injuries therefore also occur during defense transition.

See the table on page 61 for other typical injury situations for the hot spots.
### Typical injury situations in hockey

<table>
<thead>
<tr>
<th>Body region</th>
<th>Type of injury</th>
<th>Mecha- nism</th>
<th>Foul</th>
<th>Cause</th>
<th>Movement pattern</th>
<th>Game action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Craniocerebral injury, facial fracture, cranial contusion</td>
<td>Contact</td>
<td>Yes</td>
<td>Checking, opposing player (with shoulder or upper limbs)</td>
<td>Gliding forward</td>
<td>Pass, stickwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Checking, opposing player (with shoulder or upper limbs)</td>
<td>Gliding forward</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Checking, opposing player (with shoulder or upper limbs)</td>
<td>Stopping</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Collision with opposing player + fall</td>
<td>Gliding forward, skating forward</td>
<td>Not specific</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Shoulder dislocation, AC joint separation</td>
<td>Contact</td>
<td>Rarely</td>
<td>Checking, opposing player (with shoulder or torso)</td>
<td>Gliding forward, skating forward</td>
<td>Pass, stickwork, protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Checking, opposing player (with shoulder or torso)</td>
<td>Gliding forward, skating forward</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Collision with opposing player + fall</td>
<td>Gliding forward, skating forward</td>
<td>Not specific</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>Partial or total rupture of the cruciate and collateral ligaments, knee sprain and strain</td>
<td>Contact</td>
<td>Rarely</td>
<td>Collision with opposing player (knee-knee collision)</td>
<td>Gliding forward, skating forward, standing</td>
<td>Not specific</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Checking, opposing player (with shoulder or torso) + twisting/canting</td>
<td>Gliding forward, skating forward, standing</td>
<td>Not specific</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Checking, opposing player (with shoulder or torso)</td>
<td>Gliding forward, skating forward</td>
<td>Not specific</td>
</tr>
</tbody>
</table>
8 Injuries in Soccer

General overview

Injuries by competition
Competition incidence (injuries per 1,000 hours of competition) in the 2015/16 season [± 95% confidence interval]
The prevalence in soccer increased minimally by 1.3% in the 2015/16 season compared to the previous season. After soccer was the only one of the sports under consideration in the prior season in which FB 2 exhibited higher cumulative season incidences than in the highest division, this effect is no longer observed for the underlying 2015/16 season.

With a constant cumulative season incidence in the overall examination of both leagues (2.5 injuries/player/year), FB 1 (2.6 injuries/player/year) exhibits a higher occurrence of injuries than FB 2 (2.3 injuries/player/year). Significantly higher values are therefore now found in FB 1, both for the prevalence and for the cumulative season incidence.

These circumstances are by all means in line with expectations since the competition exposure in FB 1 is about 10–15% higher compared to FB 2, mainly due to participation in the European competitions and a longer time spent by the clubs in the DFB cup, while the results of the prior year are more of a surprise in this regard.

On the other hand there is no difference between the two leagues regarding the proportion of training to match injuries.

In regards to the competition incidences that decreased slightly in all competitions, the risk of injury as in the prior year was considerably lower in the international cups compared to the national competitions. This is interesting insofar as a similar tendency could not be observed in any of the other three sports, and was also not expected in view of sometimes stressful travel and the often postulated “international hard play”.

»The risk of injury is lowest in the international cup games!«
When injuries in professional soccer are examined depending on the playing position, one notes that the prevalences – the proportion of active players who sustained injuries in 2015/16 – initially do not differ statistically notwithstanding slight variations. As in the prior year, goalkeepers with an average of 1.8 injuries were injured much less often than defensive (2.7 injuries) and center field players (2.6 injuries). The tendency in the prior year that forwards (2.2 injuries/player) sustain fewer injuries overall than their fellow defense and midfield players can now be statistically verified in the 2015/16 season examined here.

Influence of the playing position

The considerably lower injury rates of goalkeepers are due to the fundamentally different requirements profile of the goalkeeper compared to all other positions. Aside from the lower overall distance covered, a smaller number of sprints, and fewer ball actions, goalkeepers were also engaged in fewer duels than field players.

This however must not be allowed to obscure the fact that goalkeepers are often exposed to situations that are associated with a very high collision potential. When intercepting a cross for example, goalkeepers often avoid violent collisions with the rapidly approaching offensive players or the own defensive players by only the narrowest of margins.
Fortunately collisions of this type are relatively rare compared to the typical main forms of injury. When such incidents do occur however, severe injuries to the head, cervical spine, shoulder, and upper limbs may result.

»Goalkeepers have a lower risk of injury than field players, but suffer more head injuries!«
In the 2015/16 season, the high proportion of training injuries observed in the prior year during the typical preparatory months of July and January could at most be confirmed in regards to preparation for the second half of the season in January. In general it must be noted that the training volume increases overall in the course of preparing for the first and second half of the season, so that the expected frequency goes up in any case. Increasing the strain gradually is highly relevant from a preventive point of view, especially in phases where high training volumes and intensities follow the restful phases in June and December.

An often postulated cluster of match injuries at the respective end of a half season could not be confirmed in that form. A falling trend from October to December can be observed in the first half of the season, where it must be noted that fewer games took place in December. An increase in match injuries can be seen during the second half of the season in April as the last full month of competition, but this is not statistically significant.

In the distribution of injuries among the various body regions, the lower limbs with more than 70% of all injuries clearly remain the focal point as they have in the past. Here more than half of all injuries involved the thigh (23.3%), knee (14.5%), or ankle (13.6%). Thigh injuries, typically muscle-tendon injuries, have once again increased noticeably compared to the prior year.
No significant differences in the distribution among body regions are discernible in the league comparison, but a clear tendency towards more ankle injuries was identified in the second league.

Regarding the distribution among training and competition, note that head injuries occurred more often during play (8.8%) than in training (4.6%), which can be attributed to more considerate head to head action in training. The reverse holds true for knee injuries (training 16.4%, play 12.3%), most of which occur with no direct opposing influences (pages 76/77). Presumably this can be explained by the higher density of landings and direction changes in training, which is when knee injuries commonly occur.
Downtime and costs

In order to meet the demand for an informative presentation of the injuries, the downtime and benefits caused by the injuries were also examined as indicators for the possible severity of injury in addition to the frequency as such.

Overall the lower limbs lead the field here as well. Knee injuries constitute the most severe injuries by far as in the prior year, but with a perceptibly declining tendency in days missed and benefits paid. On the other hand an increase in thigh injuries was seen. Lower leg injuries in fact doubled compared to the prior-year values, which is explained by several severe lower leg injuries such as tibia and fibula fractures.

These injury “hot spots” that are especially relevant for prevention will be illustrated in greater detail on the following pages along with their causes and injury mechanisms.

Head injuries are also included in the hot spots in this edition due to the key issue of craniocerebral injuries. These are subsequently analyzed in more detail, even if they would otherwise not have been included in the hot spots based on frequency or downtime and costs.

»Increase in downtime and benefits for thigh and lower leg injuries!«
Injury “hot spots”

Head injuries in soccer: 6.6 %
- 16.8 % Craniocerebral injuries
- 18.1 % Lacerations
- 2.7 % Dental injuries
- 35.2 % Muscle strain

Thigh injuries in soccer: 23.3 %
- 33.1 % Ruptures
- 23.5 % Contusions
- 8.2 % Other

Knee injuries in soccer: 14.5 %
- 18.9 % Ruptures
- 9.7 % Other

Lower leg injuries in soccer: 10.8 %
- 43.0 % Distorsions
- 59.2 % Contusions

Ankle injuries in soccer: 13.6 %
- 24.4 % Ruptures
- 15.9 % Contusions
- 3.5 % Other

Other injuries 3.4 %
Most injuries occur in the central midfield and during the first 15 minutes of play.

Causes, mechanisms, and injury situations in soccer

Injury location on the playing field
Proportion (%) of the injuries

<table>
<thead>
<tr>
<th>Location</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5.0</td>
<td>3.0 %</td>
</tr>
<tr>
<td>5.1–10.0</td>
<td>9.5 %</td>
</tr>
<tr>
<td>10.1–15.0</td>
<td>3.2 %</td>
</tr>
<tr>
<td>15.1–20.0</td>
<td>2.4 %</td>
</tr>
<tr>
<td>&gt; 20.0</td>
<td>9.2 %</td>
</tr>
<tr>
<td>Defense</td>
<td>52.7 %</td>
</tr>
<tr>
<td>Offense</td>
<td>47.3 %</td>
</tr>
</tbody>
</table>

1 Video analysis of match injuries 2010–2016 (n = 339)
The central midfield is the area of the playing field with the most injuries, both in the own (19.8%) and in the opposing half (20.7%). Here it must be critically noted that the proportion of the individual playing field zones out of the total playing field size is not equal. The markings on the playing field were used for orientation in making the division so as to ensure that the injury location could be identified as...
The tendency is for the most match injuries to occur in the first 15 minutes of play (20.2%). In an explicit examination of the first 15 minutes of play (26.0%) that deviate from the time in the game for substitute players, this trend becomes even clearer and differs fundamentally from other sports such as handball, where an increase in injuries is apparent towards the end of each half. Thus there is cause to suspect that inadequate warmup behavior as well as overall physical and cognitive preparation in the final minutes before the game begins or before substituting could be the cause of this high number of injuries so early in play.

The equal distribution of injuries between play with and against the ball observed in the 2014/15 season has shifted slightly in the 2015/16 observation period, towards more injuries in offensive play with the ball. This applies both to free play (42.9% with the ball, 34.9% against the ball) and to standard situations (defensive 7.2%, offensive 6.2%).

### Movement pattern and direction at the time of injury

<table>
<thead>
<tr>
<th>Movement Pattern</th>
<th>Proportion (%) of the Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running</td>
<td>27.9%</td>
</tr>
<tr>
<td>Sprint</td>
<td>23.1%</td>
</tr>
<tr>
<td>Landing</td>
<td>14.0%</td>
</tr>
<tr>
<td>Airborne phase</td>
<td>11.0%</td>
</tr>
<tr>
<td>Lunge</td>
<td>8.8%</td>
</tr>
<tr>
<td>Standing</td>
<td>4.9%</td>
</tr>
<tr>
<td>Stopping</td>
<td>3.2%</td>
</tr>
<tr>
<td>Direction change</td>
<td>1.9%</td>
</tr>
<tr>
<td>Other</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

### Game phase at the time of injury

<table>
<thead>
<tr>
<th>Game Phase</th>
<th>Proportion (%) of the Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free play with ball</td>
<td>42.9%</td>
</tr>
<tr>
<td>Free play against ball</td>
<td>34.9%</td>
</tr>
<tr>
<td>Free kick</td>
<td>5.3%</td>
</tr>
<tr>
<td>Corner ball</td>
<td>3.8%</td>
</tr>
<tr>
<td>Counterattack</td>
<td>3.6%</td>
</tr>
<tr>
<td>Goal-kick</td>
<td>2.4%</td>
</tr>
<tr>
<td>Other</td>
<td>7.1%</td>
</tr>
</tbody>
</table>

reliably as possible in the video analysis. Thus the expected frequency of injuries in the individual zones is already different for statistical purposes. Nevertheless this result appears logical since most ball actions and duels occur in the central midfield.
Game action of the injured player at the time of injury
Proportion (%) of the injuries

<table>
<thead>
<tr>
<th>Action</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
<td>22.1%</td>
</tr>
<tr>
<td>Tackling</td>
<td>15.2%</td>
</tr>
<tr>
<td>Dribbling</td>
<td>12.5%</td>
</tr>
<tr>
<td>Sliding tackle</td>
<td>9.7%</td>
</tr>
<tr>
<td>Shooting</td>
<td>7.7%</td>
</tr>
<tr>
<td>Pass</td>
<td>8.0%</td>
</tr>
<tr>
<td>Run to the ball/opponent</td>
<td>4.8%</td>
</tr>
<tr>
<td>Receiving the ball</td>
<td>4.2%</td>
</tr>
<tr>
<td>Clearing/toe-poke</td>
<td>3.5%</td>
</tr>
<tr>
<td>Other</td>
<td>12.3%</td>
</tr>
</tbody>
</table>

Injury mechanism by injured body region
Proportion (%) of contact, indirect contact, and non-contact injuries

<table>
<thead>
<tr>
<th>Body Region</th>
<th>Contact</th>
<th>Indirect Contact</th>
<th>Non-Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>100%</td>
<td>12.9%</td>
<td>27.4%</td>
</tr>
<tr>
<td>Thigh</td>
<td>70.0%</td>
<td>17.1%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Knee</td>
<td>46.9%</td>
<td>28.1%</td>
<td>22.7%</td>
</tr>
<tr>
<td>Lower leg</td>
<td>57.9%</td>
<td>31.6%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Ankle</td>
<td>64.4%</td>
<td>28.8%</td>
<td>6.8%</td>
</tr>
<tr>
<td>All injuries</td>
<td>49.9%</td>
<td>22.7%</td>
<td>27.4%</td>
</tr>
</tbody>
</table>
The expected statistical differences are revealed only in a position-specific examination. Forwards got injured significantly more often when their own team was in possession of the ball, while goalkeepers sustained more injuries in play situations against the ball. The injured player is in possession of the ball only slightly more than one third of the time (36.3%). With 43.9% of the analyzed injuries, the opposing team was in possession of the ball at the time of the injury.

Nearly half the injuries occurred while running (27.9%) or sprinting (23.1%) across all positions and game situations. Landing after jumps with 14.0% also remains one of the most injury-prone movement patterns. It seems worth mentioning that the proportion of injuries that occur while standing (4.9%) is greater than the proportion of injuries during stopping movements (3.2%) or direction changes (1.9%).

In examining the sport-specific action at the time of the injury, a tremendous increase is seen in the injuries resulting from header situations compared to the prior year (+8.8%). Own tackling (15.2%) and own sliding tackles (9.7%) continue to account for nearly a quarter of the game actions during which an injury occurred. The position-typical action of intercepting a cross is the most injury-prone game action for goalkeepers in a position-specific examination. Defenders get injured most frequently during headers, midfielders and forwards on the other hand during own dribbling.

Across all positions and injured body regions, nearly half (49.9%) of all injuries were due to direct contact with opposing players, fellow players, or the ball. More than a quarter of the injuries (27.4%) occurred with no external influence of any kind.

The proportion of direct contact injuries was considerably lower when examining the hot spots. With nearly 90% of the thigh and more than half the knee injuries (53.1%), external influences such as foul as the cause of injury, by injured body region

Proportion (%) of injuries by no, own and opposing foul

0.0 20.0 40.0 60.0 80.0 100.0

Head Thigh Knee Lower leg Ankle All injuries

No foul 75.0 % 88.6 % 69.8 % 57.9 % 64.4 % 69.9 %

Own foul 19.4 % 5.7 % 9.4 % 36.8 % 10.2 % 11.5 %

Opposing foul 5.6 % 20.8 % 5.3 % 5.7 % 25.4 % 18.6 %

No foul Own foul Opposing foul
contact with an opponent have at most an indirect influence on the injury event. Head and foot injuries on the other hand occur mostly due to direct contact. There were no position-specific differences in this regard among the field players. For goalkeepers however there appears to be a shift towards a higher proportion of direct contact injuries, typically while intercepting a cross.

Note that not all direct contact injuries by far are due to irregular contact of the opposing player. The proportion of injuries caused by an opposing foul is merely 18.6%. In fact an own foul was the cause of injury in 11.5% of the cases. Not even one in ten knee injuries and only one in around 20 thigh injuries was caused by an opposing foul. Furthermore the proportion of injuries that was caused by severe fouls is extremely small. Only 7.1% of all injuries were penalized with a yellow and 1.2% with a red card.

Insofar it appears that a considerable proportion of the injuries could be prevented. There is a very high proportion of non-contact or indirect contact injuries in the knee and thigh regions in particular. These generally occur during basic forms of movement such as running, sprinting, or landing and typical game actions like dribbling or own tackling. Presumably intrinsic factors play an increased role in the occurrence of the injury here.

Against the background of the low number of injuries caused by an opposing foul, the proportion of direct contact injuries also cannot be ascribed entirely to the often cited “bad luck”. While access to effective preventive measures is certainly more difficult here, there does appear to be preventive potential in regards to the own conduct in head to head situations and in the technical execution of certain style elements such as the sliding tackle.
## Typical injury situations in soccer

<table>
<thead>
<tr>
<th>Body region</th>
<th>Type of injury</th>
<th>Mechanism</th>
<th>Foulspiel</th>
<th>Cause</th>
<th>Movement pattern</th>
<th>Game action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Craniocerebral injury, facial fracture, laceration</td>
<td>Contact</td>
<td>Occasional</td>
<td>Collision with opposing player (head-head collision)</td>
<td>Airborne phase</td>
<td>Header</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>Opposing player impact (with upper limbs, mainly elbows)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td>Shoulder dislocation, AC joint separation</td>
<td>Indirect Contact</td>
<td>Frequent</td>
<td>Opposing player impact + fall</td>
<td>Running, sprinting</td>
<td>Dribbling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Collision with opposing player + fall</td>
<td>Landing</td>
<td>Header</td>
</tr>
<tr>
<td>Thigh</td>
<td>Muscle strain, ruptured muscle fibers</td>
<td>Non-contact</td>
<td>No</td>
<td>Structural overload</td>
<td>Running, sprinting, lunge</td>
<td>Running to the ball/opponent, dribbling, shooting</td>
</tr>
<tr>
<td>Knee</td>
<td>Partial or total rupture or distortion of the medial collateral ligament</td>
<td>Contact</td>
<td>Occasional own foul</td>
<td>Collision with opposing player (knee-knee collision)</td>
<td>Running, sprinting, lunge</td>
<td>Tackling, sliding tackle</td>
</tr>
<tr>
<td></td>
<td>Partial or total rupture of the anterior cruciate ligament</td>
<td>Indirect contact</td>
<td>Rarely</td>
<td>Collision with opposing player + twisting/blocking</td>
<td>Landing, landing-direction change complex, running, sprinting</td>
<td>Header, sliding tackle, dribbling, tackling</td>
</tr>
<tr>
<td></td>
<td>Partial or total rupture of the anterior cruciate ligament</td>
<td>Non-contact</td>
<td>No</td>
<td>Twisting</td>
<td>Lunge, direction change, running, sprinting</td>
<td>Tackling, sliding tackle</td>
</tr>
<tr>
<td>Ankle</td>
<td>Partial or total rupture of the lateral ligaments/syndesmosis ligament</td>
<td>Contact</td>
<td>Rarely</td>
<td>Collision with opposing player (foot-on-foot collision)</td>
<td>Landing</td>
<td>Header</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Occasional own foul</td>
<td>Opposing player kick</td>
<td>Running, sprinting, lunge</td>
<td>Tackling, dribbling, pass</td>
</tr>
<tr>
<td></td>
<td>Partial or total rupture, distortion of the lateral ligaments</td>
<td>Indirect contact</td>
<td>Occasional</td>
<td>Collision with opposing player + spraining</td>
<td>Landing</td>
<td>Header</td>
</tr>
</tbody>
</table>
## Injuries in Handball

### General overview

**Injuries by competition**

Injuries per 1,000 hours of competition [± 95% confidence interval]

<table>
<thead>
<tr>
<th>Competition</th>
<th>Rate (per 1,000 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB 1</td>
<td>77.8</td>
</tr>
<tr>
<td>HB 2</td>
<td>81.1</td>
</tr>
<tr>
<td>National cup</td>
<td>56.1</td>
</tr>
<tr>
<td>International cup</td>
<td>69.5</td>
</tr>
<tr>
<td>Total HB</td>
<td>77.7</td>
</tr>
</tbody>
</table>
Around 750 players in Germany’s top two men’s professional handball leagues played in an official club game during the 2015/16 season and were included in this study.

There has been no major change compared to the prior year when injuries in handball are examined overall. While the total prevalence (79.7%) dropped minimally, the cumulative season incidences increased slightly by 0.2 injuries per player. There was however no significant difference compared to the prior year under consideration of statistical variances.

A differentiated examination of the leagues on the other hand reveals that injuries in HB 2 have increased noticeably compared to the prior year. Second league players suffered an average of around 0.5 more injuries per player than in 2014/15. This equates to a statistically significant increase in the cumulative season incidence from 2.2 to 2.7 injuries. As a result, HB2 is now level with HB1 where a slight decrease was observed.

This change is likely due primarily to the growth of the second league to 21 teams and the associated introduction of double headers. Notwithstanding the participation of federal league clubs in European competitions and more time spent in the DHB cup, the competition exposure in the 2015/16 season was about 15% greater in HB 2 than in HB 1, where only 17 teams were playing starting with the second half of the season due to the withdrawal of one club because of insolvency. The additional game exposure in HB2 with the shorter regeneration times where applicable, for example in case of double headers, appears to have an effect on the competition incidences as well. These increased from 67.9 injuries to 81.1 injuries per 1,000 hours of play and therefore to the first league level.
» Back court and pivot players are at the highest risk!«

The risk of injury appears to be somewhat lower in DHB cup competition overall than in league games, which could presumably be because the first and second league teams can go somewhat easy on themselves against in part lower-class teams, especially in the first three rounds.

No noticeable differences were observed regarding the proportion of training and match injuries on the other hand.
Injuries in handball differentiated by playing positions are essentially the same as in the prior year. The observed prevalences in 2015/16 were comparable for all playing positions under consideration of statistical variances.

As in the previous season however, significant differences could be proven for the frequency of injury between the playing positions.

A significant increase in the frequency of injuries compared to the prior season notwithstanding, goalkeepers with an average of 2.1 injuries (2014/15: 1.6 injuries) still sustained injuries considerably less often than back court players (3.0 injuries) and pivots (2.8 injuries). Wing players with around 2.4 injuries have the lowest rate of injury among the field players. Statistically however this differs only from the group of back court players.

The differences are presumably due to heterogeneous requirements that apply to the various playing positions. Due to the delimited goal area, goalkeepers are excluded from the intense body contact observed among the field players with the exception of a few duels. This is likely the main reason for the smaller number of injuries. However, they often make highly explosive movements with a large movement amplitude.
Back court players usually have the largest number of game actions with the ball. Pivot players, who also frequently act as defense specialists in the center of defense, are exposed to more contact situations than the other field players. This is primarily due to the numerous duels and screenings far away from the ball. Wing players in the federal division are almost exclusively counter-attack specialists, and are involved in the offensive end and therefore in duel situations much less often.

**Distribution of training and match injuries in the course of the season**

Proportion (%) of training and match injuries by month

<table>
<thead>
<tr>
<th>Month</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>15.1 %</td>
</tr>
<tr>
<td>Aug.</td>
<td>9.6 %</td>
</tr>
<tr>
<td>Sept.</td>
<td>7.4 %</td>
</tr>
<tr>
<td>Oct.</td>
<td>9.0 %</td>
</tr>
<tr>
<td>Nov.</td>
<td>8.3 %</td>
</tr>
<tr>
<td>Dez.</td>
<td>5.8 %</td>
</tr>
<tr>
<td>Jan.</td>
<td>11.1 %</td>
</tr>
<tr>
<td>Feb.</td>
<td>8.3 %</td>
</tr>
<tr>
<td>March</td>
<td>7.7 %</td>
</tr>
<tr>
<td>April</td>
<td>9.3 %</td>
</tr>
<tr>
<td>May</td>
<td>6.5 %</td>
</tr>
<tr>
<td>June</td>
<td>1.9 %</td>
</tr>
</tbody>
</table>
As in the prior year, clusters of training injuries in the 2015/16 season were seen in the main preparatory months of July, August, and January, which can be explained primarily by an increase in the training exposure and therefore a higher proportion of training time compared to the other months. However, the fact that the first three months of the season were associated with the highest proportions of match injuries leaves room for speculation whether the training load in the partly very short preparatory periods was actually well managed. This should be critically questioned – also in regards to the game plan design of the national and in particular the international associations.

Competition
»Wing players incur ankle injuries more often, pivot players sustain more head injuries!«
Ankle and knee injuries were at the top of the list in the prior year and continued to represent the most frequently injured body regions in 2015/2016. Proportionately however they decreased slightly along with thigh, hand, and shoulder injuries that followed in the rankings. This leads to a much more homogenous distribution among the body regions compared to what is seen in the three other sports, where a clear injury focal point stands out in each case.

No differences were noted between the two leagues regarding the body regions. The significant cluster of ankle injuries in training (16.9%, competition 10.0) that was already observed in the prior year was however striking. This may be due to a lower rate of wearing external ankle stabilization in training. The higher number of repeated throw, block, and duel situations in training that typically lead to ankle injuries surely plays a role as well. Head injuries on the other hand were considerably underrepresented in training at 5.5% (competition 8.8%), which may be linked to more considerate behavior during duels in training.

Considerably more head injuries (9.6%) and elbow injuries (6.5%) were recorded among pivot players than in the group as a whole. Presumably, the specific requirements profile of the pivot player position is partly responsible for his, being associated on the one hand with the highest number of duels and collisions with regular as well as irregular body contact (risk of head injury) and also the largest number of dive shots (risk of elbow injury). Wing players on the other hand sustain significantly more ankle injuries (18.4%). This is likely due mainly to jumps and landings during outside corner shots. Often an opposing player runs down the wing player, which is associated with a risk of foot-foot collision, or there is interference contact in the air where the subsequent landing in the goal area constitutes a critical situation.

»Match injuries were observed in particular during the first three months of the season!«
Downtime and costs

When the downtime and benefits caused by handball injuries are examined as indicators for the possible severity of injury in addition to the frequency as such, knee injuries – notwithstanding a slight decrease in the number of cases and downtime – emerge as the key injury focal point in handball, as in the previous season.

This body region accounted for 13.2% of the injuries in the 2015/2016 season. However, they accounted for 34.8% of the days missed and 40.7% of the benefits.

Ankle, shoulder, and hand injuries followed at a considerable distance for 2015/16 in this regard. Lower leg injuries also increased markedly and therefore surpassed thigh injuries. These increases are largely explained by a small number of costly Achilles tendon rupture cases with extended downtime in the season under review.

The injury “hot spots” that are especially relevant for prevention will be illustrated in greater detail on the following pages along with their causes and injury mechanisms.

Head injuries are also included in the hot spots in this edition due to the key issue of craniocerebral injuries. These are subsequently analyzed in more detail, even if they would otherwise not have been included in the hot spots based on frequency or downtime and costs.

»Knee injuries remain the biggest problem in handball, followed by ankle, shoulder, and hand injuries.«
Handball Injury “hot spots”

- **Head injuries in handball:** 7.0 %
  - Thereof:
    - Contusions: 9.9 %
    - Lacerations: 23.1 %
    - Fractures: 14.0 %
    - Ruptures: 11.1 %
    - Luxations: 9.1 %
    - Distorsions: 35.4 %

- **Shoulder injuries in handball:** 9.3 %
  - Thereof:
    - Contusions: 22.2 %
    - Fractures: 20.7 %
    - Ruptures: 7.6 %
    - Luxations: 6.5 %
    - Distorsions: 38.9 %
    - Other: 4.3 %

- **Knee injuries in handball:** 13.2 %
  - Thereof:
    - Contusions: 33.5 %
    - Fractures: 38.9 %
    - Ruptures: 17.9 %
    - Other: 6.0 %
    - Distorsions: 42.6 %

- **Ankle injuries in handball:** 13.8 %
  - Thereof:
    - Contusions: 61.8 %
    - Fractures: 33.5 %
    - Ruptures: 5.1 %
    - Other: 33.1 %

- **Craniocerebral injuries:** 11.9 %
- **Lacerations:** 23.1 %
- **Dental injuries:** 14.0 %
- **Other injuries:** 2.0 %
- **Muscle strain:** 14.6 %
- **Shoulder injuries:** 9.3 %
- **Hand injuries:** 9.9 %
- **Distorsions:** 35.4 %
- **Knee injuries:** 13.2 %
- **Ankle injuries:** 13.8 %
- **Other injuries:** 2.0 %
- **Muscle strain:** 14.6 %
Causes, mechanisms, and injury situations in handball

Injury location on the playing field
Proportion (%) of the injuries

<table>
<thead>
<tr>
<th>Injury Location</th>
<th>Offense (%)</th>
<th>Defense (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2%</td>
<td>3.7%</td>
<td>9.4%</td>
</tr>
<tr>
<td>3.1%</td>
<td>1.0%</td>
<td>5.4%</td>
</tr>
<tr>
<td>1.2%</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>1.5%</td>
<td>1.7%</td>
<td>2.3%</td>
</tr>
<tr>
<td>0 – 5.0%</td>
<td>5.1 – 10.0%</td>
<td>10.1 – 15.0%</td>
</tr>
<tr>
<td>5.1 – 10.0%</td>
<td>10.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>10.0%</td>
<td>15.1 – 20.0%</td>
<td>&gt; 20.0%</td>
</tr>
</tbody>
</table>

1 Video analysis of match injuries 2010–2016 (n = 484)
The central offense zones, in particular the central free throw zone, are the areas of the playing field where the most injuries occur. This is where the most risky game actions with the ball, such as duels and throws, typically occur. Landings after jumps, regardless of the handball-specific game action, were by far the most common movement pattern triggering an injury.

While slightly more injuries occurred in the second half of the game (52.3%) than in the first half (47.7%), this difference is not statistically significant based on the available data. It is striking however that significantly more injuries occur in the last ten minutes of each half, and in particular during the final ten minutes of play.

There are two possible causes for this. Many handball games are not decided until the final ten minutes, so that more intensive duels could favor the occurrence of injuries. However, we were not able to find any increase in contact injuries or injuries after an opposing foul in the last ten minutes. Insofar fatigue would have to be included at least as an accompanying parameter here. Neuromuscular fatigue processes can among other things have a negative effect on the movement quality in technically complex sequences such as landings of jump shots with opposing interference contact, so that the movement patterns of the players become less physiological. Furthermore, it can be assumed that the perception performance and processing decrease with increasing fatigue, so that critical contact situations are no longer anticipated as well compared to the non-fatigued state.
»Only every fifth injury is due to an opposing foul!«
Attacking players sustain injuries noticeably more often overall than defending players. This applies equally for fast break play and set offense. It is likely that the higher cognitive and motor demands placed on attacking players are primarily responsible for this. In particular, the fact that the intensity and direction of the contact typical for handball is usually determined by the defending player, and therefore much more difficult for the attacker to allow for in executing movement patterns, likely plays a role here.

While back court players sustain an injury more often in the offensive end (61.0%), wing players are significantly overrepresented in fast break play (25.6%) and pivot players in the set defense (39.7%), especially in duels. Goalkeepers as expected get injured exclusively in defensive phases, usually during saves.

"Fatigue is a key risk factor! The largest number of injuries occurs in the final ten minutes of each half!"
Game action of the injured player at the time of injury
Proportion (%) of the injuries

**Injury mechanism by injured body region**
Proportion (%) of contact, indirect contact, and non-contact injuries
Nearly 80% of all injuries result directly during actions with the ball or against the ball, that is when the ball is with the injured player or the direct opponent.

Intensive body contact is a central element of the game in handball, especially during the numerous duels and breakthrough actions. Insofar it is no wonder that slightly more than half (52.3%) of the injuries are due to direct contact with another player or with the ball. From a preventive point of view it is therefore essential to athletically, technically, and mentally prepare the players for this unavoidable risk. Studies of other contact sports such as rugby show that there is preventive potential even in the area of duel contact injuries, for example through improved athleticism, technique, and also an understanding of the situation and the conduct during duels. It also seems wise that at least pivot players who have the highest risk of head injuries should play only with an individually fitted mouth guard.

On the other hand, 47.7% of the injuries are due solely to indirect contact or even non-contact mechanisms. Typically these are especially the severe knee injuries with extended downtime or muscular injuries in the area of the thigh and lower leg musculature. These are injuries in which intrinsic factors play an essential role in the occurrence of injury. A particularly high number of previous injuries, but also fundamental athletic or regenerative deficits, must be mentioned as risk factors here among professional players. The combination of these aspects can be observed in particular during the reintegration of players after they have sustained an injury. Insufficiently rehabilitated players often return to the playing field much too soon and without progressive adaptation training, and suffer a recurring or subsequent injury.

The large number of contact injuries notwithstanding, only about every fifth injury is associated with an opposing foul. When the “stop fouls” typical for handball in defense are taken out and only the situations that are actually penalized by the referee with a yellow card, 2-minute suspension, or red card are examined, only every ninth injury is in fact due to a foul that incurs a penalty.
As previously indicated, the injury mechanisms and fouls vary considerably depending on the injured body region. Head and hand injuries in particular are observed almost exclusively in contact situations. While a foul plays a role in 41.5% of the head injuries, typically an impact with the hand, forearm, or elbow, hand injuries tend to be caused by unintentional contact during throws, duels, or blocking actions. Collisions frequently occur here with the upper limbs or torso of the opposing player.

Shoulder injuries even more so than head injuries are most commonly seen in the context of an opposing foul (43.9%). Aside from unintentional shoulder-shoulder or shoulder-torso collisions in duels, pulling/holding the throwing arm during a throw as well as falls onto the shoulder or the extended arm after impacts in the airborne phase mainly need to be mentioned here.

While ankle injuries were more frequently contact injuries, as in basketball, they typically did not involve a foul with landings on the foot of the fellow or opposing player.

See the table on page 99 for other typical injury situations for the hot spots.

»Knee and muscle injuries in particular have a high preventive potential!«
## Typical injury situations in handball

| Body region | Type of injury                                                                 | Mecha-
|------------|--------------------------------------------------------------------------------| nism | Foul | Cause                                      | Movement pattern                        | Game action                        |
| Head       | Cranioencephalic injury, facial fracture (especially nasal bone fracture), cranial contusion | Contact | Frequent | Hitting (by) opposing player (with upper limbs) | Running, standing, airborne phase | Duel/1-on-1, throw |
|            |                                                                                 |          | Occasional | Collision with ball | Standing, airborne phase | Save (goalkeeper), block (field player) |
| Shoulder   | Shoulder subluxation/dislocation, AC joint separation, AC joint sprain, muscle injury of the rotator cuff | Contact | Occasional | Collision with opposing player (shoulder-shoulder collision, shoulder-torso collision) | Running | Duel/1-on-1 |
|            |                                                                                 |          | Frequent     | Pulling/holding opposing player | Airborne phase | Throwing |
|            |                                                                                 |          | Indirect contact | Pushing (by) opposing player + fall | Landing | Throwing |
| Hand       | Metacarpus fracture, finger/thumb fracture, finger/thumb dislocation            | Contact | Rarely       | Collision with opposing player (with upper limbs, especially hand/with torso and hip) | Running, standing, airborne phase, stopping | Throwing, duel/1-on-1, block |
|            |                                                                                 |          | No           | Collision with ball | Standing, airborne phase | Save |
| Thigh      | Muscle strain, ruptured muscle fibers                                          | Non-contact | No | Structural overload | Running, sprinting, cutting, lunge (goalkeeper) | Not specific (field player), save (goalkeeper) |
| Knee       | Partial or total rupture or distortion of the medial collateral ligament       | Contact | Rarely | Collision with fellow or opposing player (knee-knee collision); fall into the knee | Standing, landing, stopping, running | Duel/1-on-1, throwing, screening |
|            | Partial or total rupture or distortion of the anterior cruciate ligament, knee joint distortion | Indirect Contact | Occasional | Pushing (by) opposing player, holding/pulling opposing player, collision with opposing player + twisting | Landing, utting, running | Throwing, duel/1-on-1 |
|            |                                                                 | Non-contact | No | Structural overload | Cutting, landing, stopping | Faking, throwing (field player), save (goalkeeper) |
| Lower leg  | Muscle strain, ruptured muscle fibers, partial or total rupture of the Achilles tendon | Non-contact | No | Structural overload | Starting, jumping, landing, running | Not specific |
| Ankle      | Partial or total rupture, distortion of the lateral ligaments                  | Contact | No | Collision with opposing player (foot-on-foot collision) | Landing, running | Throwing, block, duel/1-on-1 |
|            | Indirect contact                                                               | Frequent | Pushing (by) opposing player + spraining | Landing | Throwing |
|            | Non-contact                                                                    | No | Spraining | Cutting, landing | Faking, throwing (field player), save (goalkeeper) |
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