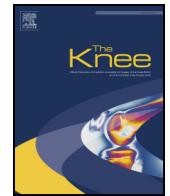




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## The Knee



## Anterior cruciate ligament ruptures in German elite soccer players: Epidemiology, mechanisms, and return to play

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## ABSTRACT

**Background:** Anterior cruciate ligament ruptures (ACLs) are severe sports-related injuries with significant consequences for affected players and teams. This study aims to identify the epidemiology and injury-related lay-off after ACLR in professional male soccer players from the first-division German Bundesliga.

**Methods:** Exposure times and incidence of anterior cruciate ligament ruptures were collected during 7.5 consecutive seasons using two media-based registers.

**Results:** A total of 72 total ACLRs were registered in 66 different players with an incidence of 0.040 per 1000 h of exposure (95% CI 0.009–0.12). On average there were 9.6 ACLRs per season and 0.53 per team and season. The mean age of players affected was 24 (standard deviation  $\pm$  3.6) years. The number of ACLRs recorded per season fluctuated during the period observed. Goalkeepers are significantly ( $P < 0.05$ ) less prone to suffer an ACLR compared to outfield players.

**Conclusions:** Understanding ACLR loading mechanisms, knowing risk factors for the injury and mean off time after ACLR are essential information for the coach, the medical staff, the elite soccer players, the insurance and team managers. Our results are in accordance with reports based on information from medical team staff. Therefore, our analysis of ACLR based on media sources may serve as an alternative for injury reports in elite soccer. The information of this study may be helpful for the medical staff taking care of professional soccer players and for orthopedic surgeons performing ACL reconstructions in this patient population.

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### 1. Introduction

Injuries have a considerable influence on the performance of professional soccer players [1–3]. During recent years, several studies have evaluated incidences and patterns of injuries in recreational [4,5] and professional soccer players [6–10]. Soccer-related knee injuries are as frequent as they are serious for affected players and teams. An injury that draws particular attention is anterior cruciate ligament rupture (ACLR) [11], as it bears the risk of serious long-term consequences, including instability, loss of performance, and osteoarthritis [12]. Fortunately, there is growing knowledge of the prevention of ACLR in soccer [13–15].

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In professional soccer players, the incidence of ACLR is higher compared to recreational athletes [16,17]. A complete tear causes long injury lay-off [2] and may even be career-ending [18]. The injury-related lay-off time is an important factor after an ACLR and various studies have focused on return to play after ACLR and ACL reconstruction [19–21]. Also, there is limited knowledge about potential risk factors for ACLR in soccer. It seems that young age, female gender [22–24], and competitive play are associated with higher rates of ACLR injuries [11,25]. The first-division German Bundesliga is one of the most popular soccer leagues in the world. The question of whether there is a difference in the incidence of ACLR and return to soccer after ACLR between the first division German Bundesliga and other professional soccer leagues remains unanswered. Thus far, there is no published data on the epidemiology and circumstances of ACLR available for the first division German Bundesliga. The information drawn from media-based registers seems to be the most reliable source of information on injuries of professional soccer players. Direct injury reports by the affected teams could potentially be biased due to lack of reporting compliance [26].

The main objectives of this study were to analyze the epidemiology and circumstances of anterior cruciate ligament tears in German elite soccer players, the time until return to play after an ACLR, and correlations between the playing position and ACLR incidence.

## 2. Patients and methods

### 2.1. Study design

In this retrospective cohort study, male professional soccer players from one of the 18 teams of the first division German Bundesliga who suffered an anterior cruciate ligament rupture between July 2009 and December 2016 were included (Table 1). Players without a professional contract were not included. Data collection was based on the registers of kicker.de® and transfermarkt.de®. These are two open-source sports databases that were selected due to the information of injuries per player in a longitudinal manner. The media- data-based registers used are crucial sources of information for investors and calculations of odds for the betting industry in German soccer. All 18 teams of the first division German Bundesliga release information to public media that is collected in those two media-based registers. Staff members of these registers analyze the data systematically. We made no direct comparison of these databases, however the information on injuries did not differ between the databases. The data from transfermarkt.de® provide special information about lay-off time and the data from kicker.de® provide special information about circumstances from ACLR (e.g., contact vs. non-contact). Since no exact information on the exact duration of practice sessions is available for all calculations it was assumed that the overall duration of practice sessions is about five sessions of 90 min and does not differ between the teams. All German soccer teams included do not perform practice sessions on Mondays. On Tuesdays, two practice sessions of 90 min each are conducted. During the rest of the week (Wednesday to Friday) practice is conducted once daily for 90 min, while Saturday or Sunday is match day. This weekly schedule is subject to modification depending on match days and other factors.

Data for all teams from the 2009/10 season through the first half of the 2016/17 season, including the pre-seasons, were analyzed. The study was approved by the local ethics review board and written consent by kicker.de® as well as transfermarkt.de® was obtained.

### 2.2. Injury definition

All ACLRs that occurred during practice or competition in the first division German Bundesliga that were reported on kicker.de® or transfermarkt.de® were collected. The day of injury was defined as the day the player was not able to take part in soccer training or match play for at least one day beyond the day of injury. Unrestricted practice was assumed as soon as the soccer player was taking part in full contact training with the team.

An ACLR was defined as a report about a tear of the anterior cruciate ligament in the database. The time to return to soccer was defined as the number of days between injury and unrestricted practice with the team. This information was adopted from transfermarkt.de®.

Incidents were considered as a match injury if reported on the same day or the day after a match where the player was actively involved [10]. A non-contact injury is defined as an injury mechanism without the interference of another player.

**Table 1**

Anterior cruciate ligament rupture demographics.

Season	All players	Mean age	n	ACLRs per 1000 exposure hours (95% CI)
2009/10	612	23.7	15	0.054 (0.03–0.11)
2010/11	580	23.9	7	0.027 (0.009–0.07)
2011/12	584	23.6	6	0.023 (0.01–0.09)
2012/13	569	23.6	7	0.037 (0.01–0.08)
2013/14	599	23.6	15	0.050 (0.03–0.10)
2014/15	574	23.7	14	0.054 (0.03–0.12)
2015/16	602	23.7	5	0.020 (0.01–0.09)
2016/17 (1.H)	520	25.5	3	0.026 (0.02–0.08)

ACLRs, anterior cruciate ligament ruptures; CI, confidence interval; 1.H, first half of the season.

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