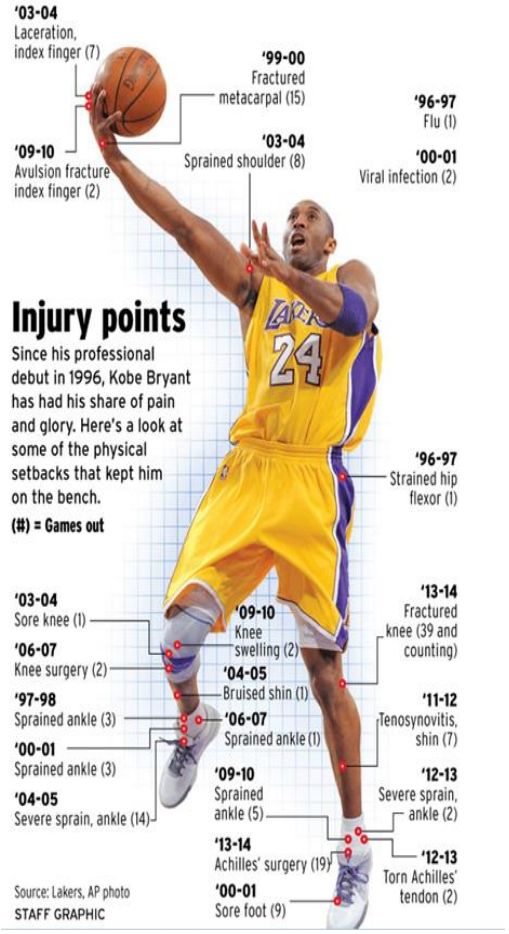
Module 4. The most frequent injuries - types and mechanisms - in basketball

Unit 4.1 Most frequent injuries (types and mechanisms) in basketball and maximum demand scenarios in basketball

Injuries are a recurrent topic in this sport. It is a constant that occurs at all levels and that, above all, affects the professional level, in which the highest performance takes place. A clear example is Kobe Bryant, one of the best players in the history of this sport. During his sports career, this player has suffered a large number of injuries of different severity and in different anatomical areas. This leads us to consider, on the one hand, the level of physical contact and on the other hand, the great demands that this sport presents from the point of view of sports performance.

Figure 1: Kobe Bryant's injuries



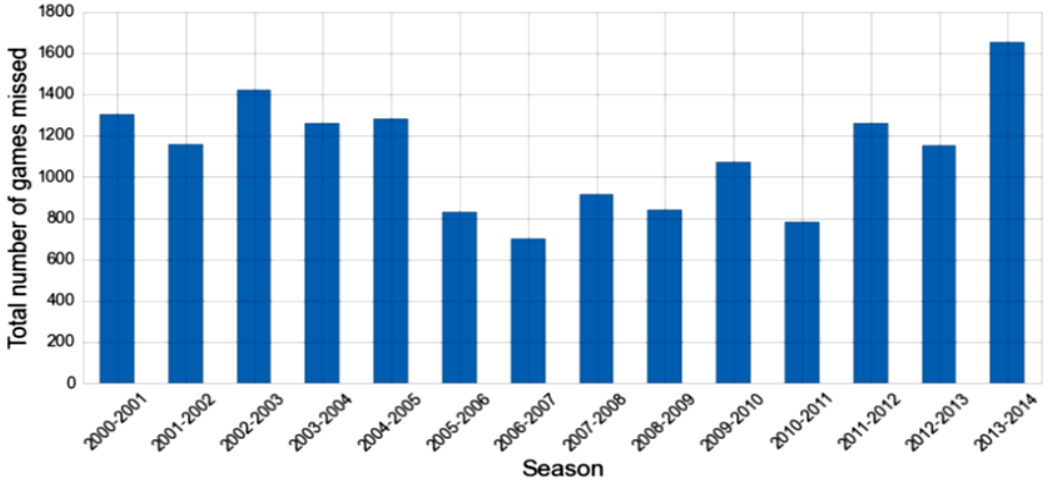
Source: Newport, 2014, https://bleacherreport.com/articles/1991934-infographic-breaks-down-kobe-bryants-injuries-by-body-part.

In sports terms, injuries are extremely relevant both for players and for teams and leagues. The economic cost that this aspect entails - as a result of medical treatments, rehabilitation and the implications of facing competitions without these players, among other factors - should not be neglected.

The NBA, for example, has revealed that DeMarcus Cousins' injuries have cost the player approximately US$150 million. This shows that the economic loss due to injuries affects not only teams and leagues, but also athletes themselves (Gozlan, 2019).

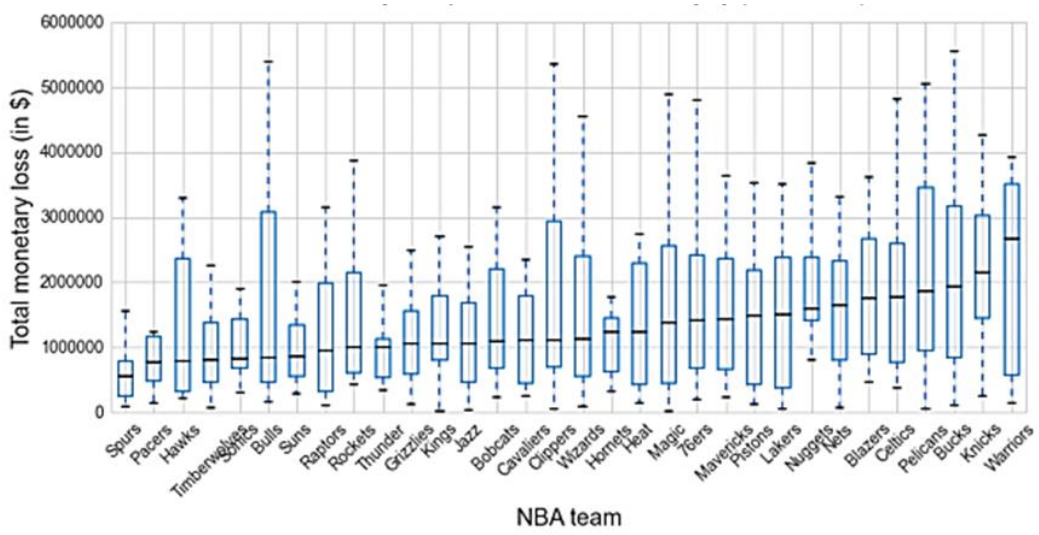
Thus, for example, it is possible to establish (in terms of millions of dollars) the losses of the teams, due to their players' absences to training and games, especially when this involves the stars of those teams.

Figure 2: Total number of games missed due to injury in the NBA in different seasons



Source: adapted from Manonelles Marqueta and Tárrega Tarrero, 1998.

Figure 3: Total monetary loss due to injuries between 2000 and 2015

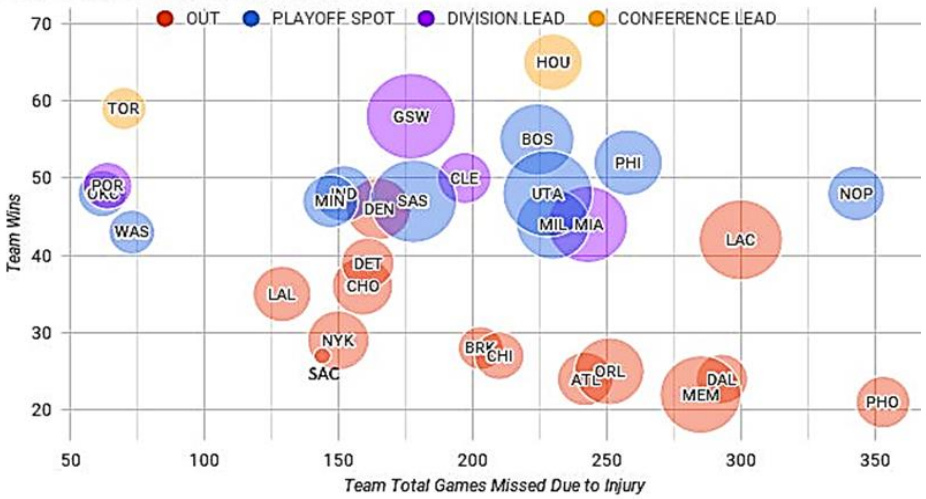


Source: adapted from Manonelles Marqueta and Tárrega Tarrero, 1998.

The previous Figure refers specifically to the salary loss of a player who has a contract but does not participate in competition because of being injured. The range of team losses encompasses from US$ 10 to US$ 50 million per team.

Another interesting analysis is the one shown in Figure 4, in which the team's performance (in won games) is related to the injuries that its members have experienced. At the same time, the graph shows the position of the team in the ranking.

Figure 4: Relationship between victories and injuries



Source: ManGamesLostNBA [usuario], 2016, https://twitter.com/mangameslostnba?lang=es.

In the 2017 and 2018 season, the Golden State Warriors were the 13th team in the ranking of lost games due to injuries. All the players considered together missed up to 161 games throughout the season. At the same time, they were in the 14th position in relation to lost minutes per game, with a total of 3,700 lost minutes. As for the loss in millions of dollars, they were ranked 25th in the NBA, with a total of US$ 26.3 million lost due to injuries suffered along the season. In that season, Steph Curry suffered two injuries at both the ankle and knee levels.

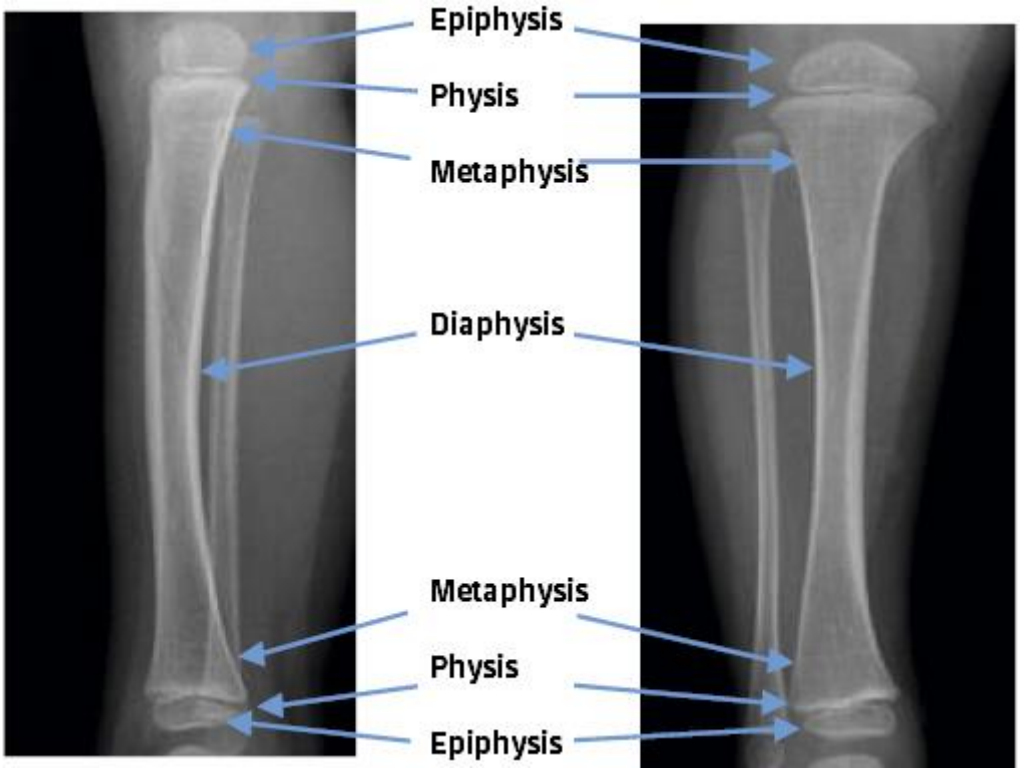
To continue, this section will deal with injuries in different categories, according to training ages. The difference between men's and women's basketball injuries and professional basketball injuries will be addressed.

The great forces produced by players when moving on the basketball court have already been mentioned in previous modules. If these movements are repeated many times, they can exert enough stress to cause injury. For example, it is known that after an entry into the basket we can get up to almost nine times the player's body weight.

At training ages, it is important to know which injuries tend to occur most frequently, as well as their incidence. Some characteristics of children make them more vulnerable to certain types of injuries than adults. The existence of an open physis in young people can

lead to fractures instead of sprains, which are often observed in adults. And pulling a tendon near a growth centre can result in traction overuse injuries such as the well-known Osgood Schlatter disease.

Figure 5: Bone anatomy



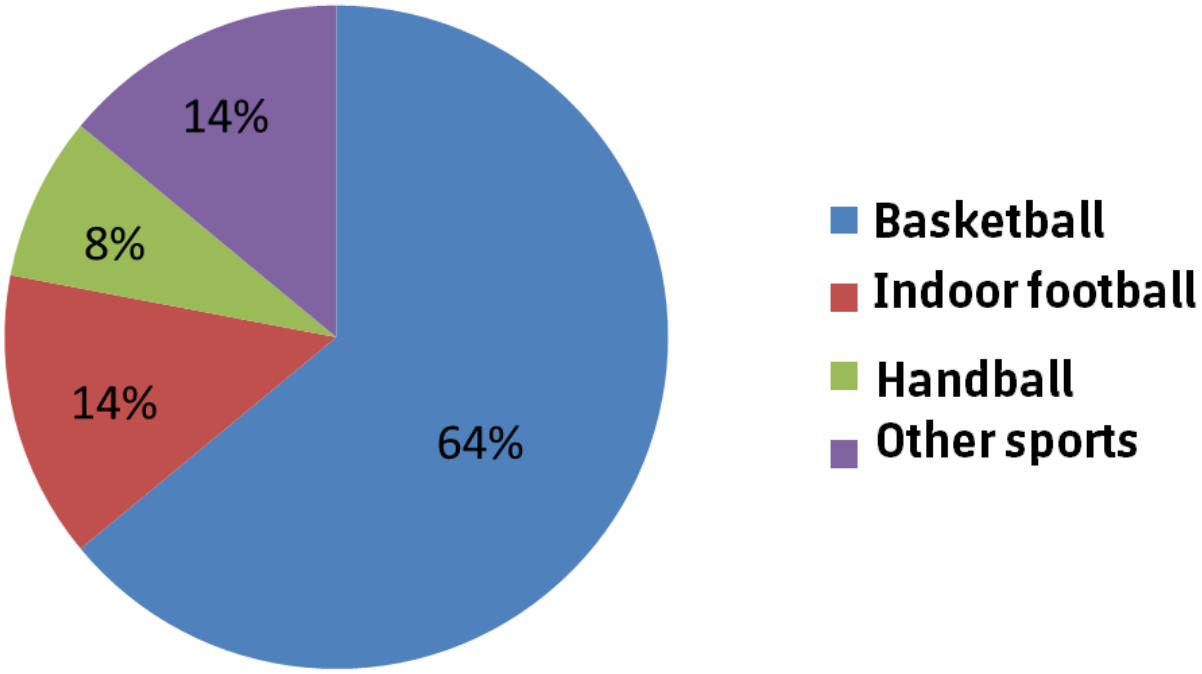
Source: López Olmedo, 2019, https://www.pediatriaintegral.es/publicacion-2019-06/fracturas-infantiles-mas-frecuentes-esguinces-y-epifisiolisis/.

Next, there is a brief description of the physis as well as the so-called **growth cartilage**. It is the growth plate or epiphyseal plate, an area located in the metaphysis, which is the area of the long bones located between the central region (diaphysis) and the extremes (epiphysis). In the rapidly growing child, the imbalances produced due to the different proportions of bone and soft tissue growth can lead to a loss of range of motion, flexibility, and coordination.

In the year 2002, more than 207,000 children ages 5 to 14 were treated in emergency care rooms for basketball injuries. 15% of children that age have suffered an injury while playing basketball. Injuries related to this sport, which in the past were observed in professionals or older people, are increasingly common in young people (Gaca, 2009).

In other words, injuries that were more typical of professional, senior or adult players tend to occur before in time. If we resort to the data provided in Spanish basketball and review the injuries produced in the community of Aragón between 2000 and 2003, 64% of them were related to basketball, 14% to indoor football, 8% to handball and 14% to other sports.

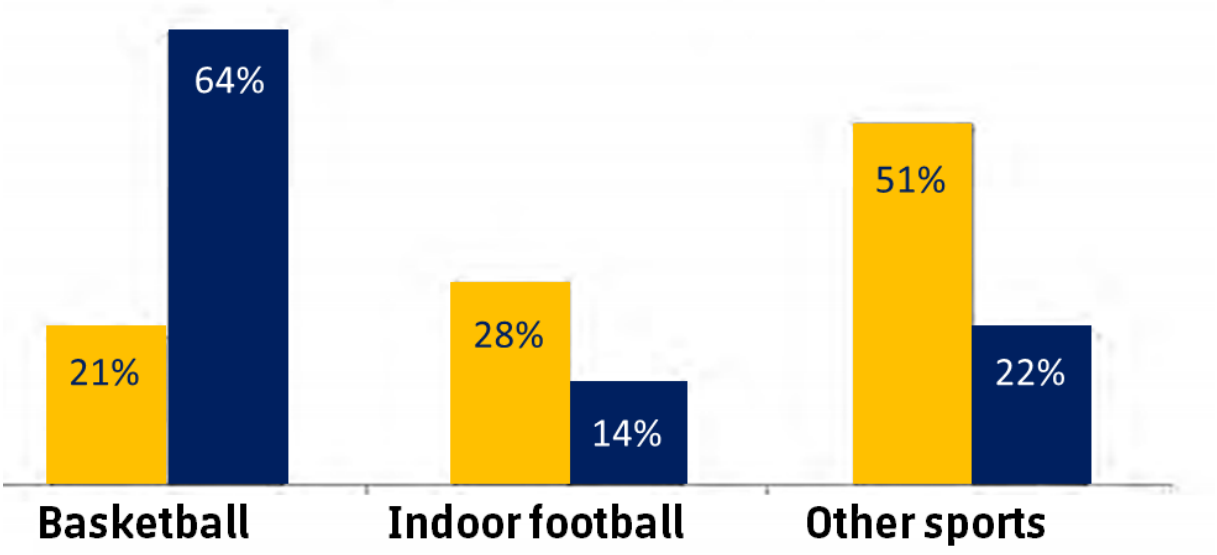
Figure 6: Distribution of sports injuries (2000-2003)



Source: Author's production based on: Dirección General del Deportes del Gobierno de Aragón, 2004, p. 14.

The fact that the percentage of children who play basketball is low compared to those who practice other sports highlights the importance of the scores displayed in the previous Figure. Therefore, the high percentage of injuries at basketball training ages should serve as a warning on the importance of this issue for our sport.

Figure 7: Comparison of accident rates by sports groups



Source: Author's production based on: Dirección General del Deportes del Gobierno de Aragón, 2004, p. 65.

There are other studies that indicate a much lower incidence of injuries on these ages. Gutgesell, in a study of 510 children between the ages of 5 and

12, found a total of 39 injuries, which show an incidence of injuries of 7.6%, a very similar number to that observed in Aragonese school basketball, which prevails among females. This number does not include significant injuries and apparently does not describe any injury due to overload. The injuries include contusions (35.9%), tugs or sprains (28.2%), epistaxis (12.8%), lacerations (5.1%) and the fracture of a finger (2.6%), These findings suggest that the research has been conducted in a group with a very low level of dedication to basketball. (Dirección General de Deportes del Gobierno de Aragón, 2004, p. 29) (General Directorate of Sports of the Government of Aragon, 2004, p. 29)

Another study, in this case, an epidemiological research study was conducted on American basketball athletes in schools. 318 players were examined over two years. In that period, 215 injuries occurred. These resulted in 1508 days of absence. The proportion of injured players was 44.7%. About 70% of injuries occurred during training and the remaining 30%, in competition.

Table 1: Ratio and degree of severity of injuries according to anatomic areas

Body region	Time loss of fewer than 7 sessions		Time loss of 7 or more sessions	
	Injuries	Rate	Injuries	Rate
Ankle	44	1.01	9	0.21
Knee	27	0.62	11	0.25
Thigh	19	0.44	1	0.02
Foot	11	0.25	6	0.14
Head	12	0.28	1	0.02
Hand	8	0.18	3	0.07
Leg	9	0.21	1	0.02
Lumbar spine/pelvis	9	0.21	1	0.02
Shoulder	7	0.16	3	0.07
Concussion	8	0.18		
Hips	7	0.16		
Other[b]	17		1	0.02
Total	178	4.09	37	0.85

[a] Injury rate per 1000 athlete-exposures based on denominator of 43,514 exposures.
[b] Other includes all other body areas with fewer than five injuries, including the multiple injury category.

Source: Meeuwisse, Selmer and Hagel, 2003, p. 380.

Meeuwisse, Selmer and Hagel (2003) analysed the body areas in which the injuries occurred. The ankle was the area of the body that suffered the most, with 44 injuries and a ratio of 1.01 compared to 27 injuries to the knee and a ratio of 0.62. These data correspond to injuries that required less than seven absences to training sessions. The same graph (Table 1) shows data for injuries that required more than seven missed training sessions.

Table 2, in turn, shows the recurrence of specific injuries, of which the ankle sprain is the most recurrent, with a total of 34 cases, which represents 15% of the total amount of injuries.

Table 2: Most common injuries in basketball

Specific injury	Total	Percentage of total
Ankle sprain	34	15.8
Thigh strain	12	5.6
Concussion	8	3.7
Quadriceps contusion	7	3.3
Iliopsoas strain	5	2.3
Knee contusion	5	2.3
ACL complete tear, acute	4	1.9
Other	140	65.1
Total	215	100.0

Source: Meeuwisse Selmer and Hagel, 2003, p. 381.

In our context, it is also important to familiarize oneself with the injurious mechanism. That implies whether, at the time of the injury, there was contact or not. The contact injuries observed were 77 (representing a ratio of 1.77), 63 of which were due to contact with other players (a ratio of 1.45), while 5 episodes occurred due to contact with the floor (a ratio of 0.12). These data have to do with the injuries that generated less than 7 missed training sessions.

Table 3: Contact and non-contact injury mechanisms

Mechanism	Time loss of fewer than 7 sessions		Time loss of 7 or more sessions	
	Injuries	Rate	Injuries	Rate
Contact	77	1.77	18	0.41
Another player	63	1.45	12	0.28
Floor	5	0.12	1	0.02
Basketball	2	0.05	1	0.02
Rim	2	0.05	0	
Nonspecific	5	0.12	4	0.09
Noncontact	6	0.14	12	0.28
Other	92	2.11	10	0.23
Total	175	4.02	40	0.92

Source: Meeuwisse Selmer and Hagel, 2003, p. 381.

In turn, the injuries that did not involve contact were 6, therefore, which exemplifies the great difference that exists in the prevalence of contact injuries in relation to non-contact injuries.

Another important factor to take into account when analysing basketball injuries has to do with the injured anatomical area. In this study, the highest number of injuries affected the ankle (53) with the knee occupying the second position (38). It should be noted that the total number of training sessions missed due to ankle injuries was 290, while knee injuries produced a total of 693 absences from training sessions.

Table 4: Relationship between number of injuries and missed sessions due to injury

Body region	Total number of injuries	Total sessions lost	Average time loss (days/injury)
Ankle	53	290.0	5.47
Knee	38	693.5	18.25
Thigh	20	84.5	4.23
Foot	17	133.0	7.82
Head	13	23.0	1.77
Hand	11	62.0	5.64
Shoulder	10	55.5	5.55
Lumbar spine/pelvis	10	50.5	5.05
Leg	10	54.5	5.45
Concussion	9	14.5	1.61
Hips	7	13.0	1.86
Multiple injuries	5	11.0	2.20
Wrist	4	6.5	1.63
Thoracic spine/ribs	4	7.0	1.75
Elbow	3	1.5	0.50
Arm	1	8.0	8.00
Total	215	1508.0	6.98

Source: Meeuwisse Selmer and Hagel, 2003, p. 381.

There are two observations in relation to the previous Table: on the one hand, the number of sessions missed due to ankle or knee injuries is excessively high in basketball. On the other hand, it is essential to highlight that knee injuries usually entail a longer rehabilitation process, which is why the number of training sessions missed due to this type of injury is so great in relation to absences due to ankle injury, especially considering that the number of ankle injuries in this case study was 1.5 times greater.

The following Table analyses the zones of the court where most of the injuries occur. As it turns out, it is the key, that is, the painted area. This should come as no surprise, since it is the place on the court where the most contacts between players take place. Of the total number of injuries (178), 81 occurred on the key.

Table 5: Zones of the court and injuries

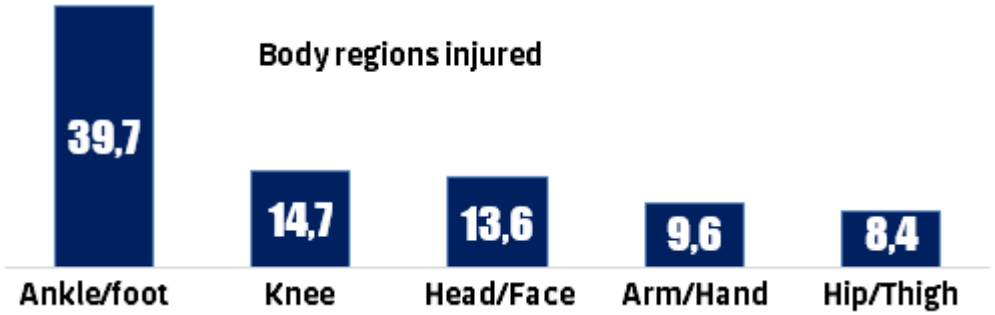
Zone	Time loss of fewer than 7 sessions		Time loss of 7 or more sessions	
	Injuries	Rate	Injuries	Rate[a]
The key	81	1.86	15	0.34
Midcourt	12	0.28	2	0.05
3-point line	7	0.16	5	0.11
Center	8	0.18	3	0.07
Out of bounds	5	0.12	2	0.05
Blank or N/A	65	1.49	10	0.23
Total	178	4.09	37	0.85

Source: Meeuwisse Selmer and Hagel, 2003, p. 381.

Another descriptive epidemiological investigation analysed injuries suffered by basketball players of different nationalities. Players belonging to the United States university league were studied from the 2005 to the 2007 seasons. The players included in the study

suffered a total of 1518 injuries, with a ratio of 1.94 injuries every 1000 hours of exposure. The competition rate was 3.27 per 1000 exposures. Regarding training, it was 1.40 (Borowski, Yard, Fields and Comstock, 2008).

Figure 8: Body regions injured in high-school basketball (2005-2007)

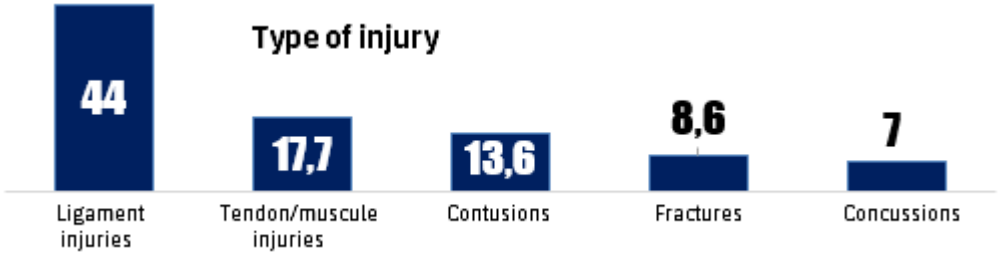


Source: adapted from Borowski, Yard, Fields y Comstock, 2008.

Once more, the body areas that suffer the most injuries are the ankle or foot (39.7% of injuries), then the knee (14.7%), the head or the face (13.6%), the arm and the hand (9.6%) and, lastly, the hip or thigh (8.4%).

It is useful to distribute the percentage of injuries according to the type of injury that was suffered. They may be: ligament injuries (44%), tendon / muscle injuries (17.7%), contusions (13.6%), fractures (8.6%) and concussions (7%). Tendons, ligaments and muscles are most frequently injured and the most important areas according to this study (Borowski, Yard, Fields and Comstock, 2008).

Figure 9: Injuries according to tissue



Source: adapted from Borowski, Yard, Fields y Comstock, 2008.

This same article shows the time lost by the players, both due to injuries that occurred in competition and in training (Figure 10). As the fundamental conclusion, the authors state that the injury patterns in high school basketball due to exposure time suggested the great importance of working on injury prevention. In other words, these data are useful to establish programs that cater for the prevention of injuries.

Table 6: Loss of time from sports practice according to different injuries

	Competition	Practice
Time loss		
Returned to activity in <1 week	52.6	50.1
Returned to activity in 1-3 weeks	28.6	31.4
Returned to activity in >3 weeks	6.9	9.2
Medical disqualification/player released from team or chooses not to return	10.9	8.2
Other	0.9	1.0
Total	100	100
Need for surgery		
Yes	8.1	6.9
No	91.9	93.1
Total	100	100

[a]Data are in percentages.

Source: Borowski, Yard, Fields and Comstock, 2008, p. 2333.

In their research paper, Manonelles Marqueta and Tárrega Tarrero (1998), analysed 17 ACB players. In the season of '93/'94, there were 282 injuries. They analysed the injured anatomical structure, which shows that the lower extremities suffered 130 injuries (of the 282 analysed ones). Out of these, 84 occurred in the ankle and foot, 40, in the knee and 6, in the leg. They registered 37 injuries in the upper extremities, with the hand suffering the most (22 injuries). The trunk suffered 52 injuries and the head, 20. 42 muscular pathologies were found, together with 2 bone pathologies due to stress.

Table 7: ACB anatomical area of injuries

TABLA 1. LESIONES POR ESTRUCTURAS ANATÓMICAS Nº jugadores protocolizados: 217 (86% del total de la liga A.C.B. Temporada 93/94) Nº total de lesiones: 282		
ESTRUCTURA ANATOMICA	Nº	%
EXTREM. INFERIORES	**130**	**46.13**
Pierna	6	2.13
Rodilla	40	14.2
Tobillo/pie	84	29.8
EXTREM. SUPERIORES	**36**	**12.76**
Antebrazo	1	0.35
Codo	2	0.71
Hombro	10	3.55
Mano	22	7.80
Muñeca	1	0.35
TRONCO	**52**	**18.39**
Cadera/pelvis	9	3.19
Raquis	43	15.2
CABEZA	**20**	**7.09**
PATOLOGIA MUSCULAR	**42**	**14.9**
PAT. OSEA POR STRESS	**2**	**0.71**
Tomado de Protocolo lesional A.E.M.B.[1]		

Source: Manonelles Marqueta and Tárrega Tarrero, 1998, http://femede.es/documentos/Epidemiologia_lesiones_baloncesto_479_68.PDF.

Regarding NBA teams, Manonelles Marqueta and Tárrega Tarrero (1998) analysed data from the '88 and '92 NBA seasons. They found a total of 3,711 injuries in this period. The most affected anatomical areas were very similar to those of ACB players. Thus, there were 2,130 injuries to the lower extremities (57.3%). The ankle was once more the most affected area, with 537 suffered injuries; and the knee was the second, with 350.

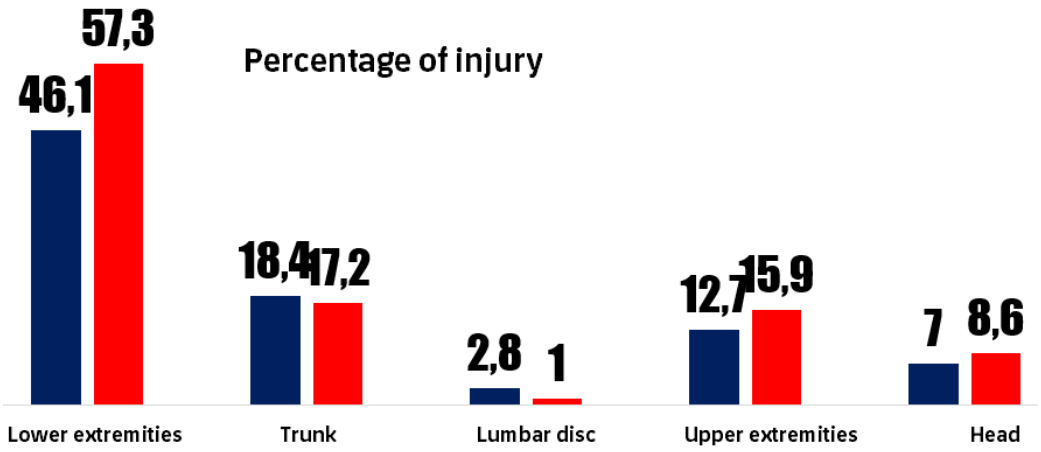
Table 8: NBA anatomical area of injuries

TABLA 2. LESIONES POR ESTRUCTURAS ANATÓMICAS Nº jugadores protocolizados: (91% del total de equipos de N.B.A. Temporadas 88-92) Nº total de lesiones: 3711		
ESTRUCTURA ANATOMICA	Nº	%
EXTREM. INFERIORES	**2130**	**57.3**
Tobillo	537	14.5
Rodilla	350	9.4
Rótula	332	8.9
Pie/dedos del pie	276	7.4
Fémur	272	7.3
Pierna	257	6.9
Ingle	106	2.9
EXTREM. SUPERIORES	**593**	**15.9**
Dedos de la mano	200	5.4
Mano/muñeca	161	4.3
Hombro	139	3.7
Húmero/codo/antebrazo	93	2.5
TRONCO	**640**	**17.9**
Columna lumbar	331	8.9
Cadera	114	3.1
Columna cervical	72	1.9
Tórax	44	1.9
Coxis/sacro	35	0.9
Columna dorsal	26	0.7
Abdomen	18	0.5
CABEZA	**321**	**8.6**
Ojo/zona periorbitaria	120	3.2
Boca/mandíbula	101	2.7
Nariz	36	1.0
Cara	33	0.9
Cráneo/cerebro	31	0.8
OTRA	**27**	**0.7**
Sistémica	24	0.6
Genitales	3	0.1
Tomado de la revisión de la National Basketball Trainers' Association (NBTA) 1993. [17]		

Source: Manonelles Marqueta and Tárrega Tarrero, 1998, http://femede.es/documentos/Epidemiologia_lesiones_baloncesto_479_68.PDF.

To sum up, if we compare both competitions (ACB and NBA) in terms of percentages, we can establish that the lower extremities in the ACB suffered 46% of the injuries, while in the NBA, they suffered 57 %. 18% of injuries were at the trunk level in ABC, and 17% in NBA; specifically, 2.8% in ABC were lumbar disc injuries, while 1% of them occurred in NBA. As for the upper extremities, ACB got 13% of them, while NBA, 16%.

Figure 10: Comparison between ACB and NBA injuries (season '93/'94)

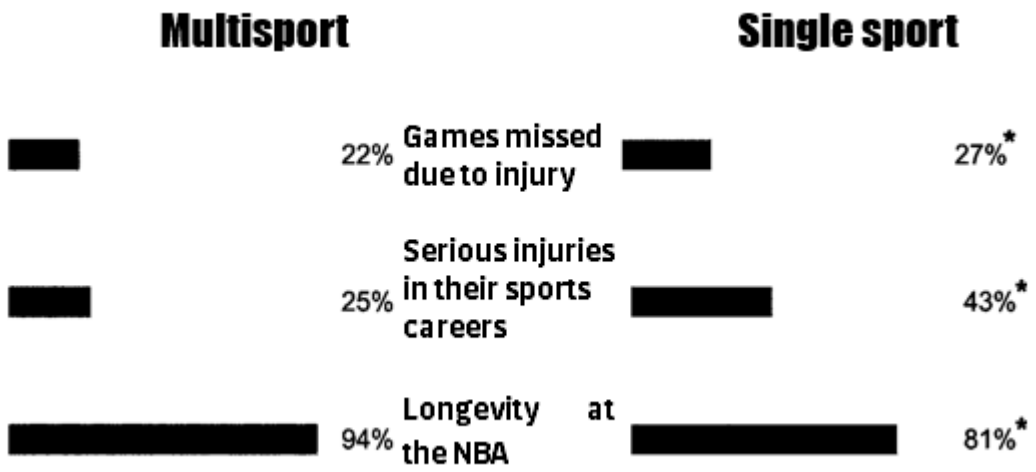


Source: adapted from Manonelles Marqueta y Tárrega Tarrero, 1998.

The following research article also presents an interesting analysis of injuries. Different NBA players were studied, namely 237 athletes who were included in the first round of the season. They were asked if they were trained athletes and if they had played only one sport, that is, if they only played basketball or if they had practised different types of sports during their sports careers; their behaviour towards injuries was also investigated.

The injuries that occurred were, for example, at the level of the anterior cruciate ligament, the group that had only practised basketball in their sports career had experienced 8 injuries; while the group that had practised various sports experienced only 3 injuries. It should be noted that the group that had only played basketball was much higher (85%) compared to the one that had practised different sports (15%). Therefore, those who had played various sports presented 22% of games missed due to injury, while those who had only played basketball showed 27% of games missed due to injury. Regarding serious injuries in their sports career, those who practised many sports showed only 25% have experienced such injuries, against 43% concerning those who had only practised basketball during their sports career. Finally, those the group that had practised various sports showed a higher longevity compared to the players who had only played basketball (Rugg, Kadoor, Feeley and Pandya, 2018).

Figure 11: Relationship between practising a single sport (basketball) and various sports

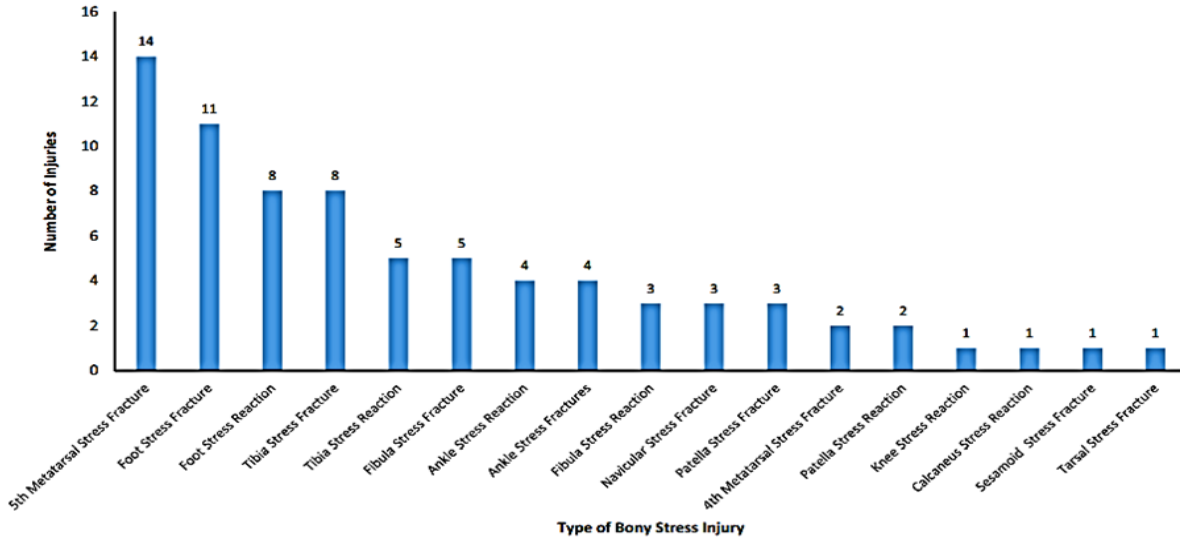


Source: adapted from Rugg, Kadoor, Feeley y Pandya, 2018.

As a conclusion, this publication provides very interesting data that indicates that players who have practised various sports tend to experience fewer serious injuries, miss fewer games due to injury, and have longer sports careers, compared to those who only practised basketball in their sports careers.

Another interesting analysis was conducted by Khan et al. (2017). In the NBA, between 2005 and 2015, players suffered a total of 76 stress-related fractures. Most of them occurred during the regular season and half of them were suffered in the first few weeks. 55% of these bone injuries affected the foot; that is, more than half of bone injuries occurred in the foot.

Figure 12: Stress-related fractures



Source: Khan et al., 2017, p. 171.

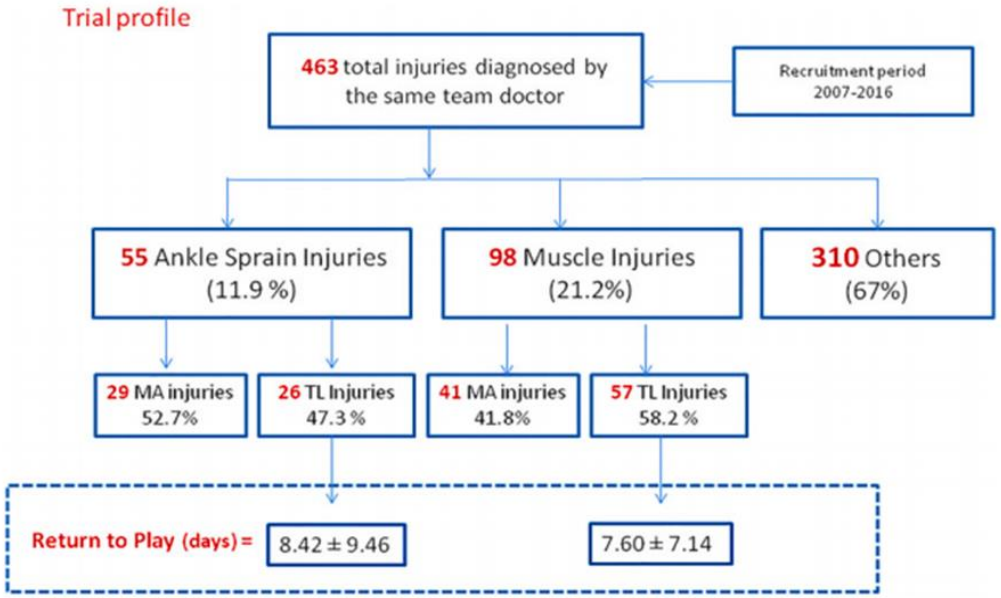
This is also helpful when generating an injury prevention programs since it is significant that half of the injuries occurred in the first six weeks. These data should be analysed and taken into account when developing a system to implement more rigorous and effective injury prevention programs.

It is well-known that injuries can lead to significant absences in games and a large money deficit. In this regard, a study carried out by researchers from Fútbol Club Barcelona led by Dr. Gil Rodas shows the increase in muscle injuries in basketball.

This 2019 study shows an analysis of fifty-nine professional players examined over nine seasons (from 2007 to 2015). The main objective was to describe the rates of muscle and ankle injuries in professional basketball players and to discuss how to manage this clinically. Different strategies were proposed to prevent such injuries. 55 ankle injuries were determined, representing 12% of the analysed cases, 98 muscle injuries (21%) and 310 injuries of other types (67%). The medical attention provided for each injury and the time of missed trainings or games were analysed, apart from the days necessary for the return to play.

It is worthy to observe the dynamics and trends revealed by the following charts extracted from the aforementioned article.

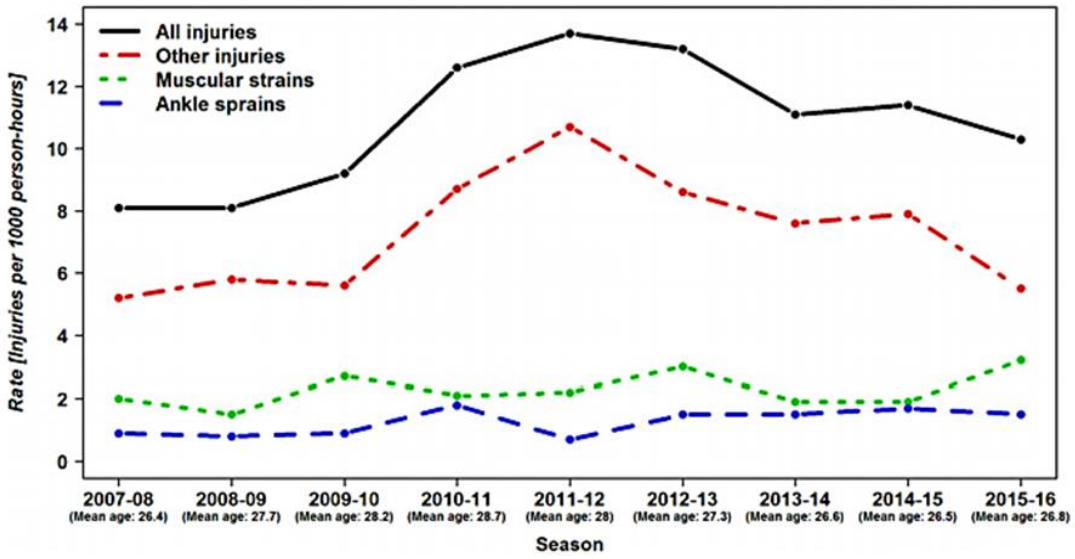
Figure 13: Total injuries and time needed to return to play in basketball



Source: Rodas et al., 2019, p. 4.

The injuries that required more medical attention or that meant a large loss of training or games were muscle injuries, followed by injuries to the ankle or foot. This data is essential when defining an injury prevention system.

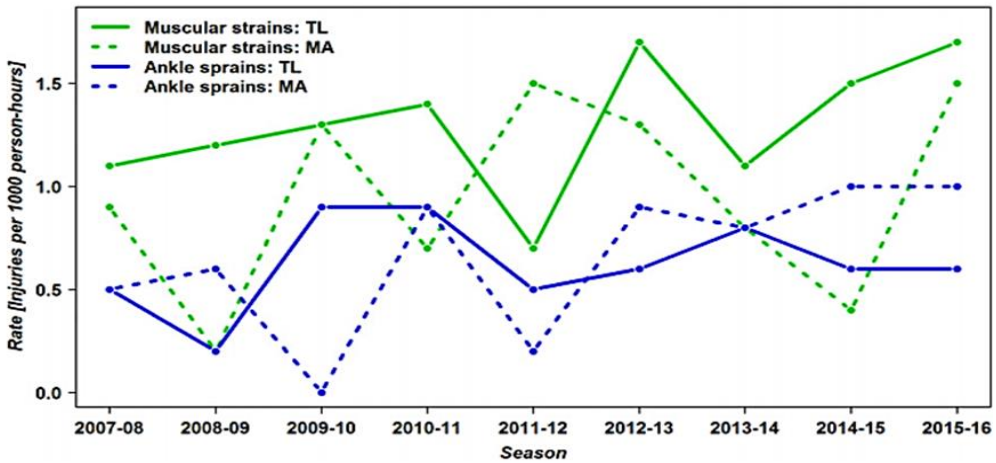
Figure 14: Injury rate by type, every 1000 hours of exposure, depending on the season



Source: Rodas et al., 2019, p. 5.

The overall incidence rate was 10.8 per 1000 hours of exposure. Regarding the total exposure time, 53.9 days were lost due to injury per 1000 hours. The rate of muscle incidents throughout the season was 1.8 times higher than that of an ankle sprain. Likewise, muscle injuries occurred more frequently and involved a greater loss of time compared to ankle sprains; therefore, the focus of the prevention strategy should be on avoiding muscle injuries.

Figure 15: Injury rate per season in the 1000 hours of exposure per person



Source: Rodas et al., 2019, p. 5.

Regarding recreational basketball, a 2002 article carried out a descriptive study based on 109 non-professional basketball players. The research reported a higher incidence of lower extremities injuries compared to the upper ones. The joint involvement, in decreasing order, was as follows: ankle, knee, spine, hand, wrist, shoulder, foot, elbow and hip. In other words, it follows a very similar line to the one analysed in relation to

professional sports. Furthermore, 59.6% of the players had visited the orthopaedic surgeon at some point in their sports career (Marante Fuertes, Barón Pérez, Casas Ruiz, Cano Gómez and Tallón López, 2002).

Regarding women's basketball, there is a higher incidence of injury than in men's basketball. 24 players were examined over three seasons in which 145 injuries occurred. Here, too, the ankle sprain was by far the most recurrent injury, and problems at the level of the knee were the second most important injury.

Table 9: Injuries in female basketball

TABLA 4. LESIONES EN BALONCESTO FEMENINO N° jugadoras protocolizadas: 24 (Temporadas 90-93) N° total de lesiones: 145		
TIPO DE LESION	N°	%
Esguince de tobillo	17	11.7
Tendinitis rotuliana/Condropatía rotuliana	16	11.03
Esguince/luxación de dedos de la mano	11	7.58
Lumbalgia	9	6.2
Hernia/protusión discal lumbar	5	3.44
Esguince de rodilla	3	2.06
Artritis/subluxación temporo-maxilar	2	1.37
Rotura meniscal	1	0.68
Tendinitis aquílea	1	0.68
Luxación de rótula	1	0.68
Tomado de Incidencia de lesiones deportivas…1997[6]		

Source: Manonelles Marqueta and Tárrega Tarrero, 1998, http://femede.es/documentos/Epidemiologia_lesiones_baloncesto_479_68.PDF.

The percentage distribution of injuries in the affected area is similar to the one observed in men's basketball. It should be noted that 15 out of 24 players (that is, 62%) had undergone some surgical intervention throughout their sports career. A high incidence was observed at the level of patellofemoral chondropathies that seems to affect females more frequently, as well as injuries of the anterior cruciate ligament, and even intervened disc herniations.

Table 10: Injuries with surgical intervention in women's basketball

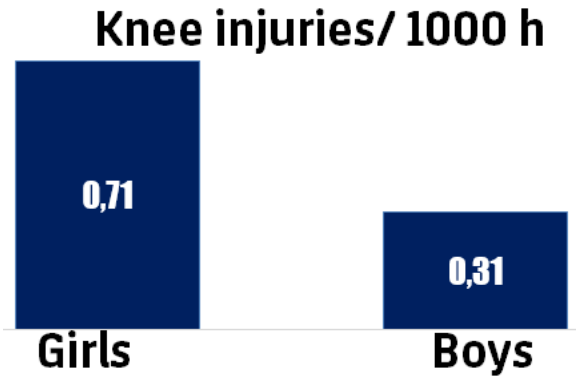
TABLA 5. INTERVENCIONES QUIRURGICAS EN BALONCESTO FEMENINO N° jugadoras protocolizadas: 24 (Temporadas 90-93) N° de jugadoras intervenidas: 15 (62.5 %) N° total de intervenciones: 27		
TIPO DE LESION	N°	%
Condropatía femoro-rotuliana	8	29.6
Rotura ligamento lateral externo de tobillo	4	14.8
Rotura de ligamento cruzado anterior	3	11.11
Hernia discal	2	7.4
Calcificaciones de tobillo	2	7.4
Calcificaciones en tendón rotuliano	1	3.7
Exéresis de fragmento óseo maleolar	1	3.7
Rotura de menisco	1	3.7
Enfermedad de Osgood-Schlatter	1	3.7
Luxación de hombro	1	3.7
Problema astragalino	1	3.7
Fractura sesamoideos	1	3.7
Apendicectomía	1	3.7
Tomado de Incidencia de lesiones deportivas...1997[6]		

Source: Manonelles Marqueta and Tárrega Tarrero, 1998, http://femede.es/documentos/Epidemiologia_lesiones_baloncesto_479_68.PDF.

Another study, in this case conducted on high school students, showed that female players had a higher incidence of knee and anterior cruciate ligament injuries during the entire season (Messina, Farney and DeLee, 1991). In this research,

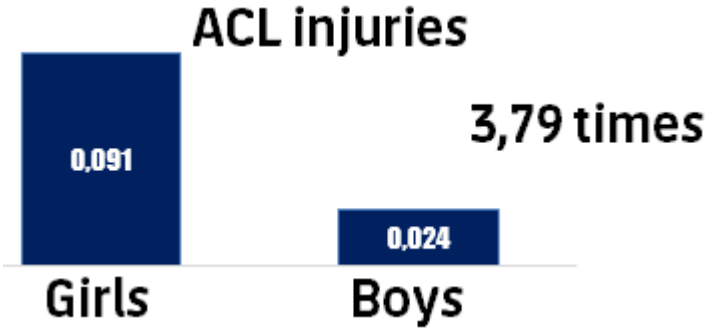
> a prospective study was carried out among male and female athletes in American institutions. They revealed that the players had a significantly higher incidence in the knee and anterior cruciate ligament (ACL) throughout an entire season. The incidence of knee injuries was significantly higher in girls (P <0.0001). The girls presented a greater number of knee injuries, and a higher incidence of injuries due to time of exposure. The incidence of knee injuries was 0.71 per 1000 hours of exposure in girls, and 0.31, in boys. Girls also have a higher incidence of severe knee injuries since 16 out of 25 required surgical treatment (64%); while as regards boys, 6 out of 18 did so (33%). (Sánchez Jover and Gómez Conesa, 2008, pp. 273-274)

Figure 16: Knee injuries per hours of exposure in basketball (comparison between young women and young men)



Source: adapted from Messina, Farney y DeLee, 1991.

Figure 17: ACL injuries per time of exposure (comparison between young women and young men)

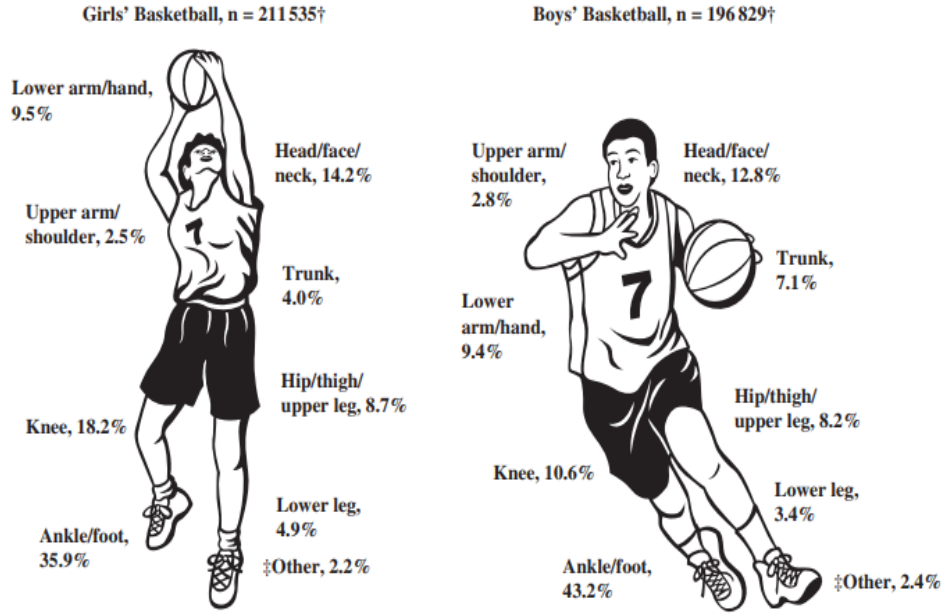


Source: adapted from Meeuwisse, Selmer y Hagel, 2003.

Another article shows a higher incidence of injuries to the anterior cruciate ligament in female players: 1 out of 65 players suffered a rupture of the anterior cruciate ligament, which amounts to 70,000 ruptures a year in the United States, with an estimated cost of about US$ 119 million (Ford, Myer and Hewett, 2003).

The study conducted by Borowski, Yard, Fields and Comstock (2008) also compares the anatomical areas affected in women and men. This study reveals the percentages that are established between injuries in the affected areas and injuries that occur either in training or in competition.

Figure 18: Location of lesions (comparison between women and men)



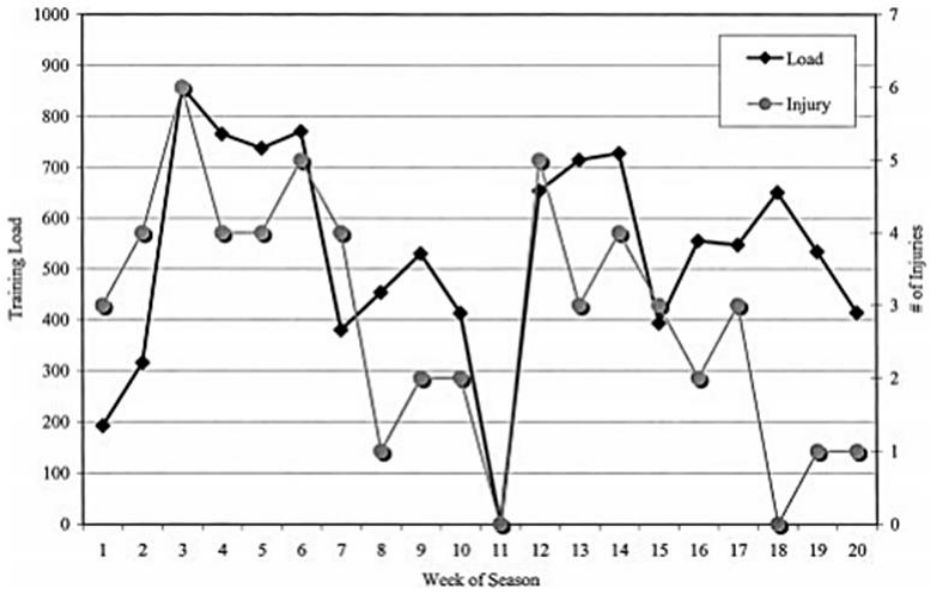
Source: Borowski, Yard, Fields y Comstock, 2008, p. 2331.

In conclusion:

> The ankle sprain is the most prevalent injury, both in training sessions and in competition. In addition, the players who were injured the most were the centres and power forwards in professional and university basketball. Contact with another player is the most frequent cause of injury. Young women have a higher injury incidence than young men. The injury rate during competition is higher than in training. (Sánchez Jover and Gómez Conesa, 2008, p. 270)

Anderson, Triplett-Mcbride, Foster, Doberstein, and Brice (2003) show the relationship between injury and training load. They claim that an increased load causes an increase in injuries, especially in the first two weeks of post-vacation training. The data suggests a causal relationship in which periodization could be linked to the probability of injury or illness. Therefore, this scientific basis must be considered when designing injury prevention programs.

Figure 19: Relationship between injury and training workload according to the time of the season



Source: Anderson, Triplett-Mcbride, Foster, Doberstein y Brice, 2003, p. 736.

Tony Caparrós, Dr. Gil Rodas and other collaborators have established the relationship between load, performance and injuries in high performance. The most important conclusion they have arrived to is that an increase in training and games is related to a higher performance of the team as well as to a greater number of injuries. This observation, depending on the type of team we work with, is of paramount importance since it may condition the performance during the season. Therefore, teams that participate in two competitions simultaneously should keep these conclusions in mind.

Table 11: Number of hours of basketball exposure, injury, and performance

Seasons	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	Total Mean per season
Exposure								
Total number of practices	283	276	268	288	281	305	304	286 (13)
Total number of games	78	79	78	72	76	88	85	79 (5)
Total number exposure hours	4540	4788	4438	4416	4060	5364	5063	4667 (407)
Total game exposure hours	244	248	227	216	243	286	264	247 (21)
Total practice exposure hours	4296	4540	4212	4200	3817	5077	4799	4420 (389)
Injuries								
Total number of injuries	13	18	21	26	17	37	29	23 (8)
Total number injuries during practice	8	11	12	11	11	16	22	13 (4)
Total number injuries during game	5	7	9	15	6	21	7	10 (5)
Total Injury Incidence per 1000 h	2,9	3,8	4,9	5,9	4,2	6,9	5,7	5 (1)
Total Injuries per 1000 h of practice	1,9	2,4	2,8	2,6	2,9	3,1	4,6	3 (1)
Total injuries per 1000 h of games	20,5	28,2	39,7	69,4	24,7	73,4	26,5	40 (20)
Performance								
Total outcomes achieved	1	2	3	2	3	2	2	2 (1)
Total team ranking	5406	6285	6465	5795	6344	7952	7427	6525 (822)
Team mean game ranking	77,4 (15,3)	91,7 (17,8)	94,1 (19,3)	88,2 (14,9)	88,9 (18,2)	92,7 (20,0)	93,8 (20,9)	90 (5)

Source: Caparrós et al., 2016, p. 399.

References

Anderson, L., Triplett-Mcbride, T., Foster, C., Doberstein, S. and Brice, G. (2003). Impact of Training Patterns on Incidence of Illness and Injury During a Women's Collegiate Basketball Season. *Journal of Strength and Conditioning Research, 17*(4), 734–738. doi:10.1519/00124278-200311000-00018

Borowski, L. A., Yard, E. E., Fields, S. K. and Comstock, R. D. (2008). The Epidemiology of US High School Basketball Injuries, 2005–2007. *The American Journal of Sports Medicine, 36*(12), 2328–2335. doi:10.1177/0363546508322893.

Caparrós, T., Alentorn-Geli, E., Myer, G. D., Capdevila, L., Samuelsson, K., Hamilton, B. and Rodas, G. (2016). The Relationship of Practice Exposure and Injury Rate on Game Performance and Season Success in Professional Male Basketball. *Journal of sports science & medicine*, *15*(3), 397–402.

Dirección General del Deporte del Gobierno de Aragón (2004). *Jornadas sobre prevención de lesiones en baloncesto* [online document]. Retrieved from http://deporte.aragon.es/recursos/files/documentos/doc-areas_sociales/deporte_y_salud/-jornadas_prevencion_lesiones_baloncesto.pdf.

Ford, K. R., Myer, G. D. and Hewett, T. E. (2003). Valgus Knee Motion during Landing in High School Female and Male Basketball Players. *Medicine & Science in Sports & Exercise, 35*(10), 1745–1750. doi: 10.1249/01.mss.0000089346. 85744.d9.

Gaca, A. M. (2009). Basketball injuries in children. *Pediatric Radiology, 39*(12), 1275–1285. doi:10.1007/s00247-009-1360-0.

Gozlan, Y. (April 24th, 2019). *NBA Executive: Injuries will cost DeMarcus Cousins $150M.* Retrieved from https://warriorswire.usatoday.com/2019/04/24/nba-executive-injuries-will-cost-demarcus-cousins-150m/.

Khan, M., Madden, K., Burrus, M. T., Rogowski, J. P., Stotts, J., Samani, M. J. ... Bedi, A. (2017). Epidemiology and Impact on Performance of Lower Extremity Stress Injuries in Professional Basketball Players. *Sports Health: A Multidisciplinary Approach, 10(2), 169–174.* doi:10.1177/1941738117738988

López Olmedo, J. (2019) *Fracturas infantiles más frecuentes. Esguinces y Epifisiolisis.* Retrieved from https://www.pediatriaintegral.es/publicacion-2019-06/fracturas-infantiles-mas-frecuentes-esguinces-y-epifisiolisis/.

ManGamesLostNBA [user] (January 13th, 2016). *How injured is YOUR team? Providing NBA injury analytics and visualizations to 23 NBA teams. Nathan Currier, PhD and http://ManGamesLost.com* [Twitter publication]. Retrieved from https://twitter.com/mangameslostnba?lang=es.

Manonelles Marqueta, P. and Tárrega Tarrero, L. (1998). Epidemiología de las lesiones en el baloncesto. *Archivos de Medicina del Deporte, 15* (68), 479-483. Available at http://femede.es/documentos/Epidemiologia_lesiones_baloncesto_479_68.PDF.

Marante Fuertes, J., Barón Pérez, Y., Casas Ruiz, M., Cano Gómez, C. and Tallón López, J. (2002). Lesiones en jugadores no profesionales de baloncesto. Estudio estadístico. *Rev. S. And. Traum. y Ort., 22*(1), 86-91.

Meeuwisse, W. H., Sellmer, R. and Hagel, B. E. (2003). Rates and Risks of Injury during Intercollegiate Basketball. The *American Journal of Sports Medicine, 31*(3), 379–385. doi:10.1177/03635465030310030901

Messina, D.F., Farney, W.C and DeLee, J.C. (1991) The Incidence of Injury in Texas High School Basketball. A Prospective Study Among Male and Female Athletes. *Am J Sports Med, 27*(3), 294-299. doi: 10.1177/036354659902700304O1.

Newport, K. (2013). *Infographic Breaks Down Kobe Bryant's Injuries by Body Part.* Retrieved from https://bleacherreport.com/articles/1991934-infographic-breaks-down-kobe-bryants-injuries-by-body-part.

Rodas, G., Bove, T., Caparrós, T., Langohr, K., Medina, D., Hamilton, B., ... Casals, M. (2019). Ankle Sprain Versus Muscle Strain Injury in Professional Men's Basketball: A 9-Year Prospective Follow-up Study. *Orthopaedic Journal of Sports Medicine, 7*(6), retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6589969/.

Rugg, C., Kadoor, A., Feeley, B. and Pandya, N. (2018). The Effects of Playing Multiple High School Sports on National Basketball Association Players' Propensity for Injury and Athletic Performance. *The American Journal of Sports Medicine. 46* (2), 402-408. doi: 10.1177/0363546517738736.

Sánchez Jover, F. and Gómez Conesa, A. (2008). Epidemiología de las lesiones deportivas en baloncesto. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte, 8* (22), 270-281.