3.2 Basketball

Basketball is a team sport in which player attributes are largely determined by the demands of the game, based on its regulations and characteristics. The first point to keep in mind is that the baskets are located at a height of 3.05. This means that in order for players to participate in both offensive and defensive game actions, the ability to reach this height is vital. For this, from an anthropometric perspective, players can make use of their height and size, and with respect to their conditional capabilities, their jumping skills are also important.

This is an example of the some of the fundamental characteristics of athletes in this sport.
At the same time, this is a shared field sport, and the measurements of the court (28 meters long by 15 meters wide) in relation to the size of the players results in a small playing space. As such, within the game we find constant instances of strength-intensive exertions when vying for space with opponents. There are also accelerations, maximum decelerations over short distances, and constant changes of direction, as well as multiple combinations of these possibilities. In relation to this, Caparros, Rodas, Padullés and Capdevila (2014) found a direct relationship between strength and velocity, and between performance and injury risk. Greater strength leads to better performance and a lower injury risk among professional Liga Endesa basketball players.

To this effect, Montgomery, Pyne and Minhan (2010) determined that around 50 explosive jumps take place per game among elite young adult players. They also proposed that the average heart rate can reach 171 beats per minute, and blood lactate concentrations reached 8.5 millimoles/liter in men and 5.7 in women at the international basketball level.

The game is divided into four 10-minute periods for Fiba Basketball and 12-minute periods in the NBA. There are rest intervals between the first and second quarters and between the third and fourth quarters, as well as a 15-minute rest between the second and third periods. The total playing time for a game, including rest intervals, ranges between 90 and 120 minutes. In terms of the distance covered during a game, the mean distance is 6,679 meters, according to publications since 2000. Regarding the intensity at which these distances are covered, Abdelkrin et al. (2010) determined that 11.5% correspond to high intensity actions,

11% to moderate intensity, 14% to low-intensity and 63% to recovery intensity. The same authors propose that the density of the workload in basketball – in other words the work time to rest time ratio – is 1:3.6. (Schelling 2012).

The characteristics of basketball – in terms of the speed of play – have undergone numerous modifications throughout its history, due to rule changes that are always aimed at creating a more dynamic sport, both for the players and for the fans. This is why the rule change in the year 2000 – where ball possession time before attempting a shot was changed from 30 seconds to 24, and the time for crossing the half-court line was lowered from 10 seconds to 8 – have had a huge influence on the physical and physiological demands of basketball. These changes are in addition to the division of games into 4 quarters, since they were previously played over two 20-minute periods (Abdelkrim, Fazaa, Ali, 2007). This results in a higher number of possessions per team throughout the game, and leads to an increase in the number of transitions from defense to attack between teams.

In this context, San Roman, Calleja, Castellano and Casamichana (2010) studied the game's fatigue effect among young international-level basketball players, estimated by measuring jumping capabilities at different moments of the game. Jumping is understood to be one of the determinant actions in basketball performance. The authors noticed a decrease in jumping capabilities both during and after the rest periods, and suggested that the cause of this phenomenon is related both to fatigue, and to a decrease in the basic conditions necessary for athletic performance (muscle temperature, heart rate, etc.).

Figure 1

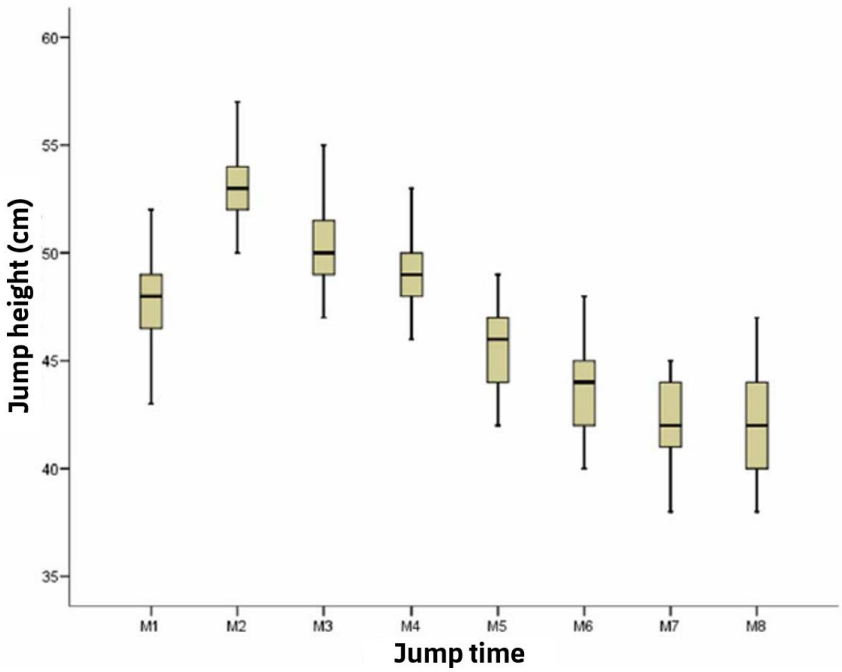

Figure 1. Box diagram representing CMJ height before, during and after competition. Each box represents the mean, deviation and 95% confidence interval.

Source: Taken from San Roman, Calleja, Castellano & Casamichana (2010).
M1= Before the warm-up. M2= Before the game. M3= Rest. M4= End of game. M5= 1 minute post-game. M6= 3 minutes post-game. M7= 5 minutes post-game. M8= 7 minutes post-game.

Continuing with the physical and physiological demands of basketball mentioned by Montgomery, Pyne and Minahan (2010), the authors found important differences between half-court exercises and full-court exercises, and they proposed the use of half-court exercises when the objective is a lower training load. Added to this are the 5-on-5 training situations that simulate the real conditions that would develop during a game, in which the peak heart rates are similar to those measured in an actual game. However, the average heart rate is higher during actual games. This indicates that during training under these conditions the intensity is similar to that achieved in a game, but repeated at a lower frequency, meaning that actual games still have a greater physical and physiological demand. This phenomenon is probably caused by the number of pauses or stops that can occur during training sessions, which is why this type of activity can be sustained for

prolonged periods of time without incurring an increase in stress due to fatigue, especially in the lower limbs.

However, when estimating the physiological demands of this sport, whether during training or competition, it is important to consider all of the actions in which the player sustains maximum static contractions. This happens during defensive blocks and rebounds, which are repetitive technical actions that appear constantly throughout the course of the game.

Injuries in Basketball

Starkey (2000) presented a study which offered an overview of 10 years of injuries and illnesses in the NBA, and revealed all of the medical conditions suffered in the league over the course of 10 seasons (between 1988/89 and 1997/98).

Ankle sprains were the most common orthopedic injuries (942, 9.4%), followed by patellofemoral inflammation (803, 8.1%), lumbar strain (491, 5.0%) and knee sprains (258, 2.3%).

The highest number of lost competition days were due to patellofemoral inflammation (7,569, 11.5%), knee sprains (5,712, 8.6%), ankle sprains (5,122, 7.7%) and lumbar strain (3,365, 5.1%).

Professional NBA athletes experienced a game-related injury rate that is twice as high as that of their university colleagues. Patellofemoral inflammation is a significant problem among NBA players.

A total of 1,094 individual players took part in this study, representing approximately 85% of the players that were on an NBA regular season roster during that time period.

Small forwards had the highest injury rate related to the game (21.7/1000 athletes studied), followed by point guards (21.3/1000 athletes studied) and centers (21.0/1000 athletes studied).

The types of injuries experienced by professional basketball players reflect the physical demands of the game. For up to 4 nights a week and up to 38 weeks a year, athletes could potentially play for up to 48 minutes and run the length of the 28.65-meter (94-foot) court from 200-

300 times per game (equivalent to 4.83-8.05 km), at the same time as jumping, stopping and making body contact with their opponents.

On the other hand, Cumps, Verhagen and Meeusen (2007) found that ankle sprains, together with injuries due to knee overuse, were the most common types of injuries among both adult males and females playing basketball at various levels. In addition to this, they found that patellar tendinitis, or jumper's knee, is particularly frequent among high-level basketball players.
They also suggested that the greater injury frequency during games is caused by the high level of competition and the maximal exertion generated, which makes athletes more vulnerable to injury.

Their results also showed that ankle sprains occurred particularly during offensive plays, although there were no significant differences between the various playing positions. Landing on an opponent's foot was identified as the leading cause of ankle sprains, which is mainly as a result of jumping.

Table: Injury mechanisms for ankle sprains in basketball

Ankle sprains	Contact	No contact	Total
Jumps	44.1%	8.8%	52.9%
Stops	5.9%	5.9%	11.8%
Runs to score	11.8%	0%	11.8%
Passes and catches	2.9%	2.9%	5.9%
Other	2.9%	14.7%	17.6%
Total	67.6%	32.4%	100%

Source: Taken from Cumps, Verhagen and Meeusen (2007)

It is important to note that the authors proposed that the classification of basketball be changed to a high injury risk sport, since over time it has evolved from a precision sport into a collision sport. This is determined by the high injury risk index of 9.8/1000 playing hours, of which 6 correspond to acute injuries and 3.8 to overuse injuries. This is supported by the fact that 69.2% of these injuries occur in contact situations, based on the proposal that classifies high-risk team sports as those which involve three fundamental components:

Contact situations, high number of jumps, and played in indoor conditions.

The injury incidence in the NBA was studied for 17 years, during which 12,594 injuries were recorded, out of which 6,287 (49.9%) occurred during matches. The lower body had the most injuries, representing 62.4% of total injuries and 57.8% of all game-related injuries. There were 1,850 ankle joint injuries representing 14.7% of the total. 1,123 of these occurred during games (17.9%), representing an injury risk of 3.4/1000 athletes studied. In terms of game absences (players out of competition due to injury), these were related to patellofemoral inflammation (n,10,370; 17.5%), which had the greatest influence on absences, collateral ligament ankle sprains (n, 5,223; 8.8%), knee sprains (n, 4,369; 7.4%) and lumbar strain (n, 3,933; 6.6%). There was no correlation found between the injury rate and player demography, including age, height, weight and years of experience in the NBA (Drakos M, Domb B, Starkey C, L Callahan, Allen A, 2010).

With respect to the effect of the injuries suffered on team performance, Caparros et al. (2016) found a high level of correlation between:

1. Number of practice sessions and hours of exposure to the injury risk, and the total number of injuries.
2. Number of practice sessions and hours of exposure to the injury risk, and team performance (estimated based on ranking and results).
3. Total number of injuries and performance.

Thus, the higher the number of practice sessions and competitions a team has, the better their performance. However, the number of injuries will also rise in correlation with this. So, in professional Spanish basketball, a team's success during the season will not be affected by the total number of injuries sustained by team members during that season. However, the more successful the season, the more exposure the team will have to injury risk, due to the prolonged length of time they will spend in competition.

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