Upper body injuries and Key Performance Indicators in professional basketball players

Álvaro Bustamante-Sánchez[1], Juan J. Salinero[2], Juan Del Coso[2]

[1]Bachelor in Sport Science, Bachelor in Computer Science. MSc in Sport Performance. Universidad Europea de Madrid. Faculty of Sport Sciences. Spain. [2]Bachelor in Sport Science. PhD in Sport Performance. PhD in Sport Performance. Sport Science School. Universidad Camilo José Cela. Spain.

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Summary

Introduction: Upper body injuries are less common than lower body injuries in basketball, but there is still a lack of knowledge about the relationship among their occurrence and the performance profile of professional basketball players. This study aimed to analyse the relationships between upper-body injuries and Key Performance Indicators (KPIs) of basketball players.
Material and method: Statistical variables of 554 professional basketball players (age: 26.97±4.86 years, height: 199.23±8.80 cm, minutes per season: 441.18±301.41) in Spanish ACB *(Asociación de Clubes de Baloncesto)* professional competition were analysed for two seasons (2012-13 and 2013-14). Besided, injury reports were registered and injuries were categorized with OSICS-10 classification. The players who played the most minutes during the season were more likely to suffer lumbar spine, head, wrist, and hand injuries. The players injured in the thoracic spine obtained a better average in steals per minute. The players injured in the head or the elbow had better +/- performance per minute. The players injured in the neck had better means per minute in received fouls, free throws made and attempted.
Results: The players injured in the lumbar spine had better means, per minute played, in assists, probably by their continuous column twists to protect the ball with the body to avoid bumps. Players injured in the shoulder had more blocked shots per minute than those not injured, probably because the realization of a block involves a shoulder flexion and rotation. It would be interesting to carry out a specific follow-up in this type of player, for this type of injury. This information could be helpful to improve injury prevention with the use of KPIs of basketball.

Key words:
Basketball. Injury. KPI. Performance. Hand. Shoulder. Elbow. Neck. Head. Spine.

Lesiones de la parte superior del cuerpo e indicadores clave de rendimiento en jugadores profesionales de baloncesto

Resumen

Introducción: Las lesiones de la parte superior del cuerpo son menos frecuentes que las de las extremidades inferiores en baloncesto, pero aún existe la necesidad de conocer la relación entre su ocurrencia y los perfiles de rendimiento de jugadores profesionales. El objetivo de este estudio es analizar la relación entre la ocurrencia de lesiones de la parte superior del cuerpo y los factores de rendimiento clave *(Key Performance Indicators, KPIs)* en jugadores profesionales de baloncesto.
Material y métodos: Se ha analizado la información estadística de 554 jugadores (edad: 26,97±4,86 años, estatura: 199,23±8,80 cm, minutos por temporada: 441,18±301,41) en la liga regular ACB durante dos temporadas (2012-13 y 2013-14). Además, se han recogido los partes médicos de cada jornada y categorizado las lesiones según el sistema OSICS 10. Los jugadores que jugaron más minutos durante la temporada fueron más propensos a sufrir lesiones en la columna lumbar, la cabeza, la muñeca y las manos. Los jugadores lesionados en la columna torácica obtuvieron un mejor promedio en robos por minuto. Los jugadores lesionados en la cabeza o el codo tuvieron un mejor rendimiento de +/- por minuto.
Resultados: Los jugadores lesionados en el cuello tuvieron mejores promedios por minuto en faltas recibidas, tiros libres realizados e intentados. Los jugadores lesionados en la columna lumbar tuvieron mejores promedios, por minuto jugado, en asistencias, probablemente por sus continuos giros de columna para proteger el balón con el cuerpo para evitar ayudas defensivas. Los jugadores lesionados en el hombro hicieron más tapones por minuto que aquellos no lesionados, probablemente porque la realización de un tapón implica una flexión y una rotación de hombro. Sería interesante realizar un seguimiento específico en este tipo de jugadores, para este tipo de lesiones. Esta información podría ser útil para mejorar la prevención de lesiones con el uso de KPIs en baloncesto.

Palabras clave:
Baloncesto. Lesiones. KPI. Rendimiento. Mano. Hombro. Codo. Cuello. Cabeza. Columna.

Correspondence: Álvaro Bustamante Sánchez
E-mail: busta.es@gmail.com

Introduction

The upper body is not usually the anatomical region most injured in basketball[1], and that is the reason why the vast majority of studies focus on the incidence of lower extremity injuries, especially in ankle and knee joints[2,3]. However, they should be paid the same attention, since any kind of injury can produce persistent symptoms[4], lower performance and adverse psychological effects among athletes[5]. Although basketball is a sport in which the handling of the ball is done with the hands, injuries in the upper extremities are far less frequent than injuries in the lower extremities[6]. Injuries in the hands and arms predominate over those that occur in the shoulders or elbows[7]. Injuries in the upper extremities, in general, accounted for no more than 13% of basketball injuries at both amateur and professional levels[8,9].

Excluding stress injuries, the fingers of the hands are the place of the upper extremities in which a basketball player is more likely to suffer a fracture[10]. The interphalangeal joints are the most injured areas: injuries of the extensor and flexor tendons of the fingers, and fractures and dislocations are the most frequent lesions[7,11]. Lacerations due to the realization of dunks have also been reported. This type of injuries occurs due to the impact of the hands with the pointed edges of the hoops or the support that joins the hoop and the backboard[12].

Several studies have analysed the incidence of hand and wrist injuries in the NBA (National Basketball Association) competition. In one of these studies, it was reported that 3.9% of the total injuries were in the wrist or in the hand[13]. In a previous study, this kind of injury was divided into wrist (1.9%), fingers (1.8%), hand (1.8%) and thumbs injuries (1.6%), with a total percentage of 7.1%[9]. Other subsequent research also divided this type of injury in several sections, reporting 4.5% of injuries on hands, 2.4% on fingers and 2.2% on thumbs, with a total percentage of 9.1% of wrist and hand injuries[14]. In the North American college basketball competitions, these types of injuries have also been studied: wrist injuries were 1.6%, and thumbs 2.3%, obtaining a total of 3.9% of hand and wrist injuries[15]. In Europe, there was reported a 9.7% of finger injuries in basketball players, although there was not used such an extensive system of classification[16].

Back injuries are relatively common in basketball players: despite their relative frequency, a large percentage of these injuries are usually muscle strains[6]. Several longitudinal studies conducted in the NBA obtained similar results: lumbar injuries accounted for 6.8% of the total (and 11.0% of total days lost due to injury), ranking fourth in importance in both occurrence as in days of convalescence[9]. 9.0% of lumbar spine injuries with respect to the total, only behind the occurrence of knee injuries (19.1%) and ankle injuries (16.9%) in NBA[14]. In a study conducted in Europe with professional and non-professional players[16], the incidence of back injury was 1.3 injuries per 1000 hours of training time. Lumbar injuries are usually among the four most common injuries, usually behind knee and ankle injuries.

Thoracic spine, head, neck, shoulder, elbow, thorax and forearm injuries have not been traditionally catalogued as predominant in professional basketball. Thoracic spine injuries have not exceeded 2% of incidence with respect to the total, with results of 1.1%[17], 1.3%[9] and 1.6%[14] in the NBA. Head injuries have been more frequent than those of the thoracic spine. If face and skull lesions are added, percentages of 1.9%[9], 5.3%[17], and 5.7%[14] were obtained with respect to the total. Neck injuries have accounted for 1.5% of total injuries[9], although in other studies[14,17], neck injuries have been classified as part of cervical spine injuries and there are no precise results on this anatomical region. Injuries in the shoulder joint have been also studied and accounting for an incidence of 3.7%[14], 3.4%[17] and 3.0%[9]. Elbow injuries have not been high in terms of incidence since they usually do not exceed 2% of all injuries. Specifically: 2.0%[13], 1.9%[14], and 1.5%[9]. Chest injuries do not usually exceed 2% of incidence. Specifically, they accounted for 1.9%[17], 1.8%[14] and 1.0%[9]. Forearm injuries are not usually recorded individually. In a study in which the arm injuries were recorded (without taking into account the joints), a percentage of 0.9% was obtained with respect to the total number of injuries[17]. Finally, abdominal injuries are very unusual and do not normally reach 1% of the total. Specifically, percentages of 0.7%[17] and 0.6%[9,14] have been obtained.

Basketball injuries have been traditionally studied according to their epidemiology: injuries per hour of exposition in both practices and games[1,9,16,18], different competitive levels[16,19,20], anatomical region or type of injury (muscular, concussion, ligamentous distension, etc.)[1,9,14], biomechanics and anthropometry[12,14,16,17,20]. Differences in performance after a long-term injury with surgery have been also studied in NBA competition[21,22], but not many researches have studied the relationship between the occurrence of injuries and the performance of players in games[3]. A wider knowledge about the relationships between Key Performance Indicators (KPIs) and the occurrence of injuries could help strength and conditioning coaches, to develop a specific preventive work with the profiles of players most prone to injury. Moreover, this information could help to improve the rules in basketball, in order to decrease the occurrence of injuries.

Therefore, the aim of this study is to analyse the occurrence of upper body injuries and their relationship with KPIs in basketball players of the ACB (Asociación de Clubes de Baloncesto) professional competition.

Material and method

Design

To analyse the injuries of basketball players in the ACB league, a cross-sectional, descriptive and retrospective methodology was used to study the upper body injuries and the performance of the players, based on the information provided by the official website of the ACB league[23] in each of the injury reports parts prior to each game of the 2012-13 and 2013-14 seasons.

Participants

The sample was the total number of ACB players during the 2012-13 and 2013-14 seasons. It was established as a requirement to be included in the study: (1) to have played at least one match of the ACB league and (2) not to have played on another team of the same competition during the season. They fulfilled both requirements a sample of 554 players from the ACB league during the 2012-13 and 2013-14 seassons, therefore they all were included in this study.

Procedure

We reviewed the information of "News and Medical Report" on the official website of the ACB Basketball League[23], corresponding to the Regular Season of 2012-13 and 2013-14, adding a total of 68 league days registered games. All the injury reports of all the disputed days were obtained. From this information, it was identified which players of the competition had suffered each type of injury, registering the anatomical region. The OSICS classification was used for the categorization of injuries[24].

Subsequently, the total individual statistics of each player were obtained for each of the two seasons[23]. The statistics collected the performance of the players for each variable in absolute values (total of the season) and per game played. As the risk of injury increases with minutes of exposure in matches[25], from the original data the individual statistics per player minute were calculated. Thus, the effect of time on the existing correlation between actions and game time was controlled.

Statistical analysis

The normality of the variables was checked with the K-S test for a sample. The data are shown as mean±standard deviation. To determine if there were significant differences (in the different performance variables during the matches), between the players who suffered a type of injury during the season and those who did not, a mean comparison was made using the t test in the case of variables with normal distribution and the Mann-Whitney U statistic for those nonparametric variables. The level of significance was established at $P < 0.05$ for all cases. The statistical program PASW Statistics 18 was used to carry out the statistical analysis.

Results

The variables of statistical performance relevant to the occurrence of upper body injuries are shown in Table 1.

Statistically significant differences have been found, relative to the total minutes played, between the set of players who presented a hand or wrist injury, and the group that did not present this type of injury

Table 1. Significant KPIs in upper body injury occurrence.

KPIs	Kind of Injury (injured or not)	N	Mean	Standard Deviation	*P*
Total minutes	Wrist or hand (No)	525	434.91	301.22	.020*
	Wrist or hand (Yes)	29	554.66	286.75	
Total minutes	Lumbar spine (No)	535	435.44	303.23	.018*
	Lumbar spine (Yes)	19	602.95	186.33	
Assists	Lumbar spine (No)	531	.063	.057	.008*
	Lumbar spine (Yes)	19	.091	.055	
Ranking	Lumbar spine (No)	531	.330	.381	.052
	Lumbar spine (Yes)	19	.424	.200	
Total minutes	Thoracic spine (No)	542	437.57	302.16	.059
	Thoracic spine (Yes)	12	604.50	217.21	
Steals	Thoracic spine (No)	542	.585	.405	.017*
	Thoracic spine (Yes)	12	.840	.275	
Total minutes	Head (No)	539	437.48	301.44	.034*
	Head (Yes)	11	624.00	248.16	
+/-	Head (No)	539	-.081	.517	.028*
	Head (Yes)	11	.094	.267	
Free throws attempted	Neck (No)	539	.091	.130	.005*
	Neck (Yes)	11	.124	.042	
Free throws made	Neck (No)	539	.068	.125	.005*
	Neck (Yes)	11	.095	.036	
Received fouls	Neck (No)	539	.099	.076	.003*
	Neck (Yes)	11	.135	.036	
Ranking	Neck (No)	539	.329	.380	.003*
	Neck (Yes)	11	.503	.131	
+/-	Elbow (No)	545	-.080	.515	.046*
	Elbow (Yes)	5	.158	.145	
Blocked shots	Shoulder (No)	541	.014	.019	.011*
	Shoulder (Yes)	9	.023	.013	

KPIs: Key Performance Indicators.

(P = 0.020). As with the results of the injuries studied previously, the group of injured players on the wrist or hand played more minutes during the regular season (119.75 minutes more than average). However, no other variables associated with the statistically significant performance have been found in the occurrence of wrist or hand injuries.

The group of injured players in the lumbar spine played more minutes on average during the regular season (specifically 167.51 more minutes). Significant differences have also been found regarding the assists performed per minute played. The group of players with a lumbar spine injury, performed more assists per minute during the season (P <0.05). There is a tendency towards significance in the case of the ranking per minute. The group of players with lumbar spine injury obtained the highest score per minute during the season (P = 0.052).

The injured players in the thoracic spine performed more steals per minute of play than the non-injured players during the regular season (P = 0.017). In addition, a tendency towards significance has been found in the minutes played: players injured in the thoracic spine played more minutes on average during the season (P = 0.059).

Injured players in the head played more minutes than the non-injured players during the regular season (P = 0.034). In addition, they obtained better results in the plus-minus statistics (P = 0.028).

Players injured in the neck tried and converted more free throws per minute than those not injured during the regular season (P = 0.005 in both cases). In addition, they suffered more fouls per minute (P = 0.003) and obtained a better ranking per minute (P = 0.003).

Players injured in the shoulder performed more blocked shots per minute than those that did not suffer shoulder injuries during the regular season (P = 0.011).

Injured players in the elbow obtained better plus-minus statistics per minute than non-injured players during the regular season (P = 0.046).

The variables of statistical performance irrelevant to the occurrence of upper body injuries are shown in Table 2.

Minutes played and received fouls per minute were studied for each anatomical region, except for those regions in which any of these variables were found significant for the occurrence of an injury, in which we included the analysis of an extra KPI that could be related to the injury (i.e. field goals attempted and wrist/hand

Table 2. Not significant KPIs in upper body injury occurrence.

KPIs	Kind of Injury (injured or not)	N	Mean	Standard Deviation	*P*
Field goals attempted	Wrist or hand (No)	525	.300	.114	.759
	Wrist or hand (Yes)	29	.293	.063	
Received fouls	Wrist or hand (No)	525	.099	.076	.944
	Wrist or hand (Yes)	29	.098	.040	
Total minutes	Elbow (No)	545	440.09	302.06	.371
	Elbow (Yes)	5	561.40	203.34	
Received fouls	Elbow (No)	545	.099	.075	.864
	Elbow (Yes)	5	.093	.041	
Total minutes	Shoulder (No)	541	439.39	301.34	.276
	Shoulder (Yes)	9	549.89	302.25	
Received fouls	Shoulder (No)	541	.099	.076	.821
	Shoulder (Yes)	9	.105	.035	
Total rebounds	Lumbar spine (No)	531	.158	.104	.483
	Lumbar spine (Yes)	19	.141	.164	
Received fouls	Lumbar spine (No)	531	.099	.076	.338
	Lumbar spine (Yes)	19	.115	.046	
Total minutes	Thoracic spine (No)	542	437.57	302.16	.058
	Thoracic spine (Yes)	12	604.50	217.20	
Received fouls	Thoracic spine (No)	542	.099	.076	.668
	Thoracic spine (Yes)	12	.108	.046	
Dunks	Head (No)	539	.010	.019	.699
	Head (Yes)	11	.008	.009	
Received fouls	Head (No)	539	.099	.075	.755
	Head (Yes)	11	.106	.048	
Total minutes	Neck (No)	539	437.90	301.66	.071
	Neck (Yes)	11	603.36	249.69	
Blocks made	Neck (No)	539	.013	.018	.441
	Neck (Yes)	11	.018	.019	

KPIs: Key Performance Indicators.

injury, since a field goal attempt involves the movement of the wrist/hand).

There were no differences in minutes played and received fouls per minute between the players injured in the elbow, the shoulder, and the thoracic spine, and those who did not suffer an injury.

There were no differences in field goals attempted and in received fouls between the players that suffered an injury in the wrist or the hand and those not injured.

There were no differences in total rebounds and in received fouls between the players that suffered an injury in the lumbar spine, and those not injured.

There were no differences in dunks and in received fouls between the players that suffered an injury in the head, and those not injured.

There were no differences in total minutes and in blocks made between the players that suffered an injury in the head, and those not injured.

Discussion

The aim of the present research was to study the occurrence of upper body injuries and their relationship with Key Performance Indicators (KPIs) for the players of the ACB professional basketball competition.

The actions of shooting have not been significant in the occurrence of hand and wrist injuries. The realization of a shot in basketball involves the flexion of the wrist and the use of the fingertips, so it could be assumed that this type of action would be relevant to suffer wrist and hand injuries: these findings suggest that this action is not sufficiently traumatic. Although the performance of dunks involve some risk of injury to the hands and wrists[12], the relative infrequency of this action in game time could be the main reason why dunks were not relevant to the occurrence of wrist and hand injuries. The playing time (total minutes) has been significant in the occurrence of this type of injuries. Exposure to injuries in games has been pointed out in several studies as a determining factor in the occurrence of lesions[1,8,16,26]. The results of this study coincide with the scientific literature, but no other aspects of statistical performance have been found that help identify profiles of players prone to suffer this type of injury. Many of the joint injuries in fingers and thumbs originate in the reception of a pass: the speed of the ball, the accuracy of the pass, and the speed of the hands of the receiver are factors that can be related to this type of injury. However, the reception of passes is not registered in the official statistics, as it is not an action that determines the performance of a player. Therefore, it would be convenient to monitor this aspect to determine if there are relationships between it and hand injuries.

Players injured in the lumbar spine have played more minutes during the season and have performed more assists per minute than the uninjured in this anatomical region. In addition, a tendency towards the significance of better ranking scores in injured players has been observed than in those not injured in the lumbar spine. If the playing time (total minutes) is analysed in the occurrence of lumbar spine injuries, exposure to injuries in matches has been pointed out in several studies as a determining factor in the occurrence of lesions[1,8,16,26]. Although performing a jump to catch a rebound involves the action of the lumbar region, we did not report that the players that were injured in the lumbar spine had better means in total rebounds.

The highest number of assists and ranking per minute played for the injured players in the lumbar spine, are relationships difficult to explain. In general, these variables coincide with the profiles of players who create and make plays on their teams, and not necessarily spot-up or catch and shoot players. This analysis suggests that players injured in the lumbar spine tend to have the ball in their hands and that are important in team attacks, receiving defensive helps from the weak side to assist the open teammate. Therefore, it can be noted that playmakers (habitual ball handlers) can suffer this type of injury by having to perform continuous column twists to protect the ball with the body and avoid defensive helps. It would be interesting to carry out a specific follow-up in this type of players, for this type of injuries. The use of magnetic resonance could be useful to clear up these relationships[6].

Players injured in the shoulder have performed significantly more blocked shots per minute than those not injured in this anatomical region. This result makes a lot of sense, since the realization of a block involves raising the arms and a rotation of the shoulder to try to avoid the shot of the opponent. However, the players injured in the shoulder did not play more minutes nor received more fouls per minute than those not injured. Therefore, it seems that the most related KPIs to shoulder injuries are the blocks made.

Players injured in the neck have suffered significantly more fouls per minute than those not injured in this anatomical region. This relation has to do with the significant greater realization of attempted and made free throws (since many of the fouls involve the realization of free throws). Better scores per minute have also been found in players injured in the neck. In general, it can be said that injured players in the neck are important for their teams and often receive fouls frequently. However, those players injured in the neck did not play more minutes per game, although this fact could be related to the low occurrence of this injury. Future studies with a greater sample should clarify this aspect.

The injured players in the elbow and the head obtained significantly better results in the plus-minus statistic. This relationship indicates that they are important in the overall performance of their teams. In addition, players injured in the head played significantly more minutes during the season, which suggests that this type of injury also has something of chance and that a longer exposure in matches implies more risk of injury, coinciding with several studies[1,8,16,26]. However, caution should be exercised in establishing relationships with these injuries, since they have not had much incidence. In this sense, some studies indicate that to find strong associations, it is advisable to register at least 30 cases of injury[27].

Even though those players that suffer an injury usually must stop their participation during the following games, those players that suffered an injury had higher means of total minutes played during the season. These results suggest the importance of playing time in games (rather than in trainings) as crucial to increase the risk of being injured.

As limitations of the present study, on the one hand, the reasons why the injuries have occurred (contact, non-contact, jumps, accelerations, etc.), and the types of injury (muscular, bone, tendon, ligament, etc.) have not been recorded. This record would have allowed a deeper analysis of injuries in professional basketball. On the other hand, there has been no access to the minutes of exposure in training of each player,

so that only exposure to injuries in competition has been considered. These limitations are due to the design of this research. However, the information provided may be of interest to advance the knowledge of injuries in professional basketball, by collecting the injuries produced in all teams of the highest competition in Spain for two full seasons, providing a new way of studying injuries and relate them to KPIs. It would be convenient to conduct studies prospectively, although it would be difficult to perform with reliable data from all the professional teams involved.

Conclusions

The players who played the most minutes during the season were more likely to suffer lumbar spine, head, hand and wrist injuries. The players injured in the lumbar spine had better means, per minute played, in assists. The players injured in the thoracic spine obtained better average in steals. The players injured in the head or the elbow had better +/- performance per minute. The players injured in the neck had better means of received fouls, free throws made and attempted. The players injured in the shoulder had better means of blocked shots. It would be interesting to carry out a specific follow-up in these types of players, and these types of injuries. This information could help to improve injury prevention.

Conflict of interest

The authors do not declare a conflict of interest.

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