# Do Basketball Players Have a High Risk of Pulmonary Embolism? A Scoping Review

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**ABSTRACT**

CASALS, M., J. A. MARTÍNEZ, J. A. CAYLÀ, and V. MARTÍN. Do Basketball Players Have a High Risk of Pulmonary Embolism? A Scoping Review. *Med. Sci. Sports Exerc.*, Vol. 48, No. 3, pp. 466–471, 2016. **Purpose**: Pulmonary embolism (PE) is a serious preventable disease that requires urgent care. In recent years, there have been several reports in the media about basketball players experiencing PE. The aim of the present study was to assess whether there is a need for in-depth studies to determine whether basketball players constitute a group particularly at risk of PE and to describe some hypotheses to be investigated. **Methods**: We reviewed original articles about PE among professional and amateur basketball players in the scientific literature (PubMed) and the Internet (Google search) for the seasons 2010–2011 to 2014–2015, both of which were included. We used search strategies that included some combination of PE-related terms. Rates of PE were calculated and were compared with those obtained from other studies. **Results**: Of the 15 cases detected, the majority were men (66.7%), mean ages being 28.8 yr among males and 20.4 yr among females. We focused on six cases which, were detected among National Basketball Association and Asociación de Clubes de Baloncesto basketball players, resulting in an average incidence of 1.27 and 2.06 cases per 1000 players per year in the National Basketball Association and Asociación de Clubes de Baloncesto, respectively. This incidence is much higher than that observed in general population studies for the same age group. **Conclusions**: Basketball players seem to have a higher risk of PE than their peers from the general population. More studies are needed to confirm these findings and identify factors predisposing them to PE to contribute to its prevention. **Key Words:** PREVENTION, SPORTS INJURY, INCIDENCE, DIAGNOSIS, ILLNESS

Pulmonary embolism (PE) is a common serious clinical entity. PE is a blockage of an artery of the lung by a substance that has traveled from elsewhere in the body through the bloodstream (embolism). The signs and symptoms of PE can include difficulty in breathing, chest pain, irregular heartbeat, coughing, or coughing up blood. Treatment typically consists of anticoagulant medication and may require thrombolysis, evaluation of underlying cause, temporary anticoagulation, and surgical intervention (22,33). Only after a long rest period, there is a possibility of returning to sports participation. Its incidence in Europe is estimated to be 95 cases per 100,000 persons per year and rises considerably with age, being rare in children and young adults (22,26) The rate of acute deaths after the first episode is estimated to be 10%, and the risk of dying within 30 d of diagnosis is 81 times higher than that in the general population; often, it is the first and only manifestation of sudden cardiac death (22,35). PE is closely related to deep venous thrombosis, and together, they constitute the entity known as venous thrombosis, which is the third most common cardiovascular disease after CHD and ictus.

In recent years, the seemingly high number of basketball players diagnosed with PE has attracted our attention. These are young athletes in good health condition, among whom the incidence of this disease should be low. For this reason, PE in athletes is rarely considered and few studies (mainly case reports) have evaluated the risk of blood clots in the lungs or PE among athletes from different sports (3,8,18–20,40,45). In this sense, the present study is in line with the International Olympic Committee's ruling on sports and health, which recognizes the importance of preventing sports-related injuries and diseases (23).

Thus, the objective of this study was to assess whether there is any reasonable evidence that professional basketball players might constitute a group particularly at risk of PE and to advance some hypotheses to be further investigated.

## METHODS

**Design.** This study implemented a scoping review, which is a type of search used to provide a preliminary assessment of the scope of literature as well as to identify strengths, weaknesses, and gaps in the research.

**Identification of cases.** To carry out a descriptive retrospective study, we first reviewed original articles about PE

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among professional basketball players in top leagues (National Basketball Association (NBA) in the United States, Asociación de Clubes de Baloncesto (ACB) in Spain, and Euroleague teams) for the seasons 2010–2011 and 2014–2015, both included, published within the scientific literature (PubMed). The search strategy included the terms "pulmonary embolism" and "basketball." Second, we searched through the Internet via Google for links to popular magazines and newspapers dealing with sports and health. We identified the relevant English and Spanish terms in news reports via Google advanced search, given that not much information was found in the scientific literature. We used search strategies that included some combination of PE-related terms such as "pulmonary embolism" or "blood clot in lungs" or "phlebitis" or "pulmonary embolus" or "pulmonary emboli" or "tromboembolismo pulmonar" and "basketball player" or "jugadores de baloncesto." We then screened articles related to the publications identified initially to expand our data sources. We repeated the same procedure using the corresponding terms in French, Italian, and Greek.

Some of the topics were overly broad as search terms and led us to the same news reports published in different newspapers from the United States, Italy, Spain, France, Greece, Turkey, Canada, Asia, and Australia, along with several blogs. Therefore, a combination of PE-related terms was used. Moreover, we also conducted advanced searches in some of the most popular basketball-related Web sites such as www.espn.com, www.foxsports.com, www.si.com, www.marca.com, www.nba.com, www.nbcsports.com, www.basketball-reference.com, www.euroleague.net, www.acb.com, www.lequipe.fr, and www.lagazzettadellosport.it.

To characterize cases, we recorded relevant information about them, such as age, height, team, league, nationality, gender, position, and year of diagnosis of the illness. In order not to mix injury and illness definitions, we only use the term "illness" in the way recommended by a recent epidemiological study on athletics (38). The term "illness" is defined like a progressively developing sensation of pain, discomfort, or loss of functioning associated, by an athlete, with repeated bouts of physical load during sports training or competition without adequate recovery periods that reach an intensity and quality making the sensation being interpreted by the athlete discordant with normal body functioning (1,9,10,39). We also recorded the most relevant sources of information describing the illness for all the selected players.

**Validation.** This review process was performed independently by two of the authors (J. C. and V. M.) to double-check the information published by all the sources. We detected some inconsistencies regarding certain characteristics of the players, which were resolved jointly by the two authors after a new search. For example, L. M. was a 19-yr-old National Collegiate Athletic Association player who died in 2011. Some media reports stated that his death was caused by PE, and he was therefore initially included as a possible case by one author. However, the other author independently found that a posterior autopsy ruled that the death was in fact caused by intoxication. This case was subsequently removed from our list.

In addition, we contacted some well-known journalists specializing in basketball from Italy, France, and Greece to check whether our search results were correct for such leagues where the amount of information publicly available was significantly lower than that in the United States and Spain. We did not give them any list of identified cases because we wanted them to conduct an independent search. In the end, they did not provide any new cases with respect to our list. The names of these journalists are available from the authors upon request.

**Coding.** The focus of our research was on PE, but some of the cases reported in the mass media mixed terms such as blood clots, phlebitis, or embolism. Because some cases of blood clots did not result in a PE and were not treated as embolism, we needed to code cases carefully to include only those fulfilling the inclusion criteria. The inclusion criteria were clear: basketball players who were medically diagnosed as experiencing a PE in the period from 2010 to 2015.

To carry out this coding, two of the authors with medical training (physicians) independently coded the cases of our initial list. Their resultant coding was identical except for three cases. Those three cases were further discussed between the two coders and finally were not considered as PE.

**Computation of incidence of pe in basketball.** We only computed incidence of PE in the basketball leagues where we had reliable information about the number of players in every year of the analysis (from season 2010–2011 to 2014–2015). Using databases such as those available via www.nba.com, www.basketball-reference.com, www.acb.com, and www.draftexpress.com, we recorded the number of players playing every year in the NBA and the ACB. We did the same for the top leagues in France (Ligue Nationale de Basket), Italy (Lega Basket (LEGA), and Greece (Hellenic Basketball Clubs Association). Together, these leagues probably constitute the most important professional basketball competitions around the world according to the Euroleague (13).

**Incidence of pe in other populations.** We also needed to obtain data about incidence of PE in other populations, not related to basketball, with a similar age to achieve a comparison. We searched PubMed for references to studies reporting the incidence of PE by age. The lack of statistics about this topic is evident, and we only found two studies (27,34) where the incidence of this illness was reported by age group (25–34 yr old), coinciding with the age range of basketball players identified in the main leagues around the world.

Finally, we also believed it necessary to compute incidence of this illness in other professional sports to have a wider perspective regarding the incidence of PE in other team sports. This analysis would allow us to better understand whether differences in incidences between basketball and the other two populations were primarily driven by basketball itself or was a more complex problem affecting professional sports. We selected the most important professional team sports playing in the United States, Spain,

France, and Italy (1), enumerated as follows: United States: hockey (National Hockey League (NHL)), football (National Football League (NFL)), soccer (Major League Soccer), and baseball (Major League Baseball) (2); Spain: soccer (Liga BBVA) (3); France: soccer (4); and Italy: soccer.

Thus, we collected data about incidence in the populations of eight additional professional team sports. To achieve this aim, we applied the same information search procedure as that for basketball. Two authors searched the main sports Web sites and recorded the cases. Subsequently, the other two authors verified the cases to select only those diagnosed as PE.

We checked information relating to other professional competitions to gain a broader perspective of the incidence of PE in other team sports. This analysis would allow us to improve our understanding of whether the hypothetical differences in the incidence between the basketball players and the other two populations studied were primarily driven by basketball as such or whether there is a more complex underlying problem affecting professional sports.

**Statistical analysis.** A descriptive study of all variables of interest was carried out; for categorical variables, absolute and relative frequencies are presented, whereas for continuous variables, measures of central tendency and of statistical dispersion were calculated.

The incidence rates of PE in the professional leagues (NBA and ACB) were calculated as the number of new PE cases in a fixed period divided by person-time at risk during that period. The denominator consisted of the sum of players involved in each season, which is equivalent to (average population size) × (duration of follow-up) and which serves as an estimate of total time at risk. We considered 5 yr (covering seasons 2010–2011 to 2014–2015) because the first case detected occurred in March 2011 and the last occurred in February 2015, although it must be remembered that the current season is not over yet.

Incidence rates of PE were calculated using the "pois.exact" function, part of the "epitools" package of the R software system, which provided 95% confidence intervals (CI) via the Poisson distribution. The incidence among professional basketball players was compared with that of the general population groups age 25–34 yr. All analyses were performed with the R statistical package version 3.1.1 (The R Foundation for Statistical Computing, Vienna, Austria).

## RESULTS

Thirteen cases were detected by searching the Internet via Google, and another two were identified in PubMed (5,6,12,14–16,25,28,29,41,42,45–48). Most cases detected were men (66.7%). Mean ages were 28.8 yr among males (SD, 6.3 yr) and 20.4 yr (SD, 1.8 yr) among females. One of these cases (professional) was diagnosed in 2011 and subsequently presented a relapse in 2013. The characteristics of these patients are presented in Table 1. The units of measurement for height and weight were converted into meters (m) and kilograms (kg), respectively. Six cases were detected among professional basketball players of the two major leagues investigated (NBA and ACB).

The average annual incidence of PE among these players is presented in Table 2, where it may be seen that the incidence is higher than that of the general populations of Minnesota (34) and Norway (27) for the same age and sex (Table 2). No cases of PE were detected among basketball players in other important European leagues such as the Greek or French, and only one case of PE was detected in Italy (Table 2). The average annual incidence of PE among other popular sports for different countries is also presented in Table 2. The NHL, NFL, and professional soccer players in France have the highest incidence. A forest plot of PE for 95% CI incidence was presented in Figure 1.

The evolution of six of these cases was satisfactory, although they had to stop playing professional basketball for at least 1 yr. The remaining case had an important risk factor and a history of surgical operation. Another relevant question, as revealed by comments in the media, is the diagnostic

TABLE 1. Characteristics of the 16 basketball players affected by PE between seasons of 2010–2011 and 2014–2015.

| Players | Nationality | Sex | Team | League | Competition | Age (yr) | Height (m) | Weight (kg) | Position | Year of Diagnosis |
|---|---|---|---|---|---|---|---|---|---|---|
| C. B. | American | Male | Miami Heat | NBA | NBA | 30 | 2.11 | 106.6 | Forward | 2015 |
| M. T. | Bosnian | Male | Brooklyn Nets | NBA | NBA | 29 | 2.06 | 116 | Forward | 2015 |
| A. V. | Brazilian | Male | Cleveland Cavaliers | NBA | NBA | 30 | 2.11 | 121.1 | Center | 2013 |
| P. M. | American | Male | F. C. Barcelona | ACB | A European league | 35 | 1.99 | 103 | Forward | 2013 |
| P. M. | American | Male | F. C. Barcelona | ACB | A European league | 35 | 1.99 | 103 | Forward | 2011 |
| P. S. | Senegal | Male | Caja Laboral | ACB | A European league | 29 | 2.08 | 113.4 | Center | 2011 |
| M. P. | Lithuanian | Male | Olimpia Milano | LEGA | A European league | 31 | 2.09 | 118 | Center | 2011 |
| T. J. | American | Male | Putnam City West | High School | Amateur | 17 | 1.93 | 90.71 | Guard | 2014 |
| G. R. | American | Female | University of Kentucky | American University Women's Basketball | Amateur | 18 | 1.85 | NA | Forward | 2013 |
| S. K. | American | Female | Akron | College | Amateur | 22 | 1.83 | NA | Guard–forward | 2013 |
| R. B. | American | Female | Minnesota Gophers | American University Women's Basketball | Amateur | 19 | 1.75 | NA | Center | 2012 |
| S. S. | American | Female | Louisville | College | Amateur | 21 | 1.75 | NA | Guard | 2013 |
| A. S. | American | Female | Louisville | College | Amateur | 22 | 1.85 | NA | Guard | 2013 |
| NA[a] | NA | Male | NA | NA | Professional | 34 | NA | NA | NA | 2012 |
| NA[b] | Hispanic | Male | NA | NA | Amateur | 18 | NA | NA | NA | 2014 |

[a]Information obtained from scientific article: Yasar U., Coskun U., Imre G., Bostan C., et al. Massive pulmonary embolism with extreme hypoxia and hypocarbia caused by knee bandage in young male. *Kardiyovasküler T₁p E-Dergisi.* 2012. Available from: http://www.turkkardiyovaskulertipe-dergisi.com.
[b]Information obtained from scientific article (45).
F.C. Barcelona, Fútbol Club Barcelona; NA, not available.

TABLE 2. Comparison between the incidence rates of PE in people age 25–34 yr from Minnesota and Norway with basketball players and other popular sports for different countries.

| | Cases | Population | Average Annual Rate × 1000 |
|---|---|---|---|
| General population | | | |
| Population of Minnesota age 25–34 yr | 5 | 50,000 | 0.1 |
| Population of Norway age 25–34 yr | 1 | 54,026 | 0.018 |
| Professional basketball players age 25–34 yr[a] | | | |
| NBA population | 3 | 2358 | 1.27 |
| ACB population | 3 | 1455 | 2.06 |
| LEGA population | 1 | 1463 | 0.68 |
| LNB population | 0 | 1314 | 0 |
| HEBA population | 0 | 1193 | 0 |
| Other professional sports in USA | | | |
| NHL professional hockey players | 2 | 4351 | 0.46 |
| NFL professional American football players | 2 | 11,513 | 0.17 |
| MLS professional soccer players | 0 | 2630 | 0 |
| MLB professional baseball players | 0 | 23,750 | 0 |
| Soccer in Europe | | | |
| Professional soccer players in Spain | 0 | 3083 | 0 |
| Professional soccer players in France | 1 | 3084 | 0.32 |
| Professional soccer players in Italy | 0 | 3466 | 0 |

[a]For the as yet incomplete 2014–2015 season, a provisional total number of players has been used. However, only small changes are expected in the figure by the end of the season.
HEBA, Hellenic Basketball Clubs Association; LNB, Ligue Nationale de Basket; MLB, Major League Baseball; MLS, Major League Soccer.



delay resulting from suspicion of the existence of other conditions (pneumonia, asthma, …), and in all cases, the recognition by players and their families of both the severity and of the high risk of death.

**Sensitivity analyses.** A simple deterministic sensitivity analysis (32) was performed to explore the potential of the bias from underreporting incident PE cases between the exposed and unexposed.

If we assume, for example, a scenario with 100% outcome specificity for exposed (NBA) and unexposed (Minnesota) groups, 80% outcome sensitivity in the exposed group, and 90% outcome sensitivity in the unexposed group, and no more than 10% difference between outcome sensitivity values of exposed and unexposed groups, the corrected incidence PE rate for NBA population, 1.59, ranged from 0.46 to 3.71.

The estimated unadjusted incidence rate ratio (IRR = exposed incidence rate/unexposed incidence rate) comparing NBA players with the Minnesota population is 12.73, but in the previous scenario considered, it would be equal to 14.32. That is, if there is an underreporting of PE cases, the estimated IRR would actually be larger than the one obtained.

## DISCUSSION

During the 5-yr span studied, at least 15 cases of PE among basketball players have been reported, indicating that the incidence of PE among professional basketball players of the NBA and ACB leagues could be higher than that in the general population of the same age and sex.

In most cases, PE has multiple causes, in which a series of permanent factors (whether congenital or not) interact with other temporary or reversible factors that may have occurred days, or perhaps weeks, before the manifestation of the disease (31) It is well-known that the incidence of PE rises with age, being more common in advanced stages of life, when there is a whole series of temporary factors of varying levels of risk as well as a high risk after surgical operations and/or severe traumatic injuries; autoimmune processes, hormonal therapies, or erythropoiesis stimulators result in moderate risk; and finally, lower levels of risk are associated with immobility or minor surgical operations, among others (22,27,30,34).

It is thus a surprise when young athletes in good health present with this condition. However, if we reflect on the activities of professional athletes, we may observe that they show an important accumulation of minor predisposing conditions that could explain why they experience this disease more often than we can consider as a conventional rate (48). Professional athletes are exposed to high levels of effort, which may result in a process of chronic inflammation, repeated injuries, frequent air travel (economy-class syndrome),



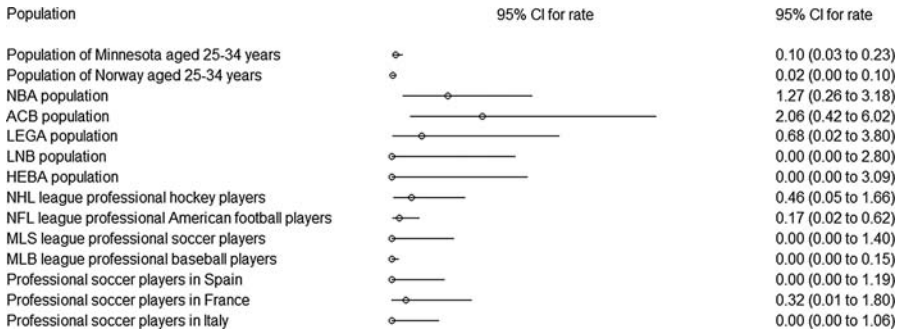


**FIGURE 1—Forest plot of PE incidence in people age 25–34 yr from Minnesota and Norway with basketball players and other popular sports for different countries.**

and the subsequent immobility (17,36,37) to novel treatments of injuries such as platelet-rich plasma (2,11,21,43) and a whole series of additional circumstances that when combined may point out professional basketball as a special population at risk. This is relevant for several issues, including primary prevention of the disease and the diagnostic suspicion of a disease that is often asymptomatic and in which an early prognosis could lead to an early treatment. Health and sporting authorities therefore ought to investigate whether in fact basketball players, particularly professional players, are possibly at a higher risk of PE than other populations and, if so, determine the predisposing factors; doing this would require having access to clinical and epidemiological information about detected cases.

There are some major limitations in the present work. One of the main limitations is that there are no official registries for cases of this disease among basketball players, so our research had to be based on searches for published information, resulting in an underestimated number of detected cases. In addition, as we have mentioned previously, we lack access to clinical information. For example, amateur league cases could be underrepresented in the media, or perhaps some important basketball players could be underrepresented for confidential reasons. PE could possibly imply that the player loses the contract or that the player's salary goes down, or it could give the player a bad reputation.

An additional problem is that to obtain denominators for the ACB and NBA leagues, we assumed we were dealing with a relatively stable population, whereas in reality, players change clubs and franchises, are permanently injured, or drop out for other reasons; in addition, some are new incorporations from other professional leagues or college and training leagues that feed into professional teams. Note also that the 2014–2015 season is still not complete, so the number of players involved can increase. Moreover, information about the true incidence of PE is very limited and existing studies are based on estimates; cohort studies provide small number of cases and hence are very prone to considerable variability (36). The same may be said of our study, with only six cases in the NBA and ACB and a very small population susceptible to high variability.

In any case, it is surprising that basketball is the sports in which most cases have been detected, and although it has not been possible to calculate rates for minor leagues because of the lack of denominators, the high number of cases among such young people is noteworthy. This could possibly bear some relation with being tall and indeed could be a risk factor, according to some authors (24). For example, the mean height in six PE cases in our study was 2.05 m (95% CI, 1.99–2.11). New studies should determine whether the height can be influential. Also notable is the frequency of cases among women basketball players, where other additional factors such as taking oral contraceptives might play a role (4,7,44). Regarding the results, the proportion of PE in our study seems to indicate a higher risk in males than in females. It probably suggests and reflects a higher participation and possibly increased illness surveillance and reporting in male sports as well as higher coverage in the media in this population.

In an attempt to better assess our findings, we reviewed the information available about other basketball leagues. We found no cases in Greece or France, but there was one in Italy. However, we do not know whether this means there are no cases or whether it is due to the confidential handling of medical information or to language-related problems in the search strategy. These observations could also be extrapolated to the results obtained from reviewing information available for other sports.

## CONCLUSIONS

There are reasonably strong signs that basketball players may constitute a group especially at risk of experiencing PE. The accumulation of many low-intensity risk factors may result in a high risk of PE. The severity of the disease, the existence of primary preventions, and the consequences for prognosis of early diagnosis and prompt treatment suggest the need to investigate whether we really are dealing with a group with an elevated risk to comply with the International Olympic Committee's ruling on protection and promotion of health among athletes.

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