British Medical Bulletin, 2018, 1–10
doi: 10.1093/bmb/ldy001

Invited Review

Osteoarthritis of the hip and knee in former male professional soccer players

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Editorial Decision 28 December 2017; Accepted 1 January 2018

Abstract

Background: Professional soccer (PS) players are at great risk of osteoarthritis (OA) of the knee and hip.

Sources of data: Following the PRISMA guidelines, the key words 'osteoarthritis' and 'soccer' or 'football' were matched with 'players' or 'former' or 'retired' and with 'hip' or 'knee' on December 24, 2017 in the following databases: PubMed, Cochrane, Google scholar, Embase and Ovid. Only comparative studies reporting the prevalence rate of OA of both hip and knee joint in former PS athletes (fPSa) and age and sex matched controls were considered.

Areas of agreement: In fPSa, the prevalence rate of OA of both hip and knee is significantly higher compared to age and sex matched controls.

Areas of controversy: The pathological pathways responsible for the development of OA of the hip and knee in PS athletes (PSa) are still not clearly understood.

Growing points: The prevalence rate of clinical OA of the hip was 8.6% in fPSa and 5.6% in controls (odd ratio (OR) = 1.5; 95% CI: 1.06–2.31). The radiographic rate of OA was 21.2% in fPSa and 9.8% in controls (OR = 2.4;

95% CI: 1.66–3.69). A total of 14.6 and 53.7% of fPSa presented clinical and radiographic signs of OA of the knee, respectively, vs 12.9% (OR = 1.16; 95% CI: 0.86–1.55) and 31.9% (OR = 2.47; 95% CI: 2.03–3.00) of controls. Sonographic evidence of OA of the knee was found in 52% of fPSa and 33% of controls (OR = 2.2; 95% CI: 1.24–3.89).

Areas timely for developing research: Preventive training programmes should be developed to reduce the number of fPSa presenting early OA.

Key words: osteoarthritis, hip, knee, soccer, football, athletes

Introduction

Osteoarthritis (OA) of the hip and knee is the fourth and eighth most prevalent pathology in female and male patients respectively, impacting negatively on work capacity and quality of life.[1] Following the increase of mean age and life expectancy of the general population, OA is expected to become the most frequent orthopaedic pathology in the elderly.[2,3] Moreover, patients with OA are at high risk to suffer from other medical conditions,[4–6] producing elevated costs for the National Health Systems.[1]

Factors such as ageing, female sex, obesity, smoking habit, rheumatological or haematological diseases, lower limb malalignment, trauma and sports activities are associated with OA of the lower limb.[4,7] Furthermore, in the last few decades, athletic activities, and in particular professional soccer (PS), have been recognized as a risk factor of OA of the lower limb.[8–13] Indeed, PS players are at greater risk for knee OA respect to athletes involved in other sports.[14]

Worldwide, ~200 000 PS athletes (PSa) are active every year.[15,16] PSa are exposed to a high risk to sustain lower limb joints trauma both during training and matches.[11,17–19] The most common type of injuries are muscle lesions,[20–23] followed by contusion and joints sprains involving the hip, knee and ankle.[17,24,25] The incidence of injuries per 1000 training hours in PSa was estimated to be 10–35.5, significantly higher than other sports.[26] Furthermore, several studies have demonstrated that the joints exposed to weight bearing and rotational motions such as the hip and knee are at high risk to develop early OA.[18,27–30] PS activity seems to play a crucial role in both aetiology and epidemiology of OA of the hip and knee, because of the synergy of overusing physical activity and high frequency of joint trauma.

Previous systematic reviews have highlighted that fPSa exhibit a high prevalence rate of OA of the ankle,[31] knee,[14,31] spine and hip.[32] However, none of these specifically evaluated the prevalence rate of OA of both hip and knee in male fPSa and age-sex matched controls.

This systematic review ascertained whether the prevalence of both hip and knee OA in male fPSa is higher compared to age and sex matched controls.

Materials and methods

The present systematic review was conducted in accordance with the PRISMA guidelines. The literature search strategy is summarized in Figure 1 (PRISMA flow diagram).

The literature search was performed on December 24, 2017 in the following databases: PubMed, Cochrane, Google scholar, Embase and Ovid. The key words matched were: 'osteoarthritis' and 'soccer' or 'football' with 'players' or 'former' or 'retired' and with 'hip' or 'knee'. All articles in English, Italian, Spanish and Portuguese language published in peer review journals from 1980 to 2017 were considered. Inclusion and exclusion criteria are summarized in Table 1.

The abstract of each article was screened. Articles without an abstract were excluded. If the

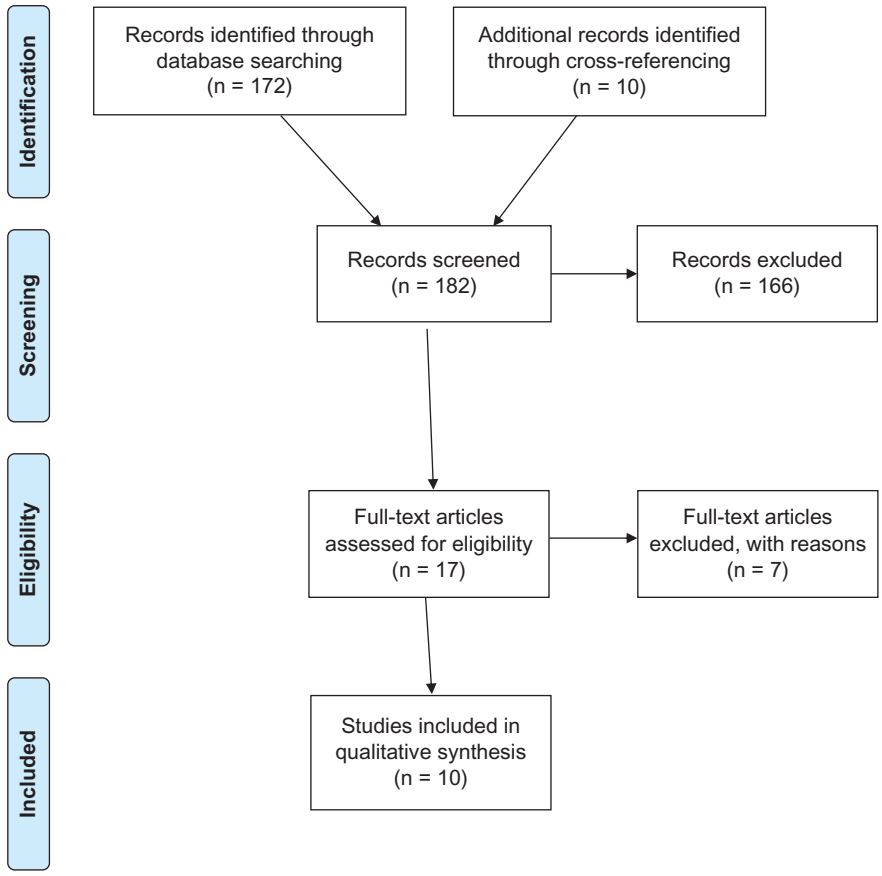

Fig. 1 PRISMA flow diagram.

Table 1 Inclusion and exclusion criteria of the study

Inclusion criteria	
Database	Medline, Google Scholar, Embase, Ovid, Pubmed
Type of study	Observational with age and sex matched control group
Language	English
Year of publication	1980–2017
Number of patients enroled	≥20
Sex of patients enroled	male
Duration of professional career	≥5
Diagnosis of OA	Radiographic, sonographic, clinical examination, clinical questionnaires
Exclusion criteria	
Type of study	Literature reviews, letters to editor, observational without control group
No of patients enroled	<20
Sex of patients enroled	Female
Duration of professional career	<5 years

abstract did not allow to assess the compliance with the defined inclusion and exclusion criteria, the full-text article was retrieved. Moreover, to identify other relevant articles eligible for the study, cross-reference search of the selected studies was performed. Two investigators (S.P. and R.P.) extracted

independently and in a blind fashion the following information from the included articles: (i) year of publication of the study; (ii) demographic details of the patients enroled in the studies (number of fPSa and controls, sex, age); (iii) role in the soccer field of fPSa; (iv) body mass index (BMI) of both fPSa and controls; (v) duration of professional career of fPSa; (vi) age at the time of diagnosis of hip and/or knee OA; (vii) prevalence rate of hip and/or knee OA in both fPSa and controls; (viii) method of diagnosis of hip and/or knee OA; and (ix) method of classification of radiographic results.

Data presentation

The continuous variables evaluated (age; duration of PS career; BMI) were expressed as mean value ± standard deviation (range). The prevalence rate of OA of both hip and knee joint in fPSa and controls was expressed as percentage (%). Odd ratio (OR) was reported as mean with 95% confidence interval.

Results

A total of 17 studies were identified as eligible for our systematic review. However, seven studies did not comply with our inclusion and exclusion criteria (six studies[8,9,33–36] without a control group; one study[37] in German language). Therefore, 10 articles[38–47] published from 1980 to 2017 were included.

All the included studies were observational, and included fPSa and an age and sex matched control group (Level III).

Demographic results

Overall, there were 3997 male individuals, of which 1406 (35.2%) were fPSa and 2591 (64.8%) were controls. The mean age was reported in 1406 (100%) fPSa and 2398 (92.5%) controls, and it was 54.7 ± 8.8 years (range: 44–70 years) and 56.3 ± 10.3 years (range: 43.7–70), respectively. The demographics characteristics of the individuals enroled in the studies are shown in Table 2.

Assessment of hip and knee OA

The prevalence rate of OA of the hip was estimated in five studies[39,40,42,44,45] involving 2470 (61.8%) individuals [fPSa: 688 (27.8%); controls: 1782 (72.2%)]. The prevalence rate of OA of the knee was estimated in eight studies[38–40,43,45–48] involving 3580 (89.5%) individuals [fPSa: 1267 (35.4%); controls: 2313 (64.6%)].

A total of eight studies[38,39,41–45,47] involving 2161 (54.1%) individuals [fPSa: 935 (43.3%); controls: 1226 (56.7%)] estimated the prevalence rate of OA of the hip and/or knee with radiographs. Of these, one study[39] involving 303 individuals [fPSa: 121 (39.9%); controls: 182 (60.1%)] used both radiographs and clinical examination, while another study[40] involving 1636 (43.6%) individuals [fPSa: 371 (22.7%); controls: 1265 (77.3%)] used a self-reported clinical questionnaire. In one study[46] involving 200 individuals [fPSa: 100 (10.7%); controls: 100 (4.7%)] the prevalence rate of OA of the knee was estimated with knee sonography.

The OA of the hip and/or knee was graded with the Kellgren–Lawrence[49] classification in three studies,[38,39,48] while the Croft,[42] Ahlback[43] and Danielsson[44] classification was used in one study each. In another study,[45] the radiographic diagnosis of OA of the hip and knee was made analysing the presence of joint space narrowing, subchondral sclerosis and cysts. Another study[50] used both the Nottingham Line Drawing Atlas (NLDA)[50] and Kellgren–Lawrence classification to grade knee OA, while in only one study[46] the presence and extent of OA of the knee was assessed with sonography according to published guidelines.[51–53]

Prevalence rate of hip and knee OA

The prevalence rate of OA of both hip and knee was higher in fPSa than controls (Table 3). The prevalence rate of clinical and radiographic OA of the hip and knee, and of sonographic OA of the

Table 2 Demographic details of the patients

	Reported in *N* (%)		Result	
	fPSa	Controls	fPSa	Controls
Patients enroled	1406 (100%)	2591 (100%)	1406	2591
Mean age[38–42,45–47]	1406 (100%)	2398 (92.5%)	54.7 ± 8.8	56.3 ± 10.3
Role in the soccer field[38,41]	67 (8%)	n.a.		
Goalkeepers			11	n.a.
Defenders			21	n.a.
Midfielders			19	n.a.
Strikers			16	n.a.
Duration of PS career[38,39,41,42,45,46]	323 (38.6%)	n.a.	15.8 ± 4.6	n.a.
BMI[38,39,47]				
During PS career	148 (17.7%)	n.a.	22.7 ± 0.5	n.a.
During investigation	1130 (28.2%)	2118 (52.6%)	26 ± 0.7	26.7 ± 1.4

fPSA, former professional soccer athletes; PS, professional soccer; BMI, body mass index.

Table 3 Overall prevalence rate of clinical and radiographic OA of the hip and knee, and of sonographic OA of the knee in fPSa and controls

	Evaluated in *N* patients		Results		OR (95% CI)
	fPSa	Controls	fPSa	Controls	
Hip OA[39,40,42,44,45]					
Clinical[39,42]	492	1447	8.6%	5.6%	1.5 (1.06–2.31)
Radiographic[39,40,42,44,45]	317	513	21.2%	9.8%	2.4 (1.66–3.69)
Knee OA[38–40,43,45,46,48]					
Clinical[39,41]	492	1447	14.6%	12.9%	1.16 (0.86–1.55)
Radiographic[38–41,43,45,47]	796	948	53.7%	31.9%	2.47 (2.03–3.00)
Sonographic[46]	100	100	52%	33%	2.2 (1.24–3.89)

OA, osteoarthritis; fPSa, former professional soccer athletes; OR, odds ratio; 95% CI, confidence interval.

knee in both fPSa and controls is reported in Table 3, with associated OR and 95% CI.

Discussion

The present systematic review assessed whether the prevalence rate of OA of both hip and knee in male fPSa was higher than that of age and sex matched individuals. fPSa present a higher prevalence rate of OA of both hip and knee compared to controls at a mean age of 55 years. The prevalence rate of clinical OA of the hip in fPSa was 8.6% (vs 5.6% of controls), while it was 21.2% for radiographic features of OA of the hip (vs 9.8% of controls). A total of 14.6 and 53.7% of fPSa had a clinical and radiographic diagnosis of OA of the knee respectively (vs 12.9 and 31.9% of controls).Moreover, the prevalence rate of sonographic OA of the knee was 52% in fPSa and 33% in controls. These results about prevalence rate of OA of the hip and knee are significantly higher than those reported in non-PSa.[54]

The results of our study are similar to those reported in different systematic reviews on the topic. Lohkamp *et al.*[32] demonstrated that the prevalence of hip OA and hip replacements is

significantly higher in former PS players compared to a control group. Similar findings were reported by Driban *et al.*[14] and Kuijt *et al.*[31] regarding OA of the knee.

The prevalence rate of OA of the hip in the general population ranges from 0.7 to 4.4%, and it increases to 3.2–4% in patients older than 60 years.[54] The prevalence rate of OA of the knee ranges from 6.1 to 21%, and it increases to 10.1% in individuals older than 70 years. Furthermore, in the United Kingdom, clinical OA of the knee in non-professional athletes aged 45 years was 12.5%, while radiographic OA of the knee in individuals older than 50 years was 18%.[54]

We included a total of 10 comparative studies in the present systematic review. The instruments used to evaluate the prevalence rate of OA strongly influence the results. Radiographic diagnosis was associated with a higher prevalence rate of OA than clinical diagnosis. Plain radiography of the hip and knee were the most common diagnostic method used in the studies included in our systematic review. However, no agreement was found within these studies in the classification of radiographic results. The Kellgren–Lawrence[49] classification was used in three studies,[38,39,48] while the Croft,[42] Ahlback[43] and Danielsson[44] classification was used in one study each, while in another study[47] the OA of the knee was scored with both Kellgren–Lawrence[49] classification and NLDA.[50] These findings suggest a huge heterogeneity of outcomes measurement, producing a high variability of results. Moreover, radiographs had an intra- and inter-rater variability of 0.85–0.91 and 0.91–0.93, respectively, to diagnose OA.[32] Furthermore, the diagnosis of OA through radiographs, especially regarding the knee, is influenced by the type of views used.[32]

Professional athletic activity stressing lower limb joints is associated with a high prevalence rate of lower limb OA.[18,55,56] Iosifidis *et al.*[39] reported a statistically significant higher prevalence rate of radiographic OA in elite athletes compared with non-sports controls (36.6% in athletes vs 23.9% in controls). However, they reported that former professional athletes without history of trauma have similar prevalence rate of lower limb OA of an age-matched control group of non-professional athletes.[39] Tveit *et al.*[40] confirmed that OA of the hip and knee is common in former PSa, while OA of the knee in impact athletes was associated with previous knee injuries.

When considering soccer, several studies have explained a relationship between overuse, repetitive loading, trauma and the development of OA of the lower limb.[57] The risk of injury is higher during matches because of contacts and increased competitiveness,[17] and PSa have an injury risk 1000 times greater compared with industrial workers.[9,33]

OA of the hip develops earlier in relatively young PSa, while OA of the knee is strongly related with history of trauma and previous surgery.[58–64] Modifications of the hip anatomy begin in young PSa because of overuse and high repetitive torsional loadings.[65] Moreover, an increased prevalence of femoro-acetabular impingement was found in PSa.[66] All these conditions determine abnormal hip biomechanics leading to cartilage degeneration and early onset of OA.[10,67–69] On the other hand, PSa are at a high risk to sustain anterior cruciate ligament (ACL) or menisci lesions during their career.[70,71] In these patients, surgery is often performed to restore knee function and allow resumption of sports participation.[72–77] However, ACL reconstruction or meniscectomy was related to the development of early OA of the knee in 50 and 92% of the patients, respectively.[2,70,71,78–82] Moreover, isolated ACL or meniscal lesions produce a 10-fold increased risk to develop OA compared to uninjured individuals.[70,71,82] Furthermore, genu varus was associated with the development of OA of the knee in young soccer players.[83]

The major strength of our systematic review is that it was conducted following PRISMA guidelines. Moreover, to assess whether the prevalence rate of OA of both hips and knees was higher in fPSa compared to non-PS individuals, only comparative studies with an age and sex matched control group were included. Another strength is that both literature search and analysis of results was performed by two independent investigators in a blind fashion. Furthermore, we have included only male fPSa, and

the amount of patients included in our study is large enough to guarantee a large enough sample for the scope of our study.

However, we are aware that the main limitation of our study is represented by its design. Another important limitation is that our results were not stratified according to history of trauma, previous surgery of the hip or knee, BMI, smoking habit, rheumatologic or hematologic diseases, which are well-known risk factors for the development of OA. Unfortunately, risk factors were rarely reported in the primary studies. Nevertheless, our results are similar to those reported in other studies about the topic, suggesting a higher prevalence of OA of both hip and knee in fPSa compared to controls and compared to the general population.

Conclusions

In fPSa, the prevalence rate of OA of both hip and knee is significantly higher compared to age and sex matched controls.

Based on the evidence available in the current peer reviewed published literature, OA of the hip is associated with overuse and repetitive loadings, resulting in morphological changes of hip anatomy which begin in youth age. Furthermore, earlier trauma, ligaments or meniscal injuries requiring surgery demonstrate evidence of a statistically significant association with OA of the knee.

The pathological pathways involved in the development of OA of the hip and knee in PSa are not clearly understood yet. These may be useful to develop effective prevention programmes to reduce the number of fPSa developing early OA.

Conflict of interest statement

The authors have no potential conflicts of interest.

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