What Is the Association of Elite Sporting Activities With the Development of Hip Osteoarthritis?

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Background: Male athletes participating in certain elite sporting activities may be at an increased risk for development of hip osteoarthritis (OA) later in life. However, the strength of the association of participation in sporting activities with the increased risk of hip OA has not been well summarized.

Purpose: To investigate the association of certain high-impact sporting activities with the risk of development of hip OA in elite athletes by conducting a systematic review of the available literature.

Study Design: Systematic review; Level of evidence, 3.

Methods: PubMed, Cochrane, and EMBASE databases were searched to identify all potential studies. Eleven studies met the inclusion criteria, which included participation in elite-level sporting activities, greater than 50% male athletes in the study population, diagnosis of hip OA by radiograph, hospital admission or total hip arthroplasty (THA), and greater than 80% follow-up. Exclusion criteria were recreational sporting activities, primarily female cohorts as there was a dearth of available literature on the topic, and self-reported symptoms without radiographic confirmation of diagnosis. Most studies were with European athletes, where elite-level was defined as involvement in national- or professional-level competition.

Results: Participation across elite-level impact sports was associated with increased risk of development of hip OA when compared with matched controls (odds ratio, 1.8-8.7). Twelve of 15 studies reviewed demonstrated an odds ratio of 1.8 or greater of developing hip OA in elite-level athletes. Handball was associated with the highest rate of OA of any sport, nearly 5 times that of matched controls. Soccer players demonstrated between 2 and 9 times increased risk of hip OA as defined by radiography or THA. Hockey players demonstrated 2 to 3 times increased risk of hip OA (THA or hospital admission). Five studies investigating the association of competitive long-distance running with hip OA demonstrated inconsistent results.

Conclusion: Currently available literature suggests that male athletes participating in elite impact sports (soccer, handball, track and field, or hockey) are at an increased risk of developing hip OA, while those participating in high-level long-distance running do not have a clearly elevated risk. Further research is warranted to elucidate the pathomechanics of development of hip OA in these patients.

Keywords: hip; arthritis; osteoarthritis; sports

Male athletes who participate in certain elite-level sporting activities appear to be at an increased risk for hip osteoarthritis (OA) later in life. However, unlike knee OA, hip OA is often seen without a history of preceding associated injury. In the past decade, our understanding of prearthritic hip pathologic changes has greatly advanced. Femoroacetabular impingement (FAI) is now recognized as a common cause of hip pain and intra-articular pathologic abnormalities in athletes.[2,3] In particular, a cam-type deformity of the proximal femoral head-neck junction has been shown by multiple epidemiologic studies to represent a risk factor for hip OA. In fact, FAI is the predominant cause of hip OA in males.[1]

Sporting activity participation during adolescence is associated with the development of cam deformity in males, as recently summarized in a systematic review.[10] However, the strength of the association of participation in elite sporting activities with the development of the risk of hip OA has not been well summarized. The purpose

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of this systematic review was to investigate the current literature on the association of sporting activity to the development of hip OA in male athletes using exclusion and inclusion criteria as defined below, modeled upon prior investigation by our group in a recently published systematic review on the association of sporting activity participation with development of a cam deformity.[10]

METHODS

We identified potential studies regarding the relationship of sports to the development of hip OA by searching PubMed, EMBASE, and the Cochrane library databases. The bibliography of reviewed studies was further analyzed for identification of any additional literature. Study titles and/or abstracts were reviewed by 2 coauthors (J.V., J.N.) independently and then compared. Full texts of potential studies were obtained and reviewed for potential inclusion. Any differences between the 2 reviewers were discussed and consensus was reached.

Inclusion criteria were defined as participation in competitive sporting activities; cohorts with greater than 50% males and a matched control group; diagnosis of hip OA by radiograph, hospital admission, or total hip arthroplasty (THA); follow-up greater than 80%; and peer-reviewed English-language studies. Exclusion criteria included recreational sporting activities, cohorts primarily composed of females, and self-reported symptoms of hip pain or arthritis. Female cohorts were excluded given the scarcity of such studies in the literature noted on preliminary review of the literature. Foreign-language studies, non–peer-reviewed studies, and those that focused on recreational sporting activities were excluded without abstract review. Database search terms including *hip, osteoarthritis, arthritis, sport*, and *athlet** returned 893 results (Figure 1). Eleven studies met criteria for this portion of the study. Additional query of EMBASE and Cochrane databases returned 90 and 0 additional potential studies, respectively, but no additional studies met criteria for inclusion.

Statistical Testing

Pooled rates of outcome of hip OA were calculated by weighting each study result by the size of the cohort. We then used the chi-square test to compare prevalence of the outcome variable between 2 groups. $P < .05$ was considered statistically significant.

RESULTS

Eleven studies (15 cohorts of athletes separated by type of athletic activity) investigating the rate of OA in males participating in sporting activities relative to controls were identified (Table 1). Soccer was the most commonly investigated sport (n = 5),[4,6,8,13,14] along with long-distance running (n = 5).[5,6,9,11,14] Definitions of OA included

Figure 1. Flowchart demonstrating identification of studies included.

radiographic measures (n = 7), THA (n = 3), and hospital admission for hip OA (n = 1). Rates of prevalence of hip OA in athletes varied from 3% to 60%, compared with 0% to 26% for controls. Eight studies (10 cohorts of athletes grouped by activity type) investigating the association of generally elite-level, impact, and cutting/pivoting sports all demonstrated higher rates of hip OA in athletes compared with controls, with odds ratios from 1.8 to 8.7. All studies utilized age- and sex-matched control cohorts, but from various sources.

Five studies investigating the association of competitive long-distance running with hip OA demonstrated inconsistent results.[5,6,9,11,14] Puranen et al[11] demonstrated lower rates of hip OA in male runners compared with controls (4% vs. 9%). Two studies demonstrated higher rates in runners (19% vs 0%[9] and 5% vs 1%[6]). Two other studies demonstrated similar rates of hip OA in runners compared with controls (6% vs 4%[14] and 5% vs 4%[5]).

Soccer was the focus of 3 studies, and the most common sport in mixed-impact sports cohorts (ie, multiple sports grouped together within a study, not allowing separation) in 2 other studies. Two studies showed a THA rate of 9% in cohorts of male soccer players with mean ages of 44 and 77 (3 to 9 times the rate in controls).[13,14] Rates of radiographic hip OA in soccer players ranged from 14% to 49% (2 to 3 times the rate in controls).[4,8] Handball was associated with the highest rate of OA of any study, with a nearly 5 times greater rate of OA relative to controls (60%; odds ratio [OR], 4.6).[7] Hockey players composed a significant portion of mixed-impact sports cohorts in 2 studies, demonstrating 2 to 3 times increased risk of hip OA (THA or hospital admission).[6,14] Track and field was the

TABLE 1
Studies Comparing Rates of Osteoarthritis in Athletes to Controls[a]

Study	Design	Sport	No. of Patients[b]	Patient Age, y, mean (range)	No. of Controls[b]	Control Matched	Hip OA Definition	Hip OA Prevalence Rate, %		OR (95% CI)	Note
								Patients	Control		
Tveit et al[14] (A)	Cohort-control	Elite impact (soccer, handball, hockey)	573	70 (50-93)	1247	Age, sex	THA	9	4	3.1 (1.8-5.1)	Rates of hip OA by questionnaire, 15% vs 8%
L'Hermette et al[7]	Cohort-control	Competitive handball	20	45 (37-54)	39 (trauma patients)	Age, sex, BMI	Radiograph (K&L ≥2)	60	13	4.6	OA rate by individual/ either hip
Shepard et al[13]	Cohort-control	Elite soccer	68	44 (32-59)	136 (gastrointestinal patients)	Age, sex	THA	9	0	8.7	Rates of hip OA by questionnaire, 13% vs 1%
Lindberg et al[8]	Cohort-control	Elite soccer	71	63 (NR)	142 (random population)	Age, sex	Radiograph (JSN)	14	4	3.4	Radiograph in 20% of each population for clinical symptoms
Klünder et al[4]	Cohort-control	Elite soccer	57	56 (40-79)	57 (hospital patients)	Age, sex, weight	Radiograph (JSN, subchondral sclerosis, cysts)	49	26	1.9	
Schmitt et al[12] (A)	Cohort-control	Elite high jump	22		22 (nonathletes)	Age, sex, BMI	Radiograph (K&L ≥2)	34	14	2.5	OA rate per hip
Schmitt et al[12] (B)	Cohort-control	Elite javelin	19		19 (nonathletes)	Age, sex, BMI	Radiograph (K&L ≥2)	58	18	3.2	OA rate per hip
Vingård et al[15]	Cohort-control	Elite track and field	114	NR (50-80)	355 (random)	Age, sex	THA	5-8	1-2	4.0	All but 3 patients with hip OA diagnosis underwent THA (NR which group)
Kujala et al[6] (A)	Cohort-control	Elite mixed (soccer, hockey, basketball, track)	760	64 (NR)	959 (healthy)	Age, sex	Hospital admission for hip OA	3	1	1.8	
Kujala et al[6] (B)	Cohort-control	Elite power sports (boxing, wrestling, weightlifting, throwing)	488	67 (NR)	959 (healthy)	Age, sex	Hospital admission for hip OA	4	1	2.5	
Kujala et al[6] (C)	Cohort-control	Elite endurance (cross-country running/ skiing)	189	70.5 (NR)	959 (healthy)	Age, sex	Hospital admission for hip OA	5	1	3.8	
Tveit et al[14] (B)	Control-cohort	Elite nonimpact (canoeing, running, other)	90	70 (50-93)	1247	Age, sex	THA	6	4	1.9 (0.6-5.9)	Rates of hip OA by questionnaire, 9% vs 8%
Marti et al[9]	Cohort-control	Elite running	27	42 (NR)	23 (healthy)	Age, sex	Radiograph (moderate/ severe JSN, sclerosis, osteophytes)	19	0		
Puranen et al[11]	Cohort-control	Elite running	74	55 (31-81)	115 (hospital patients)	Age, sex	Radiograph	4	9	0.5	
Konradsen et al[5]	Cohort-control	Competitive running	30	58 (50-68)	27 (hospital patients)	Age, sex, BMI, occupation	Radiograph (JSN)	5	4	1.3	1 athlete with THA not included in rate

[a]BMI, body mass index; JSN, joint space narrowing; K&L, Kellgren and Lawrence; NR, not reported; OA, osteoarthritis; OR, odds ratio; THA, total hip arthroplasty.
[b]All study participants and study controls were male.

focus of 2 studies (1 nonspecific; another high jump and javelin) and included in a mixed-impact sports cohort in another study.[6,12,15] Each of these studies reported 2 to 4 times increased rates of hip OA. One study included basketball among a mixed cohort of impact sports and demonstrated a rate of OA (hospital admission) double that of controls (OR, 1.8).[6] No studies investigated isolated cohorts of hockey or basketball players. No studies were identified that investigated the rates of hip OA in American football (collegiate or professional).

DISCUSSION

In this systematic review, we demonstrate that patients with a history of participation in certain elite-level impact sporting activities are at a significantly increased risk of hip OA. Overall, participation in elite-level impact sports (soccer, hockey, handball, track and field) is associated with a 2- to 9-fold increase in the risk of hip OA. Males participating in elite long-distance running do not appear to have a definite increase in risk of hip OA.

Most of the studies include European athletes, where elite level was defined as national or professional level. Soccer, the most played sport in the world, is not surprisingly the most studied sport regarding the risk of hip OA. Soccer was associated with a 2- to 9-fold increased risk of hip OA as defined by radiographs or THA. The risk of hip OA associated with participation in high-level running, hockey, basketball, and American football remains to be better defined. In particular, the association of elite-level running with hip OA is inconsistent. Of 5 studies of elite-level runners reviewed, 2 showed no difference between control and cohort, 2 showed an increased risk of hip OA in runners, and 1 study actually showed a protective benefit. The last study, Puranen et al[11] (1975), suggested that the repetitive motion of running allows for synovial fluid to enter the cartilage and provide nutrition. This benefit was not demonstrated by more recent studies.

The current literature for the systematic review investigates primarily male athletes, and these results do not appear to be applicable to females. Further research is needed to characterize differences between males and females in hip maturation and response to athletic stress. Several studies investigating participation by females in long-distance running and ballet/dancing with the association of hip OA exist but were not the focus of the current study, as there was a scarcity of available primary literature. Female participation in impact sporting activities, similar to those sports investigated for males, is a relatively recent phenomenon. Future research into the rates of development of hip OA in these athletes is needed to determine if similar trends to those seen in males exist.

Although not the focus of this review, a separate literature review on athletes participating in certain impact and jumping sports during adolescence found them to be at a 1.5 to 2.5 times increased risk of development of a bony cam deformity at skeletal maturity. Current literature supports an increased risk of the development of cam deformities in athletes participating in intensive impact sports during adolescence. However, this participation has not been directly linked to the development of hip OA. The cam deformity is best viewed as a risk factor for intra-articular hip disease and potentially OA in athletes who continue to participate in at-risk activities.[10] The current review demonstrates an association of elite-level participation in some impact sports with the development of OA. It is important to note this exposure differs significantly in level and duration of sporting activity investigated during adolescence. The risk of developing hip pain and/or OA for athletes with a proximal femoral cam deformity is unclear.

CONCLUSION

Male athletes participating in elite levels of impact sports (soccer, handball, hockey, track and field) are at an increased risk of developing hip OA, while those participating in long-distance running do not have a clearly elevated risk. Further investigation is warranted to determine if the risk of hip OA in males participating in high-level impact sports may be related to underlying cam-type FAI and continued high levels of activity.

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