HHS Public Access

Author manuscript

Curr Opin Rheumatol. Author manuscript; available in PMC 2015 May 01.

Published in final edited form as:

Curr Opin Rheumatol. 2015 May ; 27(3): 276–283. doi:10.1097/BOR.0000000000000161.

Epidemiology of osteoarthritis: state of the evidence

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Abstract

Purpose of review—This review focuses on recent studies of osteoarthritis epidemiology, including research on prevalence, incidence, and a broad array of potential risk factors at the person level and joint level.

Recent findings—Studies continue to illustrate the high impact of osteoarthritis worldwide, with increasing incidence. Person-level risk factors with strong evidence regarding osteoarthritis incidence and/or progression include age, sex, socioeconomic status, family history, and obesity. Joint-level risk factors with strong evidence for incident osteoarthritis risk include injury and occupational joint loading; the associations of injury and joint alignment with osteoarthritis progression are compelling. Moderate levels of physical activity have not been linked to increased osteoarthritis risk. Some topics of high recent interest or emerging evidence for association with osteoarthritis include metabolic pathways, vitamins, joint shape, bone density, limb length inequality, muscle strength and mass, and early structural damage.

Summary—Osteoarthritis is a complex, multifactorial disease, and there is still much to learn regarding mechanisms underlying incidence and progression. However, there are several known modifiable and preventable risk factors, including obesity and joint injury; efforts to mitigate these risks can help to lessen the impact of osteoarthritis.

Keywords

epidemiology; incidence; osteoarthritis; prevalence; risk factors

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Conflicts of interest

There are no conflicts of interest.

INTRODUCTION

Osteoarthritis is one of the most common chronic health conditions and a leading cause of pain and disability among adults [1–5], impacting many health outcomes [6–10]. This review builds upon previous comprehensive reviews of osteoarthritis epidemiology [11–13] by focusing on new research since 2013. Similarly to other reviews [11,12], potential risk factors are grouped according to person-level and joint-level characteristics. Genetic factors are covered in a separate article in this issue.

OSTEOARTHRITIS PREVALENCE AND INCIDENCE

Although osteoarthritis prevalence and incidence estimates have varied somewhat across studies [11,12], there is agreement that a substantial proportion of adults are affected. Recent cohort and community-based studies [14–20,21▪,22▪▪] have further documented the prevalence of osteoarthritis at different joints, based on radiographic findings and/or patient report. The following are highlights from these studies.

Hip

In one of few prevalence studies of hip osteoarthritis, the age-standardized prevalences of radiographic and symptomatic hip osteoarthritis were 19.6% [95% confidence interval (CI) = 16.7, 23.0%] and 4.2% (95% CI = 2.9, 6.1%), respectively, in the Framingham Study Community Cohort; men had higher prevalence of radiographic but not symptomatic hip osteoarthritis than women [14].

Knee

Among a cohort of adults (age 56–84) in Malmo, Sweden, the prevalences of radiographic and symptomatic knee osteoarthritis were 25.4% (95% CI = 24.1, 26.1) and 15.4% (95% CI = 14.2, 16.7), respectively [23]; the latter is comparable with similarly aged cohorts [11,12].

Foot

A review of midfoot and forefoot osteoarthritis found that most studies focused on radiographic osteoarthritis, with wide variability in prevalence estimates (0.1–61%) based on age, sex, and joint(s) studied [18]. Well controlled population studies are still needed to understand the prevalence and risk factors for foot osteoarthritis.

Multiple joints

Based on a 72% response rate from over 26 000 adults at least 50 years in England who completed mailed surveys [21▪], about half reported having osteoarthritis in at least one of four joint regions (hand, hip, foot, knee), and about 22% reported disabling osteoarthritis. As part of the Global Burden of Disease 2010 study, a systematic review reported that the global age-standardized prevalence of knee osteoarthritis was 3.8%, and hip osteoarthritis was 0.85% [22▪▪]; of almost 300 health conditions studied, osteoarthritis was the 11th highest contributor to disability.

An increasing number of studies [24,25▪▪,26,27] have utilized large health administrative databases to document osteoarthritis incidence. For example, based on 18 years of health records from British Colombia, Canada, the crude incidence rate of osteoarthritis was 14.6 (95% CI = 14.0, 14.8) per 1000 person-years in 2000/2001, rising 2.5–3.3% per year through 2008/2009 [25▪▪]. Primary care health records from over 3 million patients in northeast Spain showed that incidence rates per 1000 personyears (99%CIs) for knee, hip, and hand osteoarthritis were 6.5 (6.4, 6.6), 2.1 (2.0–2.1), and 2.4 (2.4–2.4) (Fig. 1) [26]. Although ascertaining osteoarthritis using administrative health records is challenging (e.g. limitations in coding accuracy, establishing valid case definitions), these studies demonstrate the strong potential of these databases to estimate the population burden and trends in osteoarthritis.

PERSON-LEVEL RISK FACTORS

The following are person-level risk factors with some evidence for association with osteoarthritis onset and/or progression.

Demographic characteristics and family history

Many studies have documented that osteoarthritis risk is greater among females and with increasing age [11,12], and some studies have shown an increased risk with lower socioeconomic status [28–30] and African American race [31,32]. Adding to prior data showing a considerable genetic and family history component to osteoarthritis, two new studies showed that having a parent with total knee replacement was associated with greater knee pain prevalence and worsening [33], as well as greater medial joint space narrowing over time [34].

Obesity and metabolic syndrome

Obesity is a key risk factor for knee osteoarthritis, increasing the risk three-fold, and evidence suggests that obesity accelerates progression of knee osteoarthritis [11,12,35]; recent work has enhanced this body of literature [36–38]. In a cohort study [39] of US women, higher baseline serum leptin was associated with greater odds of severe knee joint damage on MRI after 10 years, adjusting for BMI and other factors. Another study [40▪▪] of older adults found that almost half of the association between BMI and knee osteoarthritis was explained by leptin levels. These studies illustrate evidence for a metabolic/inflammatory pathway between obesity and osteoarthritis. A systematic review also found strong evidence for higher serum lipids and moderate evidence for obesity as risk factors for knee bone marrow lesions among individuals with asymptomatic preosteoarthritis and established osteoarthritis [41▪▪]; the finding regarding serum lipids, if confirmed, could represent an important early modifiable risk factor. Interestingly, a case–control study [42] found that statin use was associated with a lower prevalence of generalized osteoarthritis, although results of other studies regarding statin use have been mixed. Another study [43] supported the beneficial effect of weight loss or maintenance to improve osteoarthritis symptoms, finding that among a group of obese individuals, percentage change in weight was significantly associated with changes in medial tibial cartilage volume and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) WOMAC scores.

Both earlier data and recent research have also shown an association of obesity with hand osteoarthritis [11,12,44], suggesting a metabolic or inflammatory role of obesity. A Netherlands-based cohort study [45] found that percentage body fat, fat mass, and waist-to-hip ratio were all associated with hand osteoarthritis; visceral adipose tissue was associated with hand osteoarthritis in men only. The association of obesity with hip osteoarthritis has been weak and inconsistent across studies [11,12].

Nutritional and vitamin factors

The role of dietary factors in osteoarthritis has been a very active area of recent research. Among Osteoarthritis Initiative (OAI) participants, greater baseline milk intake was associated with less joint space narrowing over 4 years among women [46]. Previous studies of vitamin D and osteoarthritis have been conflicting [11,12], and a clinical trial showed no effect of vitamin D supplementation on knee cartilage loss [47]. However, two recent studies [48▪,49] of individuals with osteoarthritis showed an association between vitamin D deficiency and greater progression of symptoms and joint space progression; the latter was accentuated among individuals with high parathyroid hormone. Building on prior studies [11,12] suggesting an association of low vitamin K with osteoarthritis, a study [50] of older adults found that those with low plasma phylloquinone (vitamin K1) were more likely to have articular cartilage and meniscus damage progression on MRI over 3 years than those with sufficient levels. A protective effect of higher circulating vitamin C and E levels with osteoarthritis risk and progression has been suggested, but results have been inconsistent [11,12]. A longitudinal study of the Multicenter Osteoarthritis Study (MOST) cohort found that those in the highest tertile of circulating vitamin C actually had greater incidence of radiographic knee osteoarthritis [adjusted odds ratio (OR) = 2.20, 95% CI 1.12, 4.33] compared with the lowest tertile, with similar findings for vitamin E (adjusted OR = 1.89, 95% CI 1.02, 3.50) [51]. Overall additional research is needed to clarify the role of vitamins and other dietary factors with respect to osteoarthritis risk and outcomes.

Bone density and bone mass

Previous research identified high bone density as a risk factor for incident osteoarthritis [12], although mechanisms and a direct causal relationship remain unclear. Two recent studies [52▪,53▪] found that individuals with extreme high bone mass had greater prevalence of radiographic hip and knee osteoarthritis than control populations. Because high bone mass is likely a lifelong genetic trait, with osteoarthritis being a disease that occurs later in life, this study supports a role of high bone mass in osteoarthritis development. These studies also confirmed previous research showing that high bone mass was more strongly associated with subchondral bone sclerosis than with joint space narrowing, suggesting a hypertrophic osteoarthritis phenotype.

Smoking

A review summarized studies on the association of smoking with osteoarthritis [54], updating a meta-analysis that found an inverse association, except in cohort studies [55]. Overall this review concluded that research to date (including one recent study [56]) suggests smoking confers moderate protection for knee and hip osteoarthritis. However, smokers have a somewhat increased risk for painful osteoarthritis [55].

Other person-level risk factors

Two recent studies [57,58] examined the association of low birth weight with osteoarthritis. In an Australian cohort, both low birth weight and pre-term birth were associated with increased adjusted risk of future hip arthroplasty (but not knee arthroplasty) [57]. In the Hertfordshire Cohort Study, individuals with lower birth weight were more likely to have hip osteophytes. Although the mechanisms of the low birth weight and osteoarthritis association are not understood, this high-risk group should be monitored for other osteoarthritis risk factors and early symptoms. Prior studies [59–62] have examined the association of index-to-ring finger length ratio, an indicator for prenatal testosterone exposure, with osteoarthritis, showing mixed results for knee osteoarthritis and no association for hip osteoarthritis. A Melbourne-based cohort study [63] recently showed that lower index-to-ring finger ratio was associated with knee but not hip replacement (proxies for severe osteoarthritis).

JOINT-LEVEL RISK FACTORS

The following are joint-level risk factors with some evidence for association with osteoarthritis onset and/or progression.

Bone/joint shape

There has been increasing interest in the role of joint shape in osteoarthritis risk, with prior research showing an association of proximal femur shape with incident hip osteoarthritis [12]. Two recent studies [64,65▪] used active shape modeling to examine the association of proximal femur shape with osteoarthritis. In the Johnston County osteoarthritis Project, proximal femur shape differed between hips with incident osteoarthritis and control hips, but only among men [64]. Among OAI participants, ipsilateral proximal femur shape differed between prevalent case and control knees for both medial and lateral osteoarthritis [65▪]. In the MOST study [66▪], knees with lateral compartment osteoarthritis were associated with reduced femoral offset and increased hip height center, more valgus neck-shaft angle, and increased abductor angle compared with knees without osteoarthritis; women also had reduced femoral offset and more valgus neck-shaft angle than men, potentially clarifying sex differences in prevalence of lateral tibiofemoral osteoarthritis. Findings from another study [67] supported femoroacetabular impingement and acetabular dysplasia in the development of radiographic hip osteoarthritis and total hip arthroplasty, specifically among women.

Injury

Traumatic joint injury is a major risk factor for osteoarthritis, particularly at the knee (i.e. meniscal damage, anterior cruciate ligament rupture, or direct articular cartilage injury) [68–73] and ankle [74–76]. A recent systematic review of 20 studies supported the injury-osteoarthritis link by demonstrating that patients with anterior cruciate ligament (ACL) deficient and reconstructed knees had altered synovial fluid biomarker levels indicative of osteoarthritis, compared with controls [77▪]. Notably, injury may rapidly accelerate joint disease, as shown by an analysis of OAI data [78];among participants without baseline knee osteoarthritis, prior knee injury was associated with accelerated progression to end-stage radiographic knee osteoarthritis in 48 months (OR 9.22, 95% CI 4.50, 18.90).

Surgical reconstruction as a strategy to protect against knee osteoarthritis is questionable. In the National Swedish Patient Register [79], the hazard of knee osteoarthritis over an average of 9 years was higher among patients with reconstructed cruciate ligament injury than those treated nonoperatively (hazard ratio 1.42, 95% CI 1.27–1.58). In a study of administrative databases in Ontario, Canada [74], the cumulative incidence of knee arthroplasty over 15 years was seven times greater among patients with cruciate ligament reconstruction (1.4%) than matched control participants (0.2%, $P < 0.001$).

Muscle strength and mass

Associations between muscle strength and osteoarthritis have varied, based on specific muscles and joints examined [11,12], with recent reviews concluding that muscle weakness may confer risk for knee osteoarthritis onset and progression [80,81▪]. Among OAI participants with early radiographic knee osteoarthritis in one limb, there were no differences in muscle strength or cross-sectional area between the affected and unaffected limbs [82]. In the full OAI cohort, isometric knee extensor and flexor strength were significantly lower for symptomatic vs. asymptomatic knees, but these strength measures did not differ by radiographic severity [83]. A third OAI study [84] found that among women, frequently painful knees had greater intramuscular fat areas than contralateral pain-free knees. Whereas the specific role of muscle strength and mass in osteoarthritis structural development and progression is still somewhat unclear, muscle strength appears to play a role in knee symptoms.

Joint loads and alignment

A large body of literature addresses the role of static and dynamic alignment in knee osteoarthritis [11,12,85–87]. Although knee alignment is a clear predictor of knee osteoarthritis progression [88], findings are inconsistent for knee osteoarthritis incidence [89]. A recent study [86] of overweight women without knee osteoarthritis found an association of varus alignment with incident radiographic but not symptomatic knee osteoarthritis. A meta-analysis reported greater odds of structural knee osteoarthritis progression with increasing knee adduction moment [87]. Hallux valgus (malalignment and medial enlargement of the first metatarsophalangeal joint) has been linked with osteoarthritis in the first metatarsophalangeal joint [90], as well as knee and hip osteoarthritis [91].

Occupation and physical activity

A number of previous studies [11,12] have shown that occupational tasks involving abnormal or excessive lower extremity joint loading are associated with risk for hip and knee osteoarthritis. Moderate levels of physical activity have not been associated with osteoarthritis risk [11,12], and a new study [92▪] from the Johnston County Osteoarthritis Project reported that individuals who met physical activity recommendations were not more likely to have either radiographic or symptomatic osteoarthritis than those who were less active.

Leg length inequality

Although there were no new studies published on the association between leg length inequality (LLI) and osteoarthritis in 2014, prior studies from the Johnston County Osteoarthritis Project [93–95] and MOST [96] suggest an important relationship between LLI and prevalent radiographic knee osteoarthritis, particularly in the shorter limb. The link of LLI with osteoarthritis should be further examined, particularly because prior follow-up times were likely too short to evaluate disease development and progression.

Other joint-level risk factors

Several new studies [97▪,98,99,100▪▪,101▪▪] have focused on the predictive value of other patient-reported and/or knee structural characteristics on osteoarthritis risk and outcomes. Greater infrapatellar fat pad maximal area was significantly and beneficially associated with change in knee pain, tibial cartilage volume, and risk of medial cartilage defects among women over about 2.5 years [97▪]. Among women in the Rotterdam study [98], knee crepitus was associated with MRI features of osteoarthritis in the patellofemoral but not tibiofemoral compartment. Among OAI participants without radiographic osteoarthritis evidence, MRI lesions were associated with prevalent and incident persistent knee symptoms and incident cartilage damage [100▪▪]. Another study [101▪▪] reported that minor baseline radiographic changes significantly improved prediction of knee osteoarthritis risk, beyond an initial model including age, sex, and BMI; other questionnaires, genetic and biomarker data only modestly improved prediction.

CONCLUSION

Recent research has continued to highlight the complex nature of osteoarthritis, with confirmed or likely risk factors including demographic characteristics, obesity and dietary factors, joint loading and injury, and joint shape and alignment. Some studies [45,46,49,64,66▪,97▪,102] have highlighted interactions among these risk factors (mostly surrounding sex differences in other osteoarthritis risk factors); given the multifactorial nature of osteoarthritis, future research should carefully consider these interrelationships. Also important is the existence of multiple known modifiable or preventable risk factors for osteoarthritis incidence and/or progression (e.g. obesity, joint injury); efforts are needed to help individuals mitigate these risks, in tandem with continued research that further elucidates the mechanisms underlying osteoarthritis development.

Acknowledgements

None.

Financial support and sponsorship

Drs. Allen and Golightly receive grant funding from the Department of Veterans Affairs, Health Services Research and Development and Rehabilitation Research and Development (Allen); Patient Centered Outcomes Research Institute (Allen, Golightly); National Institute of Musculoskeletal and Skin Diseases (Allen, Golightly); National Center for Advancing Translational Sciences/National Institutes of Health KL2TR001109/ UL1TR001111 (Golightly).

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KEY POINTS

- Traditional epidemiologic studies and mining of large health administrative databases show a large and increasing impact of osteoarthritis.
- Risk factors with strong evidence for osteoarthritis onset and/or progression include age, sex, socioeconomic status, obesity, family history, joint injury, joint alignment, and occupational joint loading.
- Risk factors with emerging interest or evidence for osteoarthritis onset and/or progression include metabolic pathways (e.g. serum leptin), vitamins, joint shape, bone density, limb length inequality, muscle strength and mass, and early structural damage.
- Osteoarthritis is complex and multifactorial; future epidemiologic studies should give careful consideration to interrelationships among potential risk factors.

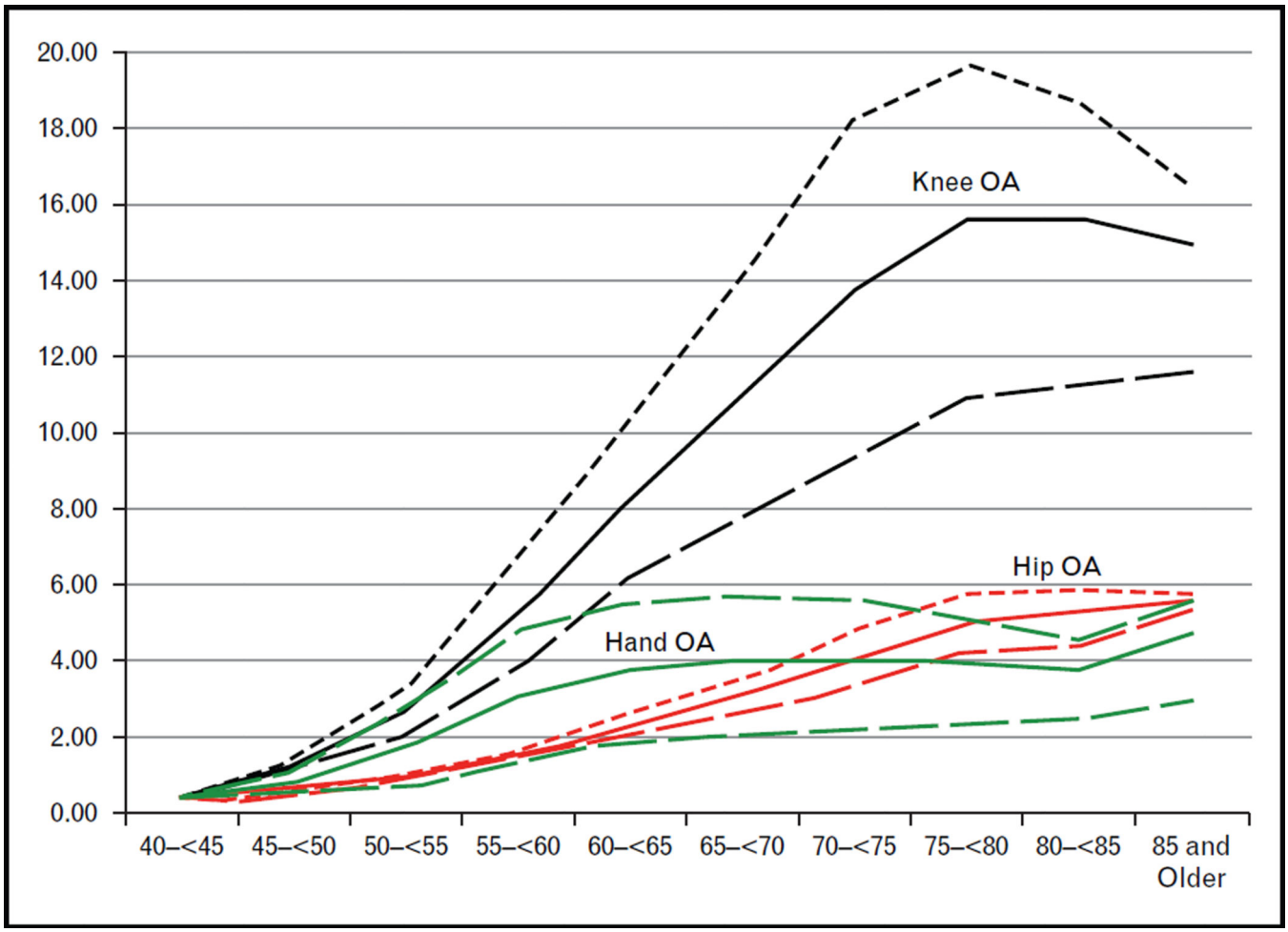

FIGURE 1.

Age and sex-specific incidence rates (/1000 person-years) of knee osteoarthritis (black), hip osteoarthritis (red), and hand osteoarthritis (green). Solid, all population; short dash line, women; long dash line, men. Reproduced from [26].