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Racial/ethnic, socioeconomic and geographic disparities in the epidemiology of knee and hip osteoarthritis

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Introduction

Osteoarthritis (OA) is the most common form of arthritis, affecting 350 million individuals worldwide (15% of the population)[1]. It is estimated that 32.5 million US adults have clinical OA of their knee, hip or hand[2], with the most common sites being knee and hip. OA most likely represents a final common pathway of many different factors including genetics, environment, and biomechanical contributors[3]. OA is also associated with substantial individual and societal costs, and the occurrence of OA, as well as associated outcomes, can

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differ across populations. This article reviews racial/ethnic, socioeconomic and geographic disparities in the incidence, prevalence and outcomes of knee and hip OA.

Knee Osteoarthritis

Racial/ethnic disparities in knee OA

There has been little exploration of racial differences in knee OA incidence. Joint-based and person-based analyses of the Johnston County OA Project found no significant differences in the incidence of radiographic knee OA (with a Kellgren-Lawrence [K-L] score ≥ 2), symptomatic OA (having pain symptoms and radiographic knee OA in the same knee joint) and severe radiographic knee OA (K-L ≥ 3) between African Americans (AAs) and whites[4,5].

Multiple US-based studies have found differences in the prevalence of knee OA between AAs and whites[6–8]. For example, in the Third National Health and Nutrition Examination Survey (NHANES-III), AAs were 50–65% more likely to have rKOA and sxKOA than whites[6]. In the Johnston County OA project, AAs had greater prevalence of severe radiographic knee OA (13.9% vs 6.6%) than whites, with no significant racial differences in overall radiographic and symptomatic OA[8]. Differences in KOA prevalence between AAs and whites seem to be more pronounced among women than men[5,9,10]. There have been few comparisons of knee OA prevalence in other racial and ethnic groups. Some research indicates that Chinese women have about 45% higher prevalence of radiographic and symptomatic knee OA than white women, with no difference between Chinese and white men[11,12]. In NHANES-III, there were no significant differences in knee OA prevalence between Mexican Americans and whites[6]

With regard to prevalence of specific radiographic features of knee OA, data from Johnston County OA project identified several racial differences.[10] Compared with whites, AAs had more severe tibiofemoral radiographic knee OA, higher prevalence of tricompartmental radiographic knee OA, greater prevalence and severity of osteophytes and joint space narrowing, and higher likelihood of sclerosis. Analyses from the Osteoarthritis Initiative (OAI) showed that AAs were more likely than whites to have valgus thrust during walking, and this could contribute to the greater risk of lateral knee OA[13].

Many studies have identified racial differences in OA-related outcomes, particularly pain and function[14–26]. Although some of these studies have included OA in other joints (particularly the hip), a focus has been on knee OA. A recent meta-analysis of racial/ethnic differences in OA pain and disability found higher pain severity in AAs than whites, with a standard mean difference of 0.57 (95% CI, 0.54 to 061) in studies using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (Figure 1)[27]. AAs also had higher self-reported disability (0.38, 95% CI, 0.22 to 0.54) and poorer performance on functional tests (−0.5, −0.72 to −0.44). AAs with OA living below the poverty line may be at the greatest risk for poor pain and functional outcomes[28].

Studies also have reported racial differences in pain sensitivity among individuals with knee OA[29,30]. For example, in a sample of patients with sxKOA, AAs exhibited greater sensitivity

to both mechanical and heat-induced pain[30]. Other research has found greater experimental pain sensitivity among Asian Americans compared with Caucasian Americans with KOA[31].

Many studies have explored potential factors underlying racial and ethnic differences in OA-related pain and function. Factors with evidence for explaining differences in pain and function between AAs and whites include: psychological resilience and perceived stress[32], depressive symptoms[16,33,34], low income and other socioeconomic factors[33,35], pain coping patterns[36], body mass index (BMI)[16], and performance of physically demanding occupational tasks[37]. One study suggests that more depressive symptoms may contribute to greater pain sensitivity among Asian Americans compared to white Americans with knee OA[31,38].

Socioeconomic disparities in knee OA

In the US, annual incidence rates of knee symptoms, radiographic knee OA, symptomatic knee OA, severe radiographic and symptomatic knee OA were estimated in longitudinal analyses of the Johnston County OA population[5]. Incidence rates for radiographic and severe radiographic knee OA were lower among individuals with higher levels of education but were only significantly different for severe radiographic knee OA (Table 1). In Spain, associations were examined in a retrospective ecological study of medical records for more than 5 million individuals in Catalonia between knee OA incidence with an area-based SES deprivation measure, the ecological MEDEA index (proportion of unemployed, temporary workers, manual workers, low educational attainment and low educational attainment among youngsters)[39]. Higher incidence rates of knee OA were found in areas that were deemed as most deprived (Table 1)[40].

Studies examining associations between SES measures and knee OA prevalence are more common. Using data from the NHANES-I in the early 1990s, education of ≤8 years compared with ≥13 years was significantly associated with radiographic knee OA and knee pain (Table 1)[41]. Findings from a population survey in Norway showed that compared to individuals with ≥12 years of education, individuals with ≤ 9 or 9–12 years were 25–30% more likely to have age-and sex-adjusted radiographic knee OA, or self-reported or doctor-diagnosed knee OA (Table 1)[42]. In a Danish study, the risk for knee OA was lower in women in a household with a higher education level and a higher risk of knee OA was associated with less income (Table 1)[43].

Associations between low education levels with radiographic knee OA have also been observed in the Johnston County OA project[44,45]. One study examined associations of education dichotomized as < 12 versus ≥ 12 years with unilateral and bilateral radiographic and symptomatic knee OA[44], adjusting for demographic and clinical covariates. Analyses were stratified by gender and also conducted in a subset of postmenopausal women. In men, only the association with symptomatic knee OA remained significant after covariate adjustment. In adjusted analyses in the total group of women, those with < 12 years of education were 50–85% more likely to have unilateral and bilateral radiographic and symptomatic knee OA. In the subset of postmenopausal women, these observations were partly explained by hormone replacement therapy. Analyses between education and radiographic and symptomatic OA in Johnston County OA cohort were expanded to explore

independent relationships between education, and two other SES variables, occupation (defined as non-managerial or not), and household community poverty level (Table 1)[45]. When all three SES measures were analyzed simultaneously in adjusted models, < 12 years of education was significantly associated with unilateral and bilateral radiographic knee OA and symptomatic knee OA.

A number of studies have identified SES differences in health-related outcomes, particularly pain, disability and the need for arthroplasty, among people with knee OA in addition to the differences in the incidence or prevalence (Table 1)[46–51]. In a study of participants with radiographic knee OA in NHANES-III, lower income levels were associated with fair or poor self-reported health status in multivariable adjusted models[51]. In the Somerset and Avon Survey of Health, individuals who reported more pain and worse function at follow-up, lower social class, comorbidities and higher BMI were associated with greater deterioration[50]. In cross-sectional analyses of the Johnston County OA project, in individuals with knee OA, low education and higher community poverty rates were both significantly associated with worse pain and function[46]. Another study found socioeconomic gradients related to both frequent knee pain and knee OA as well as health related quality of life in favor of individuals with higher levels of SES[48].

Geographic disparities in knee OA

According to the Global Burden of Disease 2010 study, the age-standardized prevalence of sxKOA is estimated at 3.8% globally[52]. Regional variations exist, where the prevalence of sxKOA is highest in the Asia Pacific high-income region, Oceania and North Africa/Middle East (Figure 2). Prevalence in the US and Europe falls in the middle range, and the lowest frequencies are reported in southern Asia.

There is evidence that the prevalence of knee OA is higher in some Asian regions. Results from a systematic review[53] point to overall prevalences of radiographic knee OA ranging from 6.5% in the Netherlands[54] to 70.8% in Japan[55]. Prevalences of symptomatic knee OA across the globe were slightly lower, where the lowest was found in Italy (5.4%)[56] and Greece (6.3%) and the highest in Korea (24.2%)[57]. More recently, the Fifth Korean National Health and Nutrition Examination Survey (2010–2012) found that, among people >50 years of age, the prevalences for radiographic knee OA were 44.6% for women and 20.9% for men, whereas symptomatic knee OA was 19.2% for women and 4.4% for men[58]. Similarly, a study in rural Wuchuan, China among people >59 years of age also reported a high prevalence of radiographic knee OA (women: 36%, men: 20%) and symptomatic knee OA (women: 27%, men: 13%)[59]. It has been suggested that the increased prevalence of knee OA in Asian regions may be due to high amounts of physical labor such as farming and fishing[59].

The prevalence of arthritis, including OA, is known to differ between rural and urban populations. In the US, 1 in 3 adults who live in predominantly rural areas have arthritis compared to 1 in 5 in metropolitan areas[60]. In the Framingham OA Study which is based in a regional urban center, the prevalence of sxKOA was reported to be 7%[61], while being 17% in the predominantly rural Johnston County OA project[62]. Compared to urban regions, rural communities generally have poorer SES (e.g., less education, lower incomes) as well as

more physical inactivity and obesity, all factors linked to OA[63,64]. The Johnston County OA project also reported that living in areas with high community poverty (≥20%) was associated with an increase in radiographic knee OA (84%) (Table 1)[45]. Further, among individuals with radiographic knee OA, greater pain outcomes were associated with living in high poverty areas (≥25%)[46]. Living in poorer neighborhoods has also been shown to be associated with worse pain and function outcomes after total knee arthroplasty, an association that was stronger among those with lower education[65].

Hip Osteoarthritis

Racial/ethnic disparities in hip OA

In Johnston County OA, AAs had lower incidence rates of radiographic and symptomatic hip OA compared with whites[66]. For symptomatic hip OA, incidence rates were 15/1000 person-years and 7/1000 person-years, respectively. These results confirmed previous joint-based analyses of the Johnston County OA cohort, also showing that the hazard of radiographic hip OA was lower among AAs than whites (adjusted hazard ratio: 0.44, 95% confidence interval 0.27–0.71)[4].

Although some indirect comparisons indicated that black individuals living Africa and in the Caribbean have lower rates of radiographic hip OA than whites[67–70], comparisons of radiographic hip OA prevalence in AAs and whites in US cohorts have not identified substantial differences[71–73]. However, data from the Johnston County OA cohort identified racial differences in prevalence of specific radiographic features of hip OA, which varied by gender[70]. Comparison of the Beijing Osteoarthritis Study with two US-based cohorts showed that hip OA was 80–90% less prevalent among Chinese individuals than whites[74]. Another study identified differences in hip morphology that may explain lower rates of hip OA among Chinese individuals compared with other groups[75].

As described above, many studies have examined racial differences in pain and function among patients with OA in AAs and whites but not other racial or ethnic groups. A number of studies including patients with knee and/or hip OA have found worse self-reported pain and function among AAs compared to whites[27]. However, there has been little research on racial / ethnic differences in pain and function with a focus specifically on hip OA. Data from Johnston County OA found racial differences in patterns of hip OA progression; generally, AAs had greater progression in pain and disability, while whites had more radiographic hip OA progression[76]. However, in cross-sectional analyses of the Johnston County OA cohort, there were no racial differences in self-reported pain or function among participants with HOA[16]. In studies including patients with knee and / or hip OA, there is some evidence for BMI, overall health, and coping and other psychological factors as potential explanatory mechanisms[16,36].

Socioeconomic disparities in hip OA

The annual incidence rates of hip symptoms, radiographic hip OA, severe radiographic hip OA, and symptomatic hip OA were estimated in the Johnston County OA project[66]. Incidence rates decreased moderately for hip symptoms and radiographic hip OA with

greater levels of education (Table 2)[66]. When education was examined in analyses stratified by race, the trend of radiographic hip OA was also significant, but attenuated in AAs[66]. In terms of analyses according to household income, the annual incidence rate of 45/1000 person-years of hip symptoms for individuals with < $15,000/year (lowest level) was among the highest incidence rates observed across all of the subpopulations analyzed in the study[66]. Furthermore, the study from Catalonia Spain discussed in the knee OA incidence section also showed higher rates of hip OA in areas that were deemed to be the most deprived[40].

As with knee OA, analyses were conducted in the early 1990s using data from NHANES-I to examine associations between education and radiographic hip OA prevalence (Table 2)[71]. Education > 12 years was significantly associated with radiographic OA compared to ≤ 12 years (OR = 1.69, 95% CI 1.01 – 2.81). However, in adjusted models the relationship was no longer statistically significant. Both the Danish and Norwegian studies, discussed in the knee OA section, examined associations between education and hip OA (Table 2)[42,43]. Increased prevalence of hip OA was significantly associated with lower levels of education in both studies. In analyses of the Danish registry, associations between lower income levels and increased hip OA were also noted[43]. Associations between education, occupation, and community poverty rate with radiographic and symptomatic hip OA were examined in the Johnston County OA project [77]. After adjusting for all SES variables and covariates simultaneously, individuals with <12 years of education were 44% more likely to have symptomatic hip OA than those with ≥ 12 years and 90% more likely to have bilateral symptomatic hip OA (Table 2)[77].

A number of studies have identified differences in pain, disability, and other health-related outcomes in hip OA (Table 2)[49,78]. In individuals with radiographic hip OA in the Johnston County OA project, low levels of education and living in low household poverty rate areas were both independently significantly associated with worse pain and function[78]. Several studies have examined associations between SES with outcomes of total hip replacement (THR)[79,80]. In analyses of the Dresden Hip Registry and the Swedish Hip Arthroplasty Register, poorer SES parameters were independent predictors of poorer pain, function, and quality of life outcomes after THR[79,80]. In analyses from the UK, patients who had the highest level of deprivation underwent THR at an earlier age, were less satisfied with their outcome, and also had an increased risk of dislocation and mortality[81].

Geographic disparities in hip OA

The reported prevalence of symptomatic hip OA tends to be greater in high-income countries compared with low-income countries. Results from the Global Burden of Disease 2010 study indicate that the global age-standardized prevalence of symptomatic hip OA in adults in 2010 was 0.85% (Figure 3)[52]. In general, the prevalence of hip OA was higher in North America high-income regions where the age-standardized prevalence was nearly 2%, followed by southern Latin America and Asia Pacific high-income regions. Prevalence was lowest in East Asia and North Africa/Middle East, while European countries tended to fall in the middle range along with Australia, Latin America and Sub-Saharan Africa.

In the Framingham OA study of adults ≥50 years of age, the age-standardized prevalence for symptomatic hip OA was reportedly higher at 4.2%, and for radiographic hip OA it was

19.6%[82], while in Korea, the prevalence of symptomatic hip OA among adults ≥50 years of age was low (0.1%–0.2%)[83]. A systematic review[53] presented prevalence rates of radiographic hip OA that ranged from 1.0% in Japan[84] and China[74] to 45% in Tasmania[85], and prevalence rates of symptomatic hip OA ranging from 0.9% in Greece[86] to 7.4% in Spain[87]. While the prevalence of radiographic knee OA was reported to be fairly high in China, radiographic hip OA is very low, being less than 1%[74,88]. However, the prevalence in other Asian countries may differ. In a Japanese study among individuals aged 23–95 years, the crude prevalence of radiographic hip OA was reported to be 18.2% in men and 14.3% in women[89]. This study also reported the prevalence of sxHOA to be 0.29% in men and 0.99% in women[89].

Community-level factors also play a role in hip OA. Results from the Johnston County OA project indicate that living in areas with high levels of household poverty is associated with a 50% higher risk of having radiographic hip OA overall and 87% higher risk of having bilateral radiographic hip OA[77]. Additionally, among individuals with radiographic hip OA, greater disability is associated with living in high household poverty areas[78]. Further, a large institutional registry of THR due to radiographic hip OA showed that WOMAC function and pain were higher in communities with census tract Medicaid coverage >10%, an indicator of community economic deprivation[90]. Further, this effect of worse WOMAC function seen in those living in areas with high Medicaid coverage was more pronounced in AAs than whites[90].

Conclusions

OA is a highly prevalent painful and disabling condition which affects the population globally. Knee and hip OA and their associated outcomes vary by race/ethnicity, SES, and geographic regions. Based on current evidence, the burden of OA may be generally higher among particular subgroups, such as AAs and those with lower SES. However, there are notable gaps in our understanding of these disparities. Most research to date on knee and hip OA has been conducted among AAs and whites. Potential mechanisms underlying disparities in OA outcomes have been determined in specific populations, but knowledge is limited about which factors may be distinct in certain subgroups or common to all. Future research should focus on examining OA occurrence in other racial/ethnic groups (e.g., Hispanic/Latino, Asian American, and American Indian/Native American populations) and on identifying modifiable factors that explain OA differences by race/ethnicity, SES, and geography in order to inform public health approaches to mitigate the burden of OA.

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Key points:

- African Americans with knee osteoarthritis (OA) have greater prevalence, severity, progression and worse pain and function compared to whites.
- There is a lower prevalence of hip OA among Chinese than US whites and a possible lower risk of hip OA among African Americans compared to whites.
- Individuals with lower levels of socioeconomic status have greater incidence, greater prevalence and worse clinical outcomes of both knee and hip OA.

Synopsis:

It is estimated that 32.5 million US adults have clinical osteoarthritis (OA), with the most common sites being knee and hip. OA is associated with substantial individual and societal costs. Race/ethnicity, socioeconomic status (SES) and geographic variations in the prevalence of knee and hip OA are well established around the world. In addition, clinical outcomes associated with hip and knee OA differ according to race/ethnicity, SES, and geography. This variation is likely multifactorial and may also reflect country-specific differences in healthcare systems. The interplay between different factors, such as geography, SES and race/ethnicity is difficult to study.

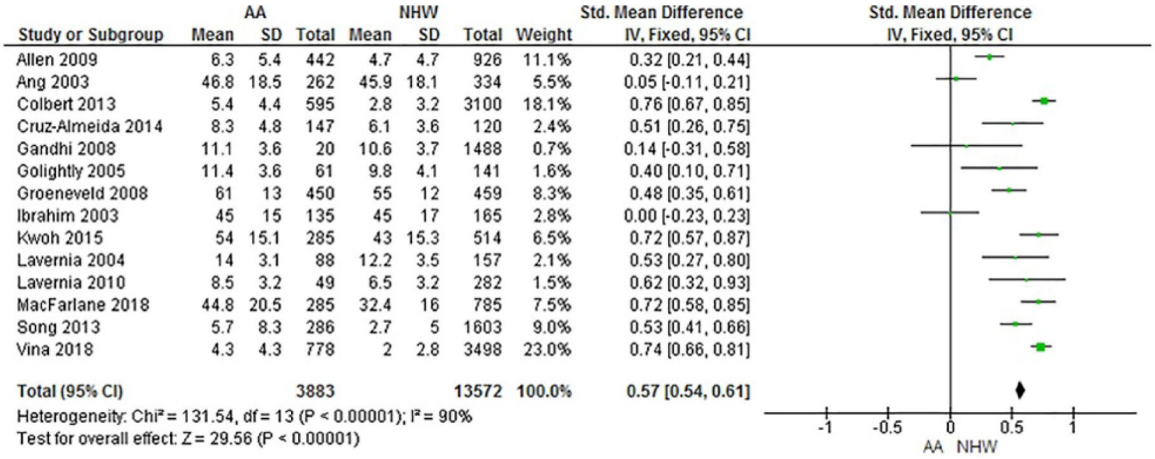
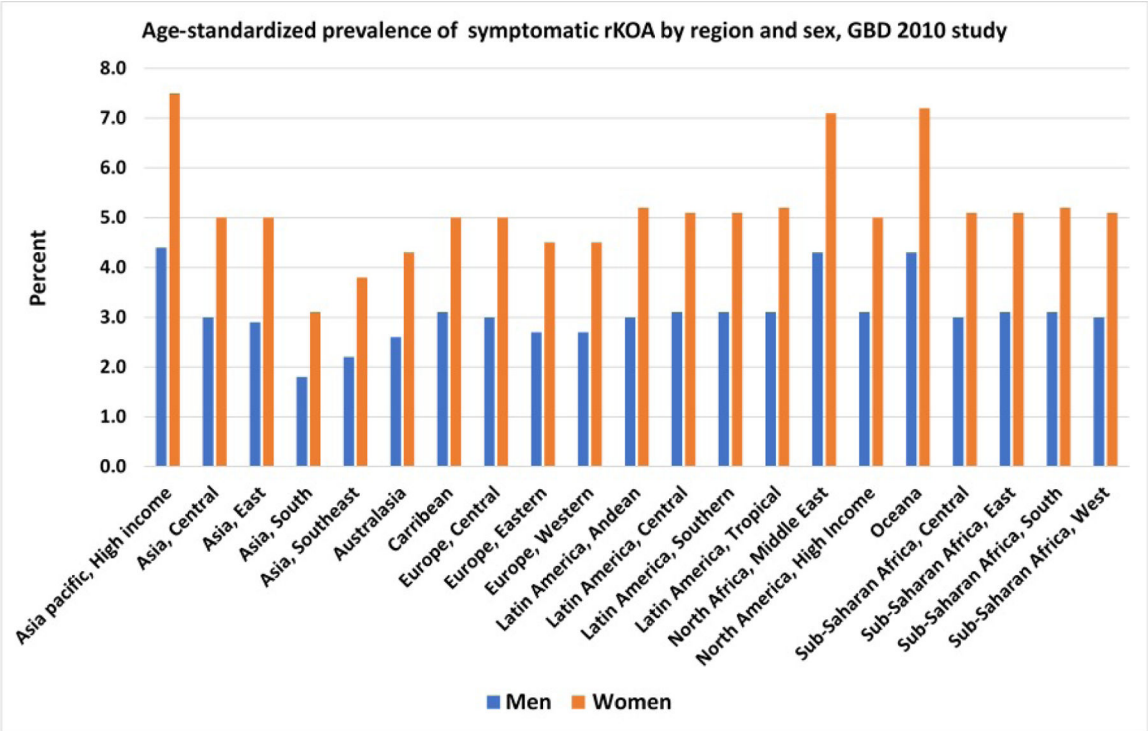


Figure 1:

Forest plot of WOMAC pain measures. High scores = worse outcome/most severe pain From Vaughn IA, Terry EL, Bartley EJ, Schaefer N, Fillingim RB. Racial-Ethnic Differences in Osteoarthritis Pain and Disability: A Meta-Analysis. *J Pain.* 2019;20(6):629–644.



Figures 2:

Age-standardized prevalence of symptomatic radiographically confirmed knee osteoarthritis, The Global Burden of Disease Study 2010

From Cross M, Smith E, Hoy D, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. *Ann Rheum Dis.* 2014;73(7):1323–1330.

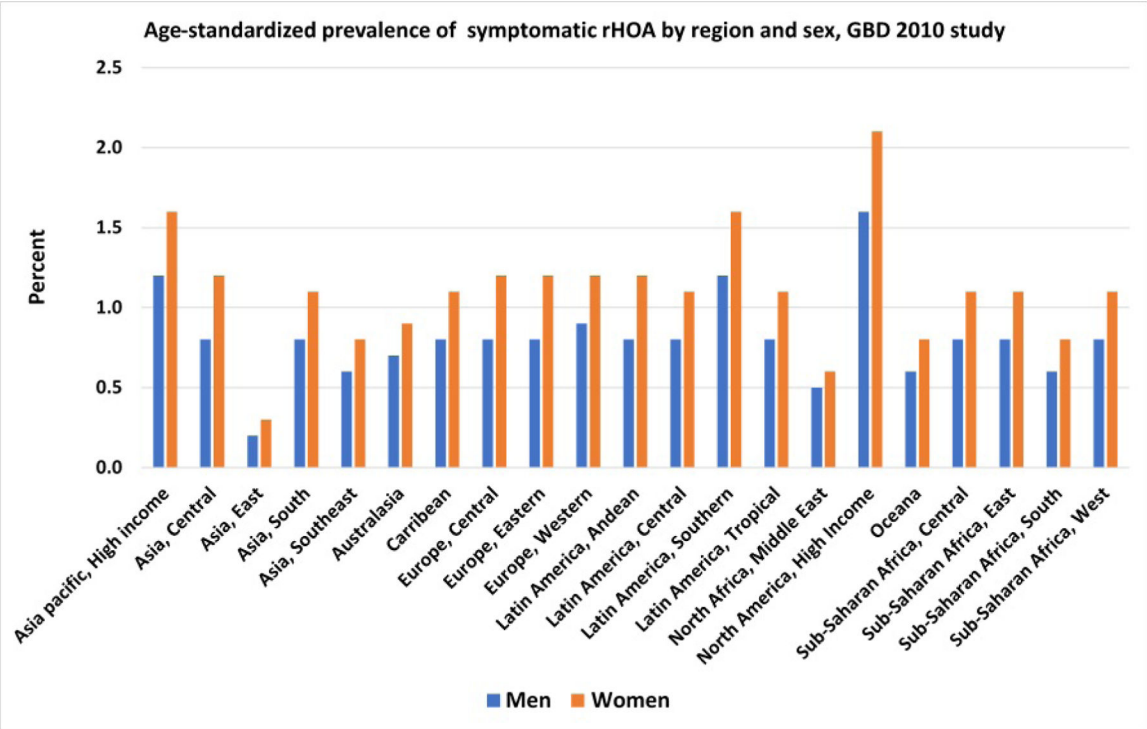


Figure 3:

Age-standardized prevalence of symptomatic radiographically confirmed hip osteoarthritis, The Global Burden of Disease Study 2010

From Cross M, Smith E, Hoy D, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. *Ann Rheum Dis.* 2014;73(7):1323–1330.

Table 1.

Summary of socioeconomic differences in the incidence, prevalence and outcomes of knee OA.

SES Measure	Study Author and Year	Data Source	Country	Health Outcome	Selected Results Point estimate (95% CI)
Education	Murphy et al 2016[5]	Joco OA	US	IR per 100 person-years for knee symptoms, rKOA, severe rKOA, sxKOA, severe sxOA	**Severe rKOA**: <high school vs ≥ high school IR=2.8 (2.3–3.4)
	Hannan et al 1992[41]	NHANES-I	US	Prevalence rKOA, knee pain	**rKOA**: ≤ 8 years vs ≥ 13 years aOR = 1.53 (1.09–2.23) **knee pain**: ≤ 8 years vs ≥ 13 years aOR = 1.34 (1.09–1.65)
	Callahan et al 2010[44]	JoCo OA	US	Prevalence of rKOA, bilateral rKOA,sxKOA, bilateral sxKOA	**sxKOA**: <12 years vs. ≥ 12 years aOR = 1.86 (1.20 – 2.87)
	Callahan et al 2011[45]	JoCo OA	US	Prevalence of rKOA, bilateral rKOA, sxKOA, bilateral sxKOA	**rKOA**: <12 years vs. ≥ 12 years aOR = 1.44 (1.20–1.73) **sxKOA**: <12 years vs. ≥ 12 years aOR = 1.66 (1.34–2.06)
	Grotle et al 2008[42]	MSK pain survey	Norway	Prevalence self-reported KOA	**self-reported KOA**: ≤ 9 years vs. > 12 years aOR =2.25 (1.43–3.57) 9–12 years vs. >12 years aOR = 2.32 (1.54–3.50)
	Jorgensen et al 2011[43]	Danish National register	Denmark	Prevalence knee OA by ICD-8 code	Highest education vs. vocational/basic school **Knee OA among women**: RR = 0.62 (0.60–0.65) **Knee OA among men**: RR = 0.50 (0.48– 0.53)
	Cleveland et al 2013[46]	JoCo OA	US	WOMAC function, pain, stiffness total in rKOA and sxKOA	**rKOA and WOMAC function**: <12 years vs. ≥ 12 years aβ = 2.83 (0.38,5.28)
	Feldman et al 2015[91]	AViKA TKR cohort	US	WOMAC pain and function, pain catastrophizing	**% with high pain (WOMAC >55) among people with knee rOA, adjusted**: Less than college: 32.6% (21.3%, 43.9%) Some college: 29.9% (19.9%, 40.0%) College graduate: 21.1% (15.3%, 26.9%)
	Kiadaliri et al 2017[48]	Malmö OA Study	Sweden	Knee pain, rKOA, KOOS pain, other symptoms, ADL, QOL, Swedish EQ-5D-3L	Education <9 years vs. 10–12 years vs. college **Frequent knee pain:** aRII = 0.71 (0.61–0.84) **rKOA:** aRII=0.53 (0.29–0.98) **KOOS pain:** aRII=0.61 (0.42–0.90) **KOOS ADL:** aRII=0.52 (0.36–0.77)
	Hawker et al 2002[47]	Mail survey Ontario	Canada	Need for knee or hip arthroplasty	**Likelihood for potential need for arthroplasty**: <high school vs. ≥ high school aOR = 1.57 (1.17–2.11)
Occupation	Callahan et al 2011[45]	JoCo OA	US	Prevalence of rKOA, bilateral rKOA, sxKOA, bilateral sxKOA	For all prevalence knee OA outcomes and non-managerial vs. managerial occupations: no significant independent association beyond educational attainment and community poverty
	Cleveland et al 2013[46]	JoCo OA	US	WOMAC function, pain, stiffness total in **rKOA** and **sxKOA**	**rKOA and WOMAC pain**: managerial vs. non-managerial occupation aβ = 0.78 (0.08,1.48)
	Kiadaliri et al 2017[48]	Malmö OA Study	Sweden	Knee pain, rKOA, KOOS pain,other symptoms, ADL, QOL, Swedish EQ-5D-3L	Occupation: unskilled manual, skilled manual, low-level non-manual, intermediate non-manual, high-level non-manual **Frequent knee pain:** aRII = 0.70 (0.60–

SES Measure	Study Author and Year	Data Source	Country	Health Outcome	Selected Results Point estimate (95% CI)
					0.82) **rKOA**: aRII = 0.55 (0.31–0.98) **KOOS pain**: aRII=0.57 (0.39–0.83) **KOOS ADL**: aRII=0.49 (0.34–0.72)
Income	Murphy et al 2016[5]	Joco OA	US	IR per 100 person-years for knee symptoms, rKOA, severe rKOA, sxKOA, severe sxOA	**Knee symptoms**: <$15,000 vs ≥$35,000 IR = 7.4 (6.3–8.7)
	Jorgensen et al 2011[43]	Danish National register	Denmark	Prevalence Knee OA by ICD-8 code	≥150% vs. 75–124% average household income **Knee OA among women**: RR = 0.80 (0.77–0.83) **Knee OA among men**: RR = 0.77 (0.74–0.80)
	Reichmann et al 2011[51]	NHANES-III OAI	US	Health Status – % poor/ fair	**Among people with rKOA**: NHANES-III: <$20,000 = 46.5% (36.8%, 56.10%) $50,000+ = 8.3% (1.9%, 14.8%) OAI: <$20,000 = 11.3% (7.5%, 15.10%) $50,000+ = 1.0% (0.0%, 2.3%)
	Hawker et al 2002[47]	Mail survey Ontario	Canada	Need for knee or hip arthroplasty	**Likelihood of potential need for arthroplasty:** ≤$20,000 vs > $40,000 aOR 1.83 (1.24–2.70)
Community Poverty	Callahan et al 2011[45]	JoCo OA	US	Prevalence of rKOA, bilateral rKOA, sxKOA, bilateral sxKOA	**rKOA**: high poverty vs. low poverty aOR = 1.83 (1.43–2.36) **sxKOA**: high poverty vs low poverty aOR = 1.36 (1.00–1.83)
	Cleveland et al 2013[46]	JoCo OA	US	WOMAC function, pain, stiffness total in rKOA and sxKOA	**sxKOA and WOMAC pain**: high poverty vs. low poverty aβ = 1.35 (0,06, 2.64)
Area-level SES	Feldman et al 2015[91]	AViKA TKR cohort	US	WOMAC pain and function, pain catastrophizing)	**% with high pain (WOMAC >55) among people with knee rOA, adjusted** Low area SES: 34.2% (25.3%, 43.1%) Mid area SES: 26.6% (17.0%, 34.2%) High area SES: 18.6% (11.8%, 25.5%)
Social Class	Peters et al 2005[50]	SASH	UK	New Zealand Score for knee pain and disability	**Knee pain and disability:** lowest social class vs highest, adjusted mean difference = 8.3 (−1.8–18.3)
Deprivation	Reyes et al 2015[40]	SIDIAP	Spain	Incidence of knee OA by ICD-10 code	**Knee OA:** Most vs. least deprived area aIRR = 1.23 (1.19–1.28)

Abbreviations: aβ = adjusted parameter estimate, ADL = activities of daily living, aOR = adjusted odds ratio, aRII= adjusted relative index of inequality, AViKA = Adding Value in Knee Arthroplasty, CI= confidence interval, ICD = International Classification of Diseases, IR= annual incidence rate, IRR = incidence rate ratio, JoCo OA = Johnston County Osteoarthritis Project, KOOS = Knee Injury and Osteoarthritis Outcome Score, MSK = musculoskeletal, NHANES = National Health and Nutrition Examination Survey, QOL = quality of life, rKOA = radiographic knee osteoarthritis, RR = rate ratio, SASH = Somerset and Avon Survey of Health, SES = socioeconomic status, SIDIAP = System for the Development of Research in Primary Care, sxKOA = symptomatic knee osteoarthritis, UK = United Kingdom, US = United States, WOMAC= Western Ontario and McMaster Universities Osteoarthritis Index

Table 2.

Summary of socioeconomic differences in the incidence, prevalence and outcomes of hip OA.

SES Measure	Study	Data Source	Country	Health Outcome	Selected Results Point estimate (95% CI)
Education	Moss et al 2016[66]	JoCoOA	US	IR per 1000 person-years for hip symptoms, rHOA, severe rHOA, sxHOA	**rHOA:** <high school: IR = 22 (16, 30) High school: IR = 22 (18, 26) >high school: IR = 17 (13, 22)
	Tepper et al 1993[71]	NHANES-I	US	Prevalence of rHOA	**rHOA:** education ≤12 years vs. >12 years aOR 1.64 (0.95, 2.85)
	Cleveland et al 2013[77]	JoCo OA	US	Prevalence of rHOA, bilateral rHOA, sxHOA, bilateral sxHOA	**Bilateral sxHOA:** education ≤12 years vs. >12 years aOR=1.91 (1.08,3.39)
	Grotle et al 2008[42]	MSK pain survey	Norway	Prevalence of self-reported hip OA	**self-reported hip OA**: ≤ 9 years vs. >12 years aOR =2.85 (1.65,4.93) 9–12 years vs. >12 years aOR = 2.70 (1.62,4.49)
	Jorgensen et al 2011[43]	Danish National Register	Denmark	Prevalence of hip OA by ICD-8 code	Highest education vs. vocational/basic school **Hip OA for women**: RR = 0.85 (0.80–0.90) **Hip OA for men**: RR = 0.65 (0.61– 0.68)
	Knight et al 2011[78]	JoCo OA	US	WOMAC function, pain, total, HAQ-DI in rHOA and sxHOA	Edgucation ≤12 years vs. >12 years **rHOA and WOMAC function**: aβ=3.22(0.73,5.7) **rHOA and HAQ-DI:** aβ=0.15 (0.05,0.35)
	Schafer et al 2010[80]	Dresden Hip Registry	Germany	WOMAC Response to THR	**Risk of nonresponse to THR**: education 12 years vs. 8 years aOR = 0.49 (0.27, 0.89)
	Greene et al 2014[79]	Swedish hip arthroplasty registry	Sweden	EuroQol response to THR	**Lower pain after THR**: education >12 years vs. ≤ 8 years aβ =−3.3 ± 0.05
Occupation	Cleveland et al 2013[77]	JoCo OA	US	Prevalence of rHOA, bilateral rHOA, sxHOA, bilateral sxHOA	For all hip OA outcomes and non-managerial vs. managerial occupations, no significant associations
	Knight et al 2011[78]	JoCo OA	US	WOMAC function, pain, total, HAQ-DI in rHOA and sxHOA	**rHOA and WOMAC pain**: non-managerial vs. managerial aβ =0.78 (0.09, 1.47)
Income	Moss et al 2016[66]	JoCo OA	US	IR per 1000 person-yrs for hip symptoms, rHOA, severe rHOA, sxHOA	**Hip symptoms:** <$15,000: IR=45 (17, 24) $15–35,000: IR=34 (27,42) ≥$35,000: IR=28 (21,37)
	Tepper et al 1993[71]	NHANES-I	US	Prevalence of rHOA	**rHOA:** highest vs. lowest quartile of family income aOR 0.99 (0.40, 2.44)
	Jorgensen et al 2011[43]	Danish National Register	Denmark	Prevalence of hip OA by ICD-8 code	≥150% vs. 75–124% average household income **Knee OA among women**: RR = 0.97 (0.93–1.02) **Knee OA among men**: RR = 0.86 (0.82–0.90)
Community Poverty	Cleveland et al 2013[77]	JoCo OA	US	Prevalence of rHOA, bilateral rHOA, sxHOA, bilateral sxHOA	**Bilateral rHOA**: high vs. low poverty aOR=1.87 (1.32,2.66)

SES Measure	Study	Data Source	Country	Health Outcome	Selected Results Point estimate (95% CI)
	Knight et al 2011[78]	JoCo OA	US	WOMAC function, pain, total, HAQ-DI in rHOA and sxHOA	**rHOA and HAQ-DI**: high poverty vs. low poverty β=0.15 (0.01, 0.29), but not significant in models that accounted for educational attainment and income
Deprivation	Reyes et al 2015[40]	SIDIAP	Spain	Incidence of hip OA by ICD-10 code	**Hip OA:** Most vs. least deprived area age and sex-aIRR = 1.23 (1.17, 1.29) fully aIRR = 1.02 (0.97, 1.07)
	Clement et al 2011[81]	Prospective cohort of THR patients	UK	Oxford hip score, dislocation, mortality	Most vs. least deprived area **Hip Dislocation**: aOR=5.3 (p=0.001) **Mortality**: OR=3.2 (p=0.02)

Abbreviations: aβ = adjusted parameter estimate, aIRR = adjusted incidence rate ratio, aOR = adjusted odds ratio, CI= confidence interval, EuroQOL = European Quality of Life, HAQ-DI = Health Assessment Questionnaire Disability Index, ICD = International Classification of Diseases, IR= annual incidence rate, IRR = incidence rate ratio, JoCo OA = Johnston County Osteoarthritis Project, MSK = musculoskeletal, NHANES = National Health and Nutrition Examination Survey, rHOA = radiographic hip osteoarthritis, RR = rate ratio, SES = socioeconomic status, SIDIAP = System for the Development of Research in Primary Care, sxHOA = symptomatic hip osteoarthritis, THR = total hip replacement, UK = United Kingdom, US = United States, WOMAC= Western Ontario and McMaster Universities Osteoarthritis Index