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Annual incidence rates of hip symptoms and three hip OA outcomes from a U.S. population-based cohort study: the Johnston County Osteoarthritis Project

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SUMMARY

Objective: Estimate annual incidence rates (IRs) of hip symptoms and three osteoarthritis (OA) outcomes (radiographic, symptomatic, and severe radiographic) overall and by race, sociodemographic characteristics, and hip OA risk factors.
Design: Analyze baseline (1991–1997) and first follow-up (1999–2003) data ($n = 1446$) from the Johnston County Osteoarthritis Project, a population-based, prospective study of adults ≥45 years in North Carolina. Hip symptoms were pain, aching, and/or stiffness on most days, or groin pain. Radiographic and severe radiographic OA were Kellgren–Lawrence (KL) grades ≥2 and ≥3, respectively. Symptomatic OA was radiographic OA with symptoms in the same hip. Sociodemographics were age, gender, race, highest attained education, and annual household income. Hip OA risk factors were self-reported body mass index (BMI) at age 18 years, clinically measured BMI at baseline, and history of hip injury.
Results: Annual IRs (median = 5.5 years follow-up) were 37, 23, 13, and 2.9 per 1000 person-years for hip symptoms, and radiographic, symptomatic, and severe radiographic hip OA, respectively. We found low IRs of radiographic and symptomatic hip OA among African Americans and high IRs of hip symptoms among the obese and the very poor. Across outcomes, IRs were highest for those with hip injury.
Conclusion: No prior studies have reported IRs of hip symptoms; IRs of radiographic and severe radiographic hip OA were similar to, and the IR of symptomatic hip OA was higher than, previous estimates. Prevention efforts should target low socioeconomic status (SES) populations and obese adults; interventions for hip OA and hip symptoms are imperative for those with hip injuries.
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Introduction

Hip osteoarthritis (OA) is a common cause of pain and disability among older adults and a predominant reason for total hip replacement (THR) surgery[1], which, in the US, is expected to grow to half a million procedures annually by 2030[2]. Among adults aged ≥45 years, radiographic hip OA affects 27%, and symptomatic hip OA (defined as radiographic OA with hip symptoms) may affect 3–9%[3,4]. Hip pain and other OA symptoms can substantially impair health and functioning, limit daily activities and reduce quality of life[5,6], and can significantly affect individuals financially through lost wages and need for informal care[7,8]. Additionally, hip OA has been associated with an increased risk of mortality among older women[9]. These costs and the poor health associated with hip OA

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are part of a global public health problem that is predicted to only worsen[10].

Epidemiological studies of incident hip OA have examined the role of demographics (women, older age, and white/African American race)[11–15] and modifiable risk factors (hip injury and obesity)[11,16–25], but most of these studies have reported ratio measures (e.g., odds ratios). Descriptive studies quantifying the incidence rate (IR) – the rate at which new cases arise in the population – provide data that can be used for projecting prevalence and forecasting health service utilization and costs. Further, hip pain and symptoms can have a substantial health and economic impact, but no studies have reported IRs of hip pain/symptoms independently of radiographic hip OA, which can be poorly correlated with symptoms[5,6,26].

Of the few studies that have reported IRs of hip OA, some were in limited populations (e.g., white race or women only) and others reported only cumulative incidences[27], which may not adequately account for variation in observation time among participants. Furthermore, some US studies were conducted several decades ago and may not represent IRs in current populations given aging, increasing racial/ethnic diversity, and increasing prevalence of obesity in the US over past decades. Of the previous studies, two in the US estimated IRs for symptomatic hip OA from health records; Wilson *et al.* estimated an age and sex-adjusted rate of 47 per 100,000 person-years for the entire population of Rochester, MN in 1985[12], and Oliveria *et al.* estimated an age and sex-adjusted rate of 88 per 100,000 person-years among HMO members aged 20–89 in Worcester County, MA between 1998–1992[11]. Three studies reported cumulative incidence of radiographic OA; from the Study of Osteoporotic Fractures, a multicenter US cohort of Caucasian women $\geq$65 years (mean follow-up 8 years), Lane *et al.* found 33% and 14% developed radiographic and severe radiographic OA (KL $\geq$ 3) respectively of the hip between 1986–1998[28]; from the Rotterdam Study, a population-based Dutch cohort aged $\geq$55 (mean follow-up 6.6 years), Reijman *et al.* estimated 17% developed incident radiographic hip OA as defined by Kellgren–Lawrence (KL) grade $\geq$2, between 1990–1999[29]; from the Johnston County OA Project (JoCo OA), Kopec *et al.* reported that radiographic OA developed in 7% of hips (joint-based analysis)[13]. Grotle *et al.* estimated 10-year cumulative incidence of self-reported hip OA of 6% in a population-based cohort ages 24–76 years in Ullensaker, Norway in 1994–2004.

Given these limited data on IRs of hip OA-related outcomes, we conducted a comprehensive hip OA incidence study using data from the JoCo OA, a large population-based, prospective cohort study in Johnston County, North Carolina. The purpose of this study was to quantify annual IRs of hip symptoms and three types of hip OA (radiographic, symptomatic, and severe radiographic hip OA). For three outcomes (hip symptoms, radiographic, symptomatic hip OA), we estimated overall IRs among African Americans and whites. For these three outcomes, we also estimated IRs by selected sociodemographic variables and hip OA risk factors, overall and for each race. Annual IRs for subgroups can be used to prioritize susceptible populations for further research and prevention efforts.

Method

We analyzed baseline (1991–1997) and first follow-up (1999–2003) data from the JoCo OA. The study's overall methodological approach is detailed elsewhere[30]. Enrolled participants represented civilian, non-institutionalized African Americans and whites $\geq$45 years who were residents of one of six designated townships in Johnston County for at least 1 year and who were physically and mentally capable of study completion. At both baseline and first follow-up, participants completed two in-home interviews, approximately 2 weeks apart, and a clinical examination. Supine anterior–posterior pelvis radiographs for both hips were read using standard Kellgren–Lawrence (KL) grade (0–4)[31]. Pelvic radiographs were not obtained from women <50 years. The institutional review boards of the Centers for Disease Control and Prevention and the University of North Carolina Schools of Medicine and Public Health approved the study's protocol.

JoCo OA staff employed various methods to minimize attrition between baseline and first follow-up. Staff used annual newsletters, personal networks, local advertising, medical providers, and community inquiries to locate and retain participants. Deaths were identified through multiple sources including local obituaries, word-of-mouth, local and North Carolina death records, and the National Death Index (NDI), the most complete source of mortality data.

Measurement of hip symptoms and hip OA outcomes

Annual IRs were estimated for hip symptoms and three types of hip OA (radiographic, symptomatic, and severe radiographic hip OA). Hip symptoms were defined as either a "yes" to the question "On most days, do you have pain, aching, or stiffness in your *(right, left)* hip?" or reported the presence of *(right, left)* groin pain. Radiographic and severe radiographic OA were defined as KL grades of $\geq$2 and $\geq$3, respectively. Inflammatory arthritis occurred in 21 participants; joints with radiographic evidence of inflammatory arthritis were treated as having missing KL grades and thereby excluded from analysis. Symptomatic OA was defined as having radiographic OA and hip symptoms in the same hip. Because symptomatic OA is the underlying cause in the majority of THRs[1], those with THR were classified as affected for all four outcomes, similar to previous studies[13,32].

For each outcome, an incident case was a participant who was not affected at baseline who developed the outcome in at least one hip by first follow-up (range 3–13 years). Baseline prevalent cases (i.e., participants having a given outcome in one or both hips at baseline) were excluded from analysis of that outcome, and therefore the number of participants varied for each outcome analysis (Table I). Analyses for hip symptoms included participants aged $\geq$45 years. Because women of reproductive age (<50 years) ($n = 312$) did not have hip radiographs, we also excluded men <50 years ($n = 175$) (Table I) so that the three hip OA outcome analyses comprised the same age groups for women and men.

Sociodemographic and hip OA risk factors

Sociodemographic characteristics (and their categorized levels) analyzed were age (45–54 or 50–54 [as appropriate], 55–64, 65–74, and $\geq$75 years), sex (men, women), race (African American, white), highest attained education (<high school [<grade 12], some/completed high school [grade 12/GED {general equivalency diploma}], >high school [college/grad school] and annual household income ($0–<15,000, $15,000–<35,000, $\geq$$35,000). The three hip OA risk factors were self-reported body mass index (BMI) in kg/m^2 at age 18 (under/healthy weight [<25], overweight/obese [$\geq$25]) and clinically measured BMI at baseline (under/healthy weight [<25], overweight [25–<30], and obese [$\geq$30] {Class I [30–<35] and Class II–IV [$\geq$ 35]}), and history of hip injury (yes, no). Self-reported BMI at age 18 was based on participants' report of their weight at age 18. The denominator for all BMI calculations was clinically measured height at baseline. Hip injury was ascertained during the baseline clinic examination with "Have you ever injured your *(right, left)* hip?".