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One in four people may develop symptomatic hip osteoarthritis in his or her lifetime

Louise B Murphy[†,*], **Charles G. Helmick**[†], **Todd A Schwartz**[‡], **Jordan B Renner**[§,‖], **Gail Tudor**[¶], **Gary G Koch**[‡], **Anca D Dragomir**[#], **William D Kalsbeek**[‡], **Gheorghe Luta**[††], and **Joanne M Jordan**[‡‡]

[†]Arthritis Program, Division of Adult and Community Health, Centers for Disease Control and Prevention, Atlanta, GA, USA

[‡]Department of Biostatistics, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, NC, USA

[§]Department of Radiology, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

[‖]Department of Allied Health Sciences, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

[¶]Husson University, Bangor, ME, USA

[#]National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, MD, USA

[*]Address correspondence and reprint requests to: Division of Adult and Community Health, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Mailstop K-51, Atlanta, GA, 30341, USA. Tel: 1-770-488-5102; Fax: 1-770-488-5486; lmurphy1@cdc.gov.

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Authors' contributions - Louise Murphy: Conception and design (reported study); Analysis and interpretation of the data; Drafting of the article; Critical revision of the article for important intellectual content; Final approval of the article; Statistical expertise; Responsibility for the integrity of the work as a whole, from inception to finished article alx2@cdc.gov
Charles G Helmick: Conception and design (Study topic) ; Analysis and interpretation of the data; Critical revision of the article for important intellectual content; Administrative, technical, or logistic support; Final approval of the article
Todd Schwartz: Conception and design (statistical methods of reported study); Analysis and interpretation of the data; Critical revision of the article for important intellectual content; Final approval of the article; Administrative, technical, or logistic support; Statistical expertise
Jordan B Renner: Critical revision of the article for important intellectual content; Final approval of the article; Collection and assembly of data; Administrative, technical, or logistic support
Gail Tudor: Conception and design (statistical methods of reported study); Critical revision of the article for important intellectual content; Final approval of the article; Statistical expertise
Gary Koch: Conception and design (statistical methods of reported study); Analysis and interpretation of the data; Critical revision of the article for important intellectual content; Final approval of the article; Statistical expertise
Anca Dragomir: Critical revision of the article for important intellectual content; Final approval of the article; Collection and assembly of data; Administrative, technical, or logistic support
William Kalsbeek: Conception and design (Johnston County Osteoarthritis Project sampling design); Critical revision of the article for important intellectual content; Final approval of the article; Statistical expertise
Gheorghe Luta: Conception and design (statistical methods of reported study); Critical revision of the article for important intellectual content; Final approval of the article; Statistical expertise; Administrative, technical, or logistic support
Joanne Jordan: Conception and design (Johnston County Osteoarthritis Project); Analysis and interpretation of data; Critical revision of article for important intellectual content; Final approval of the article; Provision of study material or patients; Collection and assembly of data; obtaining of funding; Administrative, technical, or logistic support.

[††]Department of Biostatistics, Bioinformatics and Biomathematics, Georgetown University, Washington, DC, USA

[‡‡]Thurston Arthritis Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

Summary

Objective—To estimate the lifetime risk of symptomatic hip osteoarthritis (OA).

Design—We analyzed data from the Johnston County Osteoarthritis Project (a longitudinal population-based study of OA in North Carolina, United States [*n*=3,068]). The weighted baseline sample comprised 18% blacks and 54% women, and the mean age was 63 years (range=45-93). Symptomatic hip OA was defined as a Kellgren-Lawrence (K-L) radiographic score of ≥2 (anterior-posterior pelvis x-rays) and pain, aching or stiffness on most days, or groin pain, in the same hip. Lifetime risk, defined as the proportion who developed symptomatic hip OA in at least one hip by age 85, among people who live to age 85, was modeled using logistic regression with repeated measures (through generalized estimating equations).

Results—Lifetime risk of symptomatic hip OA was 25.3% (95% confidence interval [CI] = 21.3–29.3). Lifetime risk was similar by sex, race, highest educational attainment, and hip injury history. We studied lifetime risk by body mass index (BMI) in three forms: at age 18; at baseline and follow-up; and at age 18, baseline and follow-up and found no differences in estimates.

Conclusion—The burden of symptomatic hip OA is substantial with one in four people developing this condition by age 85. The similar race-specific estimates suggest that racial disparities in total hip replacements are not attributable to differences in disease occurrence. Despite increasing evidence that obesity predicts an increased risk of both hip OA and joint replacement, we found no association between BMI and lifetime risk.

Introduction

Symptomatic hip osteoarthritis (OA) can be a highly disabling form of lower extremity OA that limits basic activities, such as walking a few blocks or climbing stairs[1], and is the most common indication for total joint replacement of the hip2. In 2007, approximately 252,000 hip replacements were performed in the United States at an estimated total cost of $4 billion 3.

Lifetime risk is the probability of developing a condition over the course of a lifetime. Whereas prevalence and incidence convey the population burden of a condition, lifetime risk describes individual risk. Lifetime risk has been estimated for various chronic conditions (e.g., symptomatic knee osteoarthritis 4, breast cancer 5, coronary heart disease 6, diabetes 7). To our knowledge, the lifetime risk of symptomatic hip OA has not been reported. We present lifetime risk estimates – defined as the proportion of the population who live to age 85 that develop symptomatic hip OA by age 85 -- for symptomatic hip OA in Johnston County, North Carolina. We estimated the lifetime risk of symptomatic hip OA overall and stratified by six factors: age, sex, race, educational attainment, history of hip injury, and body mass index (BMI) — among participants of the Johnston County Osteoarthritis (JoCo OA) Project.

Methods

The study sample were participants (*n* = 3,068) in the JoCo OA Project, a longitudinal study of the onset and progression of hip and knee OA among semirural residents of Johnston County, North Carolina, USA. The JoCo OA Project is the largest population-based,

longitudinal study in the United States to monitor the occurrence and natural history of hip OA among black and white males and females. Project methods are described elsewhere [8-10] . The JoCo OA Project cohort was selected to be representative of the civilian, noninstitutionalized, English-speaking black and white population aged ≥45 years who were residents of one of six selected townships of Johnston County for at least 1 year, and who were physically and mentally capable of completing the study's protocol.

The study protocol at both baseline (1990–1997) and first follow up (1999–2003) included an initial home interview, a clinical examination (including x-rays), and a second home interview approximately 2 weeks after the clinical examination. X-rays included supine anteroposterior radiographs of the hip, which were read for radiographic hip OA using Kellgren-Lawrence (K-L) grades by one bone and joint radiologist (JBR) 11. The intra-rater and inter-rater reliability of the JBR were previously determined to be high with a weighted kappa of 0.89 (intra-rater) and 0.86 (inter-rater) 9. Pelvic radiographs were not obtained from women of reproductive age (i.e., <50 years), therefore these women were included in only the follow-up sample of this analysis. Weight and height were physically measured by staff at the baseline and first follow-up. Study participants completed an interviewer administered questionnaire that measured sociodemographic and clinical characteristics including age, sex, race, educational attainment, income, history of hip injury, and the presence of hip symptoms ("On MOST days do you have pain, aching or stiffness in your **left** (or **right**) hip?"). In the baseline questionnaire, participants reported their height and weight at age 18. Because symptoms of hip OA may manifest in a broader region of the hip [12], the trained examiner queried participants about their pain at numerous sites in the broader hip region (e.g., left and right groin pain) using a standardized history and examination protocol.

Multiple strategies were used to minimize cohort attrition between baseline and follow up (e.g., annual newsletters, advertisements in local media and medical and community settings, inquiries throughout the community). Participants' deaths were identified by reviewing local obituaries, North Carolina state and local death records, and the US National Death Index (NDI) and through word of mouth. The NDI is the most complete and accurate source of US mortality data with the sensitivity ranging from 93 to 98% and specificity of virtually 100% [13, 14].

ANALYSIS

First, we examined the baseline sociodemographic characteristics, symptoms and OA status. Next, we estimated the lifetime risk for symptomatic hip OA. Symptomatic hip OA was defined as the presence of both radiographic K-L grade ≥2 (at least mild radiographic OA 11) in at least one hip and hip symptoms reported in the radiographically affected joint. To determine whether estimates varied with symptom definition, we estimated lifetime risk using two definitions: 1) the presence of pain, aching, or stiffness in the radiographically affected hip or 2) the presence of pain, aching, or stiffness or groin pain in the radiographically affected hip. The Estimates were similar for the two definitions (reported in Results), and so we used the second, or broader, definition for the remainder of the analyses. The analysis was person-based (i.e., unit of analysis was person rather than hip). Hips with radiographic evidence of inflammatory arthritis (i.e., rheumatoid arthritis) at baseline or follow up were excluded, and joints that had undergone replacement were classified as affected with symptomatic hip OA because hip OA is the most common indication for hip replacements2..

The overall lifetime risk for symptomatic hip OA was estimated as a model-predicted prevalence of symptomatic hip OA at age 85 for those who survived to at least this age; in

this model, age was the independent variable and symptomatic hip OA the dependent variable. We then estimated lifetime risks stratified by sex, race, highest educational attainment, BMI, and history of hip injury. BMI, educational attainment, and history of hip injury were modeled as time dependent variables, that is, we analyzed participants' values at each time point. BMI was examined in three separate models: 1) at age 18, 2) at baseline and follow up, and 3) in a summary of BMI over the life course (i.e., BMI at age 18, at baseline, and at follow up). In model 1 and 3, BMI was examined as a two category variable—under-/normal weight or overweight/obese — because there was insufficient sample size to examine overweight and obese separately.

When considering how to model BMI, continuous BMI at baseline and follow-up were compared. Participants' BMI, on average, increased by only 1.0 unit at follow-up. A potential interaction between age and categorized BMI in association with symptomatic hip OA was evaluated; it was not statistically significant ($p=0.114$). Because there is no published evidence that a change of 1.0 BMI unit changes risk of OA onset, BMI (categorized) was treated as a time-dependent covariate (that is, the BMI of participants at each observation point was analyzed). We also modeled lifetime risk with BMI at age 18 as a continuous variable. We observed a curvilinear relationship resulting from unstable estimates for the small number of respondents who were overweight/obese at age 18 and had a high lifetime risk.

Lifetime risk is the probability of developing a condition over a lifetime. This lifetime probability is equal to the cumulative incidence of a condition over the cohort's lifetime. Furthermore, the cumulative incidence of symptomatic hip OA is equal to lifetime prevalence because symptomatic hip OA is a persistent, low-mortality condition. There are at least two strengths to including all cohort members, regardless of OA status at baseline. First, OA symptoms may be intermittent or abate (e.g., responsiveness to treatment of symptoms). By including prevalent and incident cases, we captured a higher proportion of participants who have ever had symptomatic OA. Second, the cumulative aspect of the lifetime risk estimate ensures data from all participants, including those who may subsequently die or leave the cohort for other reasons (e.g., move outside the catchment area), which may reduce selection bias.

Estimates were derived from logistic regression models by using generalized estimating equations (GEE). We used GEE logistic regression, rather than traditional time-to-event survival analysis methods used in other studies of lifetime risk, for several reasons. First, many participants had the condition of interest at baseline, which would exclude them from a time-to-event analysis. Second, there was considerable cohort attrition between baseline and follow-up, typical in cohort studies. Therefore, life table analysis would result in an overestimation of risk because of the extensive censoring among those participants who were absent at follow-up. Finally, while survival analysis methods are indicated when modeling time to event, in studies of onset of slowly evolving conditions, such as OA, a precise measure of the time to event, or date of OA onset, is unknown without frequent follow-up of cohort members. Therefore, without a date of OA onset, lifetime risks were derived using GEE logistic regression. GEE logistic regression models the probability of onset at, or prior to, the current observation time and therefore provides estimates for points along the Kaplan-Meier curve, similar to estimates derived in a more traditional time-to-event analysis. The sample analyzed comprised people aged 45-93 years and therefore the predicted probabilities were interpolated (i.e., based on a set of known data points for younger and older cohort members) rather than projected from a sample of younger participants.

We conducted a preliminary analysis to assess whether the relationship between age and lifetime risk was linear. Continuous age was modeled as untransformed and transformed [i.e., logarithm (age), square root ($age^{1/2}$), and the addition of a quadratic term (age + age^2)] . Untransformed continuous age was used in the remaining analyses because its association with lifetime risk provides a simpler (linear) interpretation, the quadratic age term was not statistically significant at α=0.05, and the p values for the ln(age) and $age^{1/2}$ terms were similar in significance (p=0.001) to the untransformed age term.

We estimated the probability of developing symptomatic hip OA by age 85. Analyses were conducted in SUDAAN [15], with adjustment for three sources of error resulting from the study design—repeated measures across study participants, multiple participants per household, and a two-stage clustered sampling design.

We conducted a sensitivity analysis to determine the potential bias of cohort attrition on the lifetime risk estimate. First, we conducted backward selection logistic regression (explanatory variables were age [five year categories]; sex; race; educational attainment; BMI at age 18; and BMI at baseline [history of hip injury was not included because of insufficient sample size]) to identify risk factors (at α = 0.10) for onset of symptomatic hip OA between baseline and follow up. Age and race were significantly associated with incident disease. Second, we calculated the proportion of the sample that each combination of the two strata, including missing values, represented. Steps one and two of these analyses were limited to participants who did not have symptomatic hip OA at baseline.

Third, using the proportions estimated in the previous step, we selected a random sample from each of the five groups of nonparticipants at follow up (i.e., had a household interview only, declined participation, lost to follow up, moved from study area, physically or mentally unable to participate). Fourth, we estimated the overall lifetime risk: Randomly selected persons were recoded as having OA at follow up and remaining members of each group were recoded as unaffected. We conducted steps three and four 10 times to determine the range of the simulated lifetime risk estimates.

Results

The average age of the 2,756 eligible participants at baseline was 63 years (range = 45–93 years). The baseline sample excluded 321 women who were ineligible for having x-rays at baseline because they were aged <50 years (Fig. 1). The weighted sample comprised 18% blacks, 53% women, and 55% with an annual of income of <$20,000 (Table 1). Sixty-five percent of the participants were married or in common-law marriages, and 58% had at least a high school education. Only 11% of participants reported being overweight or obese at age 18, but 67% were overweight or obese at baseline. Forty-one percent reported hip or groin symptoms, and 13% had symptomatic OA in at least one hip at baseline when symptoms were defined as either the presence of pain, aching, or stiffness or groin pain.

The overall lifetime risk for symptomatic hip OA was 24.2% (data not presented) when the definition of symptoms was limited to presence of pain, aching, or stiffness. The lifetime risk increased minimally to 25.3% when defined as the presence of either pain, aching, or stiffness or groin pain (Table 2). The overall lifetime risk estimated in the sensitivity analysis (i.e., simulation of estimate as if there was no loss to follow up) was 29.4 % (range = 29.1% to 29.9%) (data not presented).

Women were 10% more likely than men to develop symptomatic hip OA (28.6% [95% CI = 23.6–33.6] versus 18.5% [95% CI = 12.5–24.5]) (Table 2). There were no differences in lifetime risk by race or education levels. The lifetime risk for participants who reported a hip

injury in the symptomatic and radiographic affected hip was 50.0% (95% CI = 14.4–85.6) compared with 22.1% (95% CI=18.3-25.8) among those reporting no injury.

Lifetime risk was similar across levels of BMI at baseline and at follow up (Table 2). Similarly, the lifetime risk for participants reporting being under- or normal weight (26.4%) at age 18 was similar to participants who reported being overweight or obese (21.7%, respectively) (Table 2). We examined BMI across three points (age 18, baseline, and follow up). There was sufficient sample size to examine BMI trajectories among only those who reported being under or normal weight at age 18. We found no statistically significant differences across the estimates.

Discussion

The overall lifetime risk for symptomatic hip OA was 25.3%, suggesting that one in four Johnston County residents who live to age 85 are at risk of developing symptomatic hip OA. Although it was not a statistically significant difference, the lifetime risk was higher for women (28.6%) than men (18.5%), which is consistent with previous prevalence and incidence studies of symptomatic hip OA[16].

We found similar lifetime risks for blacks and whites, and the race-specific prevalence of symptomatic hip OA in the JoCo Project cohort also was the same for blacks and whites8. The race-specific prevalence of radiographic hip OA has been compared in at least four other studies. Two African studies found a lower prevalence among blacks17, [18], whereas two US studies—a national, population-based National Health and Nutrition Examination Survey I (NHANES I) survey[19] and a survey of senior citizen centers in Brooklyn, New York18—indicated a comparable prevalence among blacks and whites. Hip replacements are a well recognized and effective procedure for reducing pain and improving physical function among people with debilitating hip OA. Some studies have found evidence of greater unmet need for hip replacements among blacks compared with whites20. Our analysis did not account for differences in symptom severity, an indication for hip replacement. However, the similar race-specific risk estimates suggest an equal need for hip replacements for blacks and whites.

Lifetime risk also was similar across education levels. Education was used as an indicator of socioeconomic status because self-reported income data were missing for a high proportion (20%) of the baseline study sample, which is consistent with many epidemiologic studies[21] . At least one previous study has found an association between education and prevalent hip OA22, but education is not a recognized risk factor for incident disease23.

Although lifetime risk was higher for participants with a self-reported hip injury (50.0% [95% CI = 14.4–85.6]) than those without (22.1% [95% CI = 18.3–25.8]), the difference was not statistically significant. Hip injury and onset of hip OA have been linked in previous studies[19], 24. The lack of association in this study may have resulted from the small number of people who reported a hip injury in the radiographically affected hip at baseline.

The association between BMI and total hip replacement is strong 25-[27], but the evidence for association using other definitions of hip OA is equivocal. A meta-analysis of studies examining the association between BMI and hip OA indicated moderate evidence of a relationship (summary odds ratio=2) between BMI and hip OA when all studies were considered (i.e., studies including clinical and radiographic definitions) but no relationship when limited to studies examining radiographic disease only[28]. Four longitudinal studies have reported that obesity at age 18 predicts a moderate to strongly increased risk for symptomatic hip OA and hip joint replacements in later life25, 26, 29, [30]. Obesity at age 18 and at the time of hip replacement was independently associated with an increased risk for

total hip replacement among women in the Nurses Cohort Study[25]. However, another study reported that obesity in early life was associated with an increased risk for hip replacement, but weight gain in the fourth and fifth decades of life did not predict later risk for hip replacement[31]. We found similar risks in all BMI analyses which is consistent with evidence from studies examining radiographic hip OA; to date, too few JoCo study participants have undergone hip replacement procedures to reliably estimate an association between BMI and hip replacement. The majority of participants reported being under- or normal weight at age 18. Our analysis of BMI across three time points found that no differences across varying life course BMI trajectories; however, because a small proportion of respondents reported being overweight or obese at age 18, there was only sufficient power to estimate disease risk among respondents who reported being under or normal weight at age 18. In our study, BMI at age 18 was self-reported and is likely subject to recall bias[32]. Although there was a substantial difference in BMI at age 18 and baseline, the prevalence of overweight or obesity among all, including younger, adults has increased substantially in recent decades [33, 34] ; it is plausible that BMI in this cohort was substantially lower among participants at age 18.

At least seven different definitions of hip OA have been used across epidemiologic studies to classify hip OA, including K-L grades, minimal joint space width (JSW) and Croft's grade[35]. K-L grades are the most common measure35. Two potential limitations of K-L classification are the emphasis on osteophytes35 and potentially problematic intra- and inter-rater reliability when assessing radiological features relative to a published atlas35،36. Relative to other measures, K-L grades show lower incidence and similar or lower prevalence of radiographic hip OA36، [37]; a strong association between K-L grades and hip pain among women and people aged ≥65 years (comparable or better than JSW)[38]; moderate to high inter-rater and intra-rater agreement; similar or higher predictive validity for total hip replacements compared with JSW and Croft's grade37،38; and moderate to strong predictive validity for progression of hip OA, especially among people with hip pain at baseline37، [39].

We provide a model-predicted prevalence of OA by age 85 for those who achieve this age or older. This can be reasonably interpreted as the lifetime risk of OA for people who live to at least 85 years. This differs from a definition that estimates the risk of disease for the remaining lifetimes of people who live to varying ages [5,6,7]. However, because age 85 is a reasonable expected lifespan for individuals in the US, this estimate represents an informative, helpful, and relevant quantity which would be meaningful to most individuals, as they see themselves potentially living to that age. Our results are mortality-adjusted in the sense that we assume that for the portion of the sample that has died, they would have had OA in the same proportion as those who lived and are estimated by the model to have OA by age 85.

Our lifetime risk estimates were likely underestimated for five reasons. First, the sensitivity analysis found an estimate of 29.4%. This slightly higher lifetime risk may indicate an association between disease status and nonparticipation at first follow up; physical limitations caused by the onset of symptomatic hip OA between baseline and follow up was one reason for nonparticipation at first follow up. Second, the JoCo OA Project sample comprised men aged ≥45 years and women aged ≥50 years (pelvic radiographs were not obtained for women of reproductive age). The onset of hip OA is very uncommon among people aged 45 years or younger[40]، 41. Nevertheless, there may have been cases of symptomatic hip OA in the younger Johnston County population that were not captured in this study.

Third, interviewers determined participants' history of hip pain through oral questioning at the household interview. Birrell et al. reported that schematics are slightly more sensitive

than verbal query in detecting hip pain[12]. Therefore, a small proportion of participants in our study were potentially misclassified as not having hip symptoms. As well, we defined symptoms of hip OA as pain in the hip or groin. However, symptoms of hip OA can manifest in other parts of the broad hip region, including the low back. Other sites in the hip region were not included in the analysis because only hip and groin pain were measured at both baseline and at follow up.

Fourth, OA symptoms may be intermittent [42].. We derived the lifetime risk estimate using symptom status at both baseline and at follow up to increase the likelihood of capturing experience of hip pain, thus reducing misclassification of symptomatic hip OA. Last, a maximum of 11 years of follow-up data were available. We believe that lifetime risk will be higher with increased observation time, as previous studies of lifetime risk have reported higher probabilities with increasing observation time[6, 43, 44].

While estimating prevalence and incidence among people aged ≥85 years can be problematic because of decreased survival (i.e., small sample sizes at older ages), the lifetime risk statistic is a cumulative measure and uses pooled information from across age groups. Therefore, disease risk at age 85 can be estimated with increased precision. GEE repeated-measures modeling was used to reduce selection bias and to increase statistical power, as data for all cohort members were analyzed, regardless of follow-up status. The proportion of the sample participating in the first follow up (among those who were eligible) was 71%, and 90% of this group completed the x-ray evaluation (Figure 1)[4, 10].

We have estimated the lifetime risk of symptomatic hip OA to be one in four and previously reported the lifetime risk of symptomatic knee OA to be nearly one in two. The higher occurrence of symptomatic knee OA compared with hip OA is consistent with higher frequency of knee OA observed using other measures of disease burden (e.g., prevalence and incidence). Various statistical methods have been used to derive lifetime risk estimates for other chronic conditions and there is considerable variability in the characteristics of the samples (e.g., age, race/ethnicity) and sampling frames (e.g., clinic- versus population based). We believe that this substantial heterogeneity precludes comparisons of lifetime risk estimates across conditions.

We recommend caution in generalizing our results to the US population. In 1990, the distribution of age and sex in the baseline Johnston County population was comparable to the US population[4, 45, 46], but the Johnston County population had a higher proportion of black (18% versus 12%), rural (76% versus 25%), less educated (35% versus 25% had not completed high school), and lower-income residents (median income of $25,169 versus $30,056). The differences in race and education may be unimportant because although Johnston County had a higher proportion of blacks and people with less education, we found that lifetime risks were similar by race and educational attainment. The proportion of overweight or obese participants aged ≥45 years in the United States and Johnston County was similar (66% in baseline JoCo OA study sample [1990–1997] versus 63.0% in the United States in 1988–1994 NHANES 47).

The lifetime risk statistic is considered an accessible statistic for describing risk to lay audiences. It is familiar to the general public because it has been used to convey the person-level risk of other chronic conditions, such as breast cancer[48]. The JoCo OA Project is the only longitudinal, population-based study of OA in the United States that includes blacks and whites of both sexes who are middle aged and older. The uniqueness of this sample has enabled us to generate estimates from a sociodemographically diverse sample. The high lifetime risk for symptomatic hip OA observed in our study further illustrates the substantial public health burden of arthritis across a range of diverse groups.

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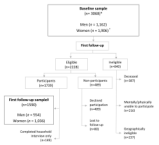

Fig. 1.

Study sample at baseline and first follow up

* Baseline response rate=3068/5138=60%; clinic cooperation rate=3068/3690=83%.

† Women aged < 50 years (i.e., reproductive age) did not have pelvic radiographs (*n*=312).

† First follow-up sample comprised those who completed clinic examination and household interview (response rate=1590/2228=83%; clinic cooperation rate=1590/ 1739=91%). All women had hip radiographs at first follow up because they were aged ≥ 50 years.

Figure 2.
Lifetime risk of symptomatic* hip OA in the JoCo OA.
* Symptomatic was defined as either “pain, aching, or stiffness in at least one hip joint” or “pain in groin” in the radiographically affected hip.
† Weighted to Johnston County population distribution in the 1990 United States Census.
‡ Stratified lifetime risk estimates may not sum to overall lifetime risk estimate because of missing data for stratification variables (Table 1).
** Education, BMI, and history of hip injury were time dependent (i.e., participants’ measurements at baseline and follow-up were analyzed).
†† BMI at age 18 was calculated from self-reported height and weight. Baseline BMI was calculated from height and weight measurements at baseline clinical examination.
‡‡ History of hip injury in the symptomatic and radiographically affected joint.

Table I

Selected sociodemographic and clinical characteristics of Johnston County Osteoarthritis Project cohort at baseline—hip analyses (n = 2,756[*])

Variable	Percentage[†,‡,§]
Age (years)	
45–59	42
60–74	44
≥75	14
Women	53
Black	18
Marital status	
Married/common-law	65
Widowed	23
Household income <$20,000 per year	55
Education	
Less than high school	42
Completed high school	32
More than high school	26
Body mass index at age 18[//]	
Under or normal (<25)	89
Overweight or obese (≥25)	11
Body mass index[//]	
Under or normal (<25)	32
Overweight (25 to <30)	42
Obese (≥30)	25
Symptoms[¶]	
Pain, aching, or stiffness in at least one hip	37
Pain in groin	16
Pain, aching, or stiffness in at least one hip or pain in groin	41
Symptomatic OA in at least one hip[**]	12
Total joint replacement in at least one hip[††]	<1
History of hip injury	
In either hip	6
In radiographically affected hip	1

OA = osteoarthritis.

[*] Excludes 312 women of reproductive age who were ineligible for hip radiographs at baseline but eligible for hip radiographs at first follow up. The characteristics of the entire cohort (*n* = 3,068) at baseline is described elsewhere[4].

[†] Weighted to Johnston County population distribution in the 1990 United States Census.

[‡] Some percentages were rounded and may not equal 100.

§The denominator of percentages do not include participants with the following missing baseline data: marital status (*n* = 1); income (*n* = 545); education (*n*=7); body mass index (BMI) at age 18 (*n* = 130); BMI (*n* = 92); history of hip injury (*n* = 7); pain, aching, and/or stiffness in at least one hip (*n* = 61); hip replacement status (*n*=61); groin pain (*n* = 28); radiographs for both hips (*n* = 49); symptoms and radiographs for both hips (*n* = 40).

//BMI at age 18 was calculated from self-reported height and weight. Baseline BMI was calculated from height and weight measurements taken at baseline clinical examination.

¶Independent of hip radiographic OA status.

**_Symptomatic_ was defined as either “pain, aching, or stiffness in at least one hip joint” or “pain in groin” in the radiographically affected hip. This includes people with total hip replacements in at least one hip.

††Observed in radiographs.

Table II

Lifetime risk of symptomatic[*] hip osteoarthritis in the Johnston County Osteoarthritis Project cohort

	Proportion[†] (95% confidence interval)
Stratified	
Sex	
Men	18.5 (12.5–24.5)
Women	28.6 (23.6–33.6)
Race	
Black	23.9 (20.2–27.6)
White	26.0 (21.2–30.7)
Education[‡]	
Less than high school	24.3 (18.8 –29.7)
Completed high school	27.6 (23.5 – 31.8)
More than high school	23.2 (20.9 – 29.7)
Body mass index at age 18 years[**]	
Underweight or normal (<25)	24.6 (20.3 – 28.9)
Overweight or obese (≥25)	20.6 (7.5– 33.6)
Body mass index[‡,**]	
Underweight or normal (<25)	25.5 (18.2 –32.7)
Overweight (25 to <30)	23.5 (17.8–29.2)
Obese (≥30)	31.1 (23.1–39.2)
History of hip injury[‡,††]	
No	22.1 (18.3–25.8)
Yes	50.0 (14.4–85.6)
Overall[‡‡]	25.3 (21.3 – 29.3)

[*] Symptomatic was defined as either “pain, aching, or stiffness in at least one hip joint” or “pain in groin” in the radiographically affected hip.

[†] Weighted to Johnston County population distribution in the1990 United States Census.

[‡] Education, body mass index (BMI), and history of hip injury were time dependent (i.e., participants’ measurements at baseline and follow up were analyzed).

[**] BMI at age 18 was calculated from self-reported height and weight. Baseline BMI was calculated from height and weight measurements at baseline clinical examination.

[††] History of hip injury in the symptomatic and radiographically affected joint

[‡‡] Stratified lifetime risk estimates may not sum to overall lifetime risk estimate because of missing data for stratification variables (Table 1).