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Associations of Educational Attainment, Occupation and Community Poverty with Hip Osteoarthritis

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Abstract

Objective—To examine cross-sectional baseline data from the Johnston County Osteoarthritis Project for the association between individual and community socioeconomic status (SES) measures with hip osteoarthritis (OA) outcomes.

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COMPETING INTERESTS
The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS
LFC contributed to study conception and design, participated in data analysis and interpretation, and in the drafting and reviewing of the manuscript. RJC contributed to data analysis and interpretation, and in the drafting and reviewing of the manuscript. LPP, BS, TAS, JBR, RR, and JMJ contributed to study design and interpretation and reviewing of the manuscript. All authors read and approved the final manuscript.

Methods—We analyzed data on 3,087 individuals (68% Caucasian and 32% African American). Educational attainment and occupation were used as *individual* measures of SES. Census block group household poverty rate was used as a measure of *community* SES. Hip OA outcomes included radiographic OA (rOA) and symptomatic OA (sxOA) in one or both hip joints. Multivariable logistic regression models were used to estimate odds ratios (OR) and 95% confidence intervals (CI) for the association of each hip OA outcome with each SES variable separately, then with all SES measures simultaneously. Associations between hip OA outcomes and SES variables were evaluated for effect modification by race and gender.

Results—Living in a community of high household poverty rate showed independent associations with hip rOA in one or both hips (OR=1.50; 95% CI=1.18–1.92) and bilateral (both hips) rOA (OR=1.87; 95% CI=1.32–2.66). Similar independent associations were found between low educational attainment among those with sxOA in one or both hips (OR=1.44; 95% CI=1.09, 1.91) or bilateral sxOA (OR=1.91; 95% CI=1.08–3.39), after adjusting for all SES measures simultaneously. No significant associations were observed between occupation and hip OA outcomes, nor did race or gender modify the associations.

Conclusion—Our data provide evidence that hip OA outcomes are associated with both education and community SES measures, associations which remained after adjustment for covariates and all SES measures.

INTRODUCTION

Osteoarthritis (OA), the most prevalent form of arthritis, is a painful and often disabling condition, currently affecting over 27 million adults in the United States (1, 2). The most common forms of OA are knee OA and hip OA, which can significantly impact a person's mobility and sometimes necessitate surgical procedures, such as total joint replacement (3). As such, OA is a major source of disability and can have a great impact on quality of life including fatigue, psychological distress including depression, behavioral and social outcomes and reduced physical function (4). Several factors place individuals at a higher risk of developing hip OA, including older age, female gender, high body mass index (BMI), previous hip injury, genetics or family history of OA, and lower levels of education or socioeconomic status (SES) (1, 2, 5–8).

Previous studies have shown associations between measures of SES such as educational attainment and occupation and the development of chronic illness and arthritis (9–14). In particular, several studies have examined the relationship between lower levels of educational attainment and both OA prevalence and poorer health status outcomes (5, 13, 15–20). Two of these have examined SES measures and radiographic OA (rOA) of the knee (5, 21). The first evaluated the First National Health and Nutrition Examination Survey (NHANES-I, 1971 to 1975), noting that low educational attainment levels were associated with both rOA and symptomatic OA (sxOA) of the knee; however, only knee sxOA remained independently associated after controlling for occupation, age, race, obesity and knee injury (5). Additionally, our group assessed the relationship between lower educational attainment and knee rOA and sxOA in a cross-sectional sample of 2,627 non-Hispanic African Americans and Caucasians in the Johnston County OA Project (21). After adjusting for known risk factors, it was shown that lower educational attainment was associated with increased prevalence of knee sxOA in both men and women, and with knee rOA in women.

Few studies have examined associations between educational attainment and OA prevalence in the hip. Also using data from NHANES-I, Tepper and colleagues examined the relationship between years of education (dichotomized as 'greater than' and 'less than/equal to' 12 years of school) and rOA. Although univariate logistic regression analyses suggested that higher educational level was associated with hip rOA, a multivariate model determined

that this relationship was of borderline statistical significance (19). In contrast, a study carried out in Norway reported increased prevalence of self-reported hip OA among those with fewer than 12 years of education (22).Another recent Australian study reported a non-significant U-shaped association of total hip replacement with SES, which was defined as the Index of Relative Socioeconomic Disadvantage (IRSD) of the census district where one lived (23). Although not specific to hip OA, an additional study by Brennan et al. reported that those living in the highest quintile of neighborhood disadvantage had higher rates of self-reported arthritis (24). It appears that no other study has evaluated SES and hip OA specifically.

In addition to individual measures, community factors have also been found to play a role in the development of arthritis and other chronic illness (25–31). Even after controlling for a person's level of educational attainment, arthritis and other chronic diseases have been found to be associated with the poverty rate of one's socioeconomic environment. Two studies of arthritis prevalence in Canada examined correlations between geographic and provincial location and rates of self-reported arthritis (27, 30). One study, which adjusted for age, sex, education, and body mass index (BMI), found that Quebec had a lower prevalence of arthritis and most other chronic conditions, compared to the remaining provinces in Canada indicating that place of residence is an important factor for arthritis prevalence (30). The second Canadian study found both individual and regional-level SES measures, such as the prevalence of low income families within a region, to be associated with variations in the rates of self-reported arthritis (27). Additionally, a study of 7,770 patients in family practice sites throughout North Carolina showed that after adjusting for individual educational attainment, both Caucasian and non-Hispanic African American individuals from communities with high poverty rates had higher rates of self-reported arthritis (26). Further, previous results from the Johnston County Osteoarthritis Project showed that living in an community with a poverty rate of 25% or more was positively associated with knee rOA and sxOA (15) as well as with disability in persons with hip OA (17).

At this time, there is very limited research on the association between educational attainment and hip OA, and community poverty levels factors have not been examined in radiographically diagnosed hip OA. A better understanding of the role of individual and community attributes could help policymakers develop targeted programs toward reducing hip OA. The purpose of this study is to examine associations between educational attainment and occupation (individual level SES) as well as neighborhood household poverty rate (community level SES) with hip rOA and sxOA in the Johnston County OA Project. It is hypothesized that both individual and community level SES factors will be independently associated with both hip rOA and sxOA.

MATERIALS AND METHODS

The Johnston County OA Project is an ongoing community-based cohort of persons with OA, which is described in detail in a previous publication (32). Briefly, this study is a prospective cohort study of knee and hip OA. The study was designed to be representative of civilian, non-institutionalized African Americans and Caucasians over the age of 45 who resided in one of six towns or townships in Johnston County, North Carolina for at least one year, were living in the county at the time of study enrollment, and physically and mentally capable of completing the study protocol.

This investigation is a cross-sectional analysis examining the frequency of rOA and sxOA and their associations with two individual social determinants (education and occupation) and a community contextual factor (block group poverty rate). Analyses were carried out using baseline data from 4,098 individuals who entered the cohort in two periods -- 1990–

1997 (original study enrollment period) and 2003–2004 (cohort enrichment with new enrollees) (Figure 1). All participants completed two in-home interviews and a limited clinical and functional examination, which included an assessment of weight (kg) using a balance beam scale, height (cm) measured with a stadiometer, and a radiographic examination of the hips to diagnose rOA and sxOA. Pelvic radiographs were not obtained from women younger than 50 years (N=482). At least one hip radiograph was available for 3,384 individuals, who were included in the analyses (see Figure 1). At baseline, all participants provided informed written consent at the time of recruitment. The study was approved by the Institutional Review Boards of the University of North Carolina Schools of Medicine and Public Health and the Centers for Disease Control and Prevention.

Osteoarthritis Measures

Four main OA measures were used in this study: rOA and sxOA, defined both generally (OA in either hip) or bilaterally (OA in both hips).

Radiographic Hip OA—Women ages 50 years and over and all men had anterior-posterior pelvic radiographs which were obtained with the subject supine and with feet at 15 degrees rotation. Radiographs of the hips were read by a single bone and joint radiologist (JBR) and assigned a Kellgren-Lawrence grade (KL-grade) for each hip on a scale of 0–4, where higher values show evidence of more severe osteoarthritic deterioration of the joint. Unilateral rOA was defined as having a KL grade 2 in one hip and bilateral rOA was defined as having KL grade 2 in both hips.

Symptomatic Hip OA—Symptomatic hip OA was defined as presence of rOA (KL-grade 2) in at least one hip, plus self-reported symptoms *in the same hip*. Hip symptoms for each hip were assessed by answering the question: "On most days, do you have pain, aching, or stiffness in your (right, left) hip?" A *general* finding of sxOA was made for a person if there was sxOA in at least one hip. *Unilateral* sxOA was defined as having rOA with symptoms in one hip and *bilateral* sxOA was indicated by rOA in both hips and symptoms in both hips.

Primary Exposures of Interest

The primary exposures of interest included two individual level measures of SES and one community level measure of SES.

Individual level measures of SES

Educational Attainment: Education was used as a dichotomous variable indicating having completed less than 12 years of formal schooling or 12 years or more (referent).

Occupational Category: Occupation was dichotomized to distinguish between occupations that are managerial and those that are not (referent). Six U.S. Census classifications were applied to the principal occupation indicated by the participant. Occupations classified as non-managerial were: (1) Service; (2) Farming, Forestry, and Fishing; (3) Precision Production, Craft, and Repair; (4) Operators, Fabricators, and Laborers. Managerial occupations were: (5) Managerial and Professional; (6) Technical, Sales, and Administrative Support (33).

Community level measure of SES

Household Poverty Rate—Household poverty rate was determined through the percentage of households with income below the poverty level within a US Census block group at the time of entry into the study. Research suggests that percentage of households in poverty is a good indicator for community-level SES and has been shown in some studies to

be a better indicator of the SES environment than census tract measures (28, 34). Each participant's physical address was geocoded, linked to the US Census block group identification number, and then used to extract aggregated census information. The census-based household poverty rate assigned to a participant's block group is intended to indicate the contextual or community SES where the resident lives. For example, two residents of the same block group will share the same household block group poverty rate but they may have different *individual* SES characteristics such as educational attainment and occupation. In Johnston County, 67 of 68 block groups had at least one participant, where household poverty rates range from 0 to 50%. For this study, poverty was categorized based on tertile cut points of block group poverty rates, resulting in cut-points of 12% and 25%. This three-level variable was defined as low (referent), medium or high community poverty rates.

Covariates

Factors considered as potential confounders of the associations between SES variables and hip OA measures were: gender (male, female), race (black, white), BMI (weight in kg/[height in m]^2), currently smoking (no, yes), self-reported prior hip injury (no, yes), and occupational activity score. Occupational activity score was based on self-reports of frequencies of four employment-related activities: squatting, standing, lifting and walking (0=never, 1=seldom, 2=sometimes, 3=often, 4=always). The sum (0–16) of the individual scores was dichotomized as low (<10) or high (10).

Statistical Analysis

For this study we carried out a complete-case analysis, leading to an additional 297 subjects to be excluded from the analysis due to missing values for one or more covariates, leaving 3,087 for analysis (see Figure 1). Frequency of hip measures and SES variables was similar between datasets which did and did not exclude subjects for missing values for covariates. All analyses were carried out using the statistical software package SAS version 9.2 (SAS Institute Inc., Cary, NC).

For the assessment of the associations between hip rOA measures and individual and community SES, odds ratios (ORs) and 95% confidence intervals (CI) were calculated using logistic regression models for the presence of hip rOA or hip sxOA (35). Multinomial logistic models were used to assess the association of predictors with hip rOA laterality measures (*e.g.*, unilateral rOA and bilateral rOA versus no rOA). All models were adjusted for age. Using manual backward elimination, other potential confounders listed above as covariates were removed from models beginning with those with the highest *P* value. Variables were retained in the final models if their inclusion changed the estimate of effect by >10% (35). Adjustment for covariates beyond age did not appreciably alter estimates of effect by more than 10% for either hip rOA or hip sxOA; therefore, reported associations are adjusted for age only. Additional analyses managed within street-level correlation (with an exchangeable working correlation structure) using generalized estimation equations methodology. We found no meaningful differences in results when accounting for within street correlation, therefore reported results are from models that do not consider street-level correlation.

Effect measure modification on the multiplicative scale between all SES predictors and race was evaluated using the log likelihood ratio test to compare logistic regression models with and without the cross-product terms. We found no significant evidence of effect modification by race. Similar analyses also found no effect modification by gender.

To evaluate the possibility of a segregation effect, we also looked at percentage of African American residents in each block group. For the 67 block groups, the percentage of African

American residents ranged from 0 to 93% and averaged 16.8%. Because of racial disparities in income, there is a strong positive correlation (r=0.83) between household poverty rate and this measure of segregation. Ultimately, percentage of African American residents in the block group was determined to have less predictive value and was dropped from the final modeling approach.

RESULTS

There were 3,087 participants in the Johnston County OA Project who met the study criteria for this analysis, of which 31.8% were African American and 56.8% female (Table 1). Overall, 27% had rOA, 10.6% had rOA in both hips, 9.7% with rOA reported symptoms in the same hip, and 2.1% had bilateral sxOA. The mean age of the study sample was 62.7 years, 36.1% had less than a high school education, 42.7% had a non-managerial job, and 22.2% lived in areas where over 25% of the sample lived at or below the poverty level. Demographic characteristics were similar for participants with any (one or both) hip rOA and the subset with bilateral disease. Similarly, those with any (one or both) hip sxOA and the subset with bilateral sxOA were similar with respect to most demographic characteristics, although those with bilateral sxOA had a higher frequency of both obesity and current smoking. The frequency of hip OA measures did not vary according to race, and there was no evidence for effect modification by race on the SES variables (data not shown).

Odds ratios for the association between individual SES predictors and hip OA measures are shown in Table 2. High community poverty was associated with both hip rOA and sxOA measures in either hip, and low educational attainment was associated with hip sxOA in one or both hips. However, non-managerial occupation showed no association with any of the hip OA measures. These associations held for most comparisons, even with simultaneous adjustment for all SES characteristics in the same model. Participants living in areas with poverty levels over 25% were more likely to have rOA in one or both hips (OR=1.50; 95% CI=1.18–1.92) when compared to living in areas with poverty levels lower than 12%. Similarly, those who did not attain a high school diploma had 40% greater odds of having sxOA in one or both hips (OR=1.44; 95% CI=1.09–1.91), when compared to those with a high school diploma or more education.

The results of age-adjusted multinomial regression models for the association of individual SES characteristics with unilateral and bilateral hip rOA and sxOA are presented in Table 3. When evaluating hip rOA in one or both hips, we observed that persons with less than 12 years education were more likely to have bilateral, but not unilateral, hip rOA when compared to those with 12 or more years of education (OR = 1.32; 95% CI = 1.03–1.70). Similarly, those who lived in areas with a block group poverty rate >25% were observed to have greater odds of bilateral hip rOA (OR = 1.96; 95% CI = 1.38–2.77). When analyses were limited to only those with sxOA, we observed that those with less than 12 years education had greater odds of having both unilateral (OR = 1.36; 95% CI =1.02–1.82) and bilateral (OR = 2.01; 95% CI =1.19–3.39) hip sxOA when compared to those with 12 years or more education. Those living in areas with a block group poverty rate >25% were more likely to have unilateral sxOA (OR =1.57; 95% CI = 1.04–2.38).

The associations for the evaluation of unilateral or bilateral rOA were attenuated somewhat when considering all SES characteristics simultaneously in regression models (Table 4). In models which included education, occupation and block group poverty, associations which remained were living in a high poverty block group for bilateral hip rOA (OR = 1.87; 95% CI = 1.32–2.66) and low education for bilateral disease in the subset restricted to sxOA (OR = 1.91; 95% CI =1.08–3.39).

The addition of gender, race, obesity, smoking, hip injury and occupational activity to regression models did not appreciably alter the results and therefore are not reported here.

DISCUSSION

Our results suggest that socioeconomic factors have a significant impact on hip OA measures. Persons living in high poverty areas have a significantly increased association with any rOA (in one or both hips), and those with low educational attainment have a significantly increased association with sxOA. These results were independent of age, gender, race, BMI, smoking, hip injury, occupational physical demands, and other SES factors. Our study supports findings from the few studies that have examined the association of educational attainment with hip OA, and ours is the first study to examine the roles of both community-level and individual-level SES measures in persons with hip OA. Given the high frequency of rOA and sxOA in our rural population (32), it is important to investigate if individual and community-level SES both contribute to OA measures.

We found that living in a high-poverty block group where 25% or more of households had income below the poverty level was associated with rOA overall, an association that was especially strong for those with bilateral disease. The socioeconomic context of a community affects the environment in which one lives in regardless of personal socioeconomic characteristics. Community poverty is often characterized by reduced access to health care, recreation facilities, and senior centers. This may contribute to individual risk factors and behaviors associated with hip OA, such as low levels of physical activity and high levels of obesity. However, these individual behaviors do not explain all the variance seen across regions. These community socioeconomic characteristics have also been shown to impact health outcomes, including self-rated health, quality of life, chronic conditions and mortality (29, 36–38).

Our findings with regard to individual SES factors, particularly education, indicate associations with hip OA measures. We found that low education was associated with increased sxOA, reinforcing findings from NHANES-I which also found education to be associated with hip OA (19). Our results also corroborate results from a Norwegian study which found increased self-reported hip OA among those with fewer than 12 years of education (22) as well as those from a recent study in Denmark which investigated the association between education levels and risk of OA hospitalization among men and women 15–73 years of age (39). This study reported education to have a modest inverse association with hip OA among both men and women. Of note is a recent Australian study that showed those living in a higher disadvantaged area was associated with fewer hip replacements than those living in an area that was less disadvantaged (40). That study did not report rates of hip OA by region nor poverty rates making it difficult to compare our results.

Our study showed no independent association between managerial or non-managerial occupation with any hip OA measure. These results suggest that education and community poverty are more important SES predictors of hip OA measures than occupation. This finding is supported by a previous study which showed that only income and education remained significant predictors of physical health in persons with self-reported arthritis (37). It has been suggested that community-level SES measures may provide further information that is not captured by individual-level measures alone (29).

OA of the hip is a common disorder and is a leading cause of disability in the elderly. Traditional risk factors for hip OA are age, BMI, genetic predisposition, and occupations that require prolonged periods of standing, bending or heavy lifting (41, 42). However, these individual-level risk factors do not account for all of the associations observed; therefore, it

has been argued that that SES is a fundamental cause of disease which puts people at '*risk of risks*' (43). SES is a complex combination of an individual's education, income and occupation and the socioeconomic environment of one's neighborhood. These various measures of SES may operate through different mechanisms to affect the risk for OA, including the potential for SES to influence lifestyle behaviors, preventive health care, health management, problem-solving abilities, and access to health care. For example, those with higher income have better access to medical care; it has also been suggested that individuals with higher education are better able to process information regarding healthy behaviors (23).

Strengths of our study include the utilization of measures of both radiographic and symptomatic hip OA in a well-described sample of men and women with a high participation rate that includes a large representation of African American participants. The Johnston County OA Project enabled us to obtain data from a large sample, and we were able to obtain data from virtually all block groups within Johnston County (67 out of 68). Finally, we were able to examine segregation as well as household poverty rate as a contextual variable.

There are also limitations that warrant mention. The study data are limited to individuals living within a single, non-urban county, thereby limiting generalizability. Further, we did not include a measure of participant income as an individual SES measure, as these data were not available. As household poverty rates were documented by block group, our community SES measure was fairly crude as they were limited to US Census variables that focused on aggregated individual-level variables. As street of residence represents diversity among its members, our primary analysis does not account for correlation between those living on the same street. However, additional models, which do account for such a correlation, were considered. Results remained robust with the exception of the effect for block group poverty levels exceeding 25%, which exhibited slightly attenuated effects and wider confidence intervals relative to the reported results. However, the results from this additional consideration did not change statistically significant results nor the general nature of our conclusions. The SES measures used in our study may represent different facets of social circumstances; however, all individual measures can affect one's health behaviors and predict health status (44, 45). Area-level poverty has been shown to be a good measure of geographic distribution of socioeconomic inequalities in health, and enables measurement of the effect of local environment beyond the impact of individual SES (46). There is also the issue of reverse causation, where having OA could affect SES. Of the SES measures used in our study, education is the least likely to be affected by reverse causation since it generally occurs early in life and OA is generally a disease of aging. Finally, our study is based on cross-sectional data, therefore we are not able to determine causality.

In some previous studies it has been suggested that race is a proxy for SES. However, in our study we found that frequency of rOA and sxOA were similar in Caucasians and African Americans despite African Americans being more likely to be obese, have more physically demanding occupations, have lower education and live in a higher poverty areas. It has also been shown that pain and function, as well as pain perception, are not different between African Americans and Caucasians at any radiographic severity level of OA (47, 48). That the frequency, function and pain of hip OA are similar in Caucasians and African Americans supports our findings that socioeconomic factors are the more important determinants of rOA and sxOA measures than race.

In conclusion, our study expands the literature examining the association between measures of SES and OA measures. We were able to examine SES measures in association with hip rOA, which is an understudied area of OA research. Further, we were able to identify the

relationship between SES and several different hip OA measures, including radiographic and symptomatic hip OA, as well as unilateral and bilateral hip OA measures for both rOA and sxOA. We were also able to examine these associations in a large sample of both African Americans and Caucasians. Finally, our study examined not only two important measures of individual SES (education and occupation), but also included a measure of community SES (block group poverty rate) to help identify aspects of SES that are important predictors of hip OA measures.

Acknowledgments

REFERENCES

1. Dagenais S, Garbedian S, Wai EK. Systematic review of the prevalence of radiographic primary hip osteoarthritis. Clinical orthopaedics and related research. 2009; 467(3):623–637. [PubMed: 19037710]

2. Lubar D, White PH, Callahan LF, Chang RW, Helmick CG, Lappin DR, et al. A National Public Health Agenda for Osteoarthritis 2010. Seminars in arthritis and rheumatism. 2010; 39(5):323–326. [PubMed: 20307725]

3. DeFrances CJ, Podgornik MN. 2004 National Hospital Discharge Survey. Advance data. 2006; (371):1–19. [PubMed: 16703980]

4. Callahan LF, Blalock SJ. Behavioral and social research in rheumatology. Current opinion in rheumatology. 1997; 9(2):126–132. [PubMed: 9135916]

5. Hannan MT, Anderson JJ, Pincus T, Felson DT. Educational attainment and osteoarthritis: differential associations with radiographic changes and symptom reporting. Journal of clinical epidemiology. 1992; 45(2):139–147. [PubMed: 1573430]

6. Murphy LB, Helmick CG, Schwartz TA, Renner JB, Tudor G, Koch GG, et al. One in four people may develop symptomatic hip osteoarthritis in his or her lifetime. Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society. 2010; 18(11):1372–1379.

7. Ingvarsson T, Stefansson SE, Hallgrimsdottir IB, Frigge ML, Jonsson H Jr, Gulcher J, et al. The inheritance of hip osteoarthritis in Iceland. Arthritis and rheumatism. 2000; 43(12):2785–2792. [PubMed: 11145037]

8. Valdes AM, Spector TD. Genetic epidemiology of hip and knee osteoarthritis. Nature reviews. Rheumatology. 2011; 7(1):23–32. [PubMed: 21079645]

9. Callahan LF, Smith WJ, Pincus T. Self-report questionnaires in five rheumatic diseases: comparisons of health status constructs and associations with formal education level. Arthritis Care Res. 1989; 2(4):122–131. [PubMed: 2487716]

10. Dalstra JA, Kunst AE, Borrell C, Breeze E, Cambois E, Costa G, et al. Socioeconomic differences in the prevalence of common chronic diseases: an overview of eight European countries. International journal of epidemiology. 2005; 34(2):316–326. [PubMed: 15737978]

11. Odutola J, Ward MM. Ethnic and socioeconomic disparities in health among patients with rheumatic disease. Current opinion in rheumatology. 2005; 17(2):147–152. [PubMed: 15711226]

12. Sainio P, Martelin T, Koskinen S, Heliovaara M. Educational differences in mobility: the contribution of physical workload, obesity, smoking and chronic conditions. Journal of epidemiology and community health. 2007; 61(5):401–408. [PubMed: 17435206]

13. Thumboo J, Chew LH, Lewin-Koh SC. Socioeconomic and psychosocial factors influence pain or physical function in Asian patients with knee or hip osteoarthritis. Annals of the rheumatic diseases. 2002; 61(11):1017–1020. [PubMed: 12379527]

14. Herd P, Goesling B, House JS. Socioeconomic position and health: the differential effects of education versus income on the onset versus progression of health problems. Journal of health and social behavior. 2007; 48(3):223–238. [PubMed: 17982865]

15. Callahan LF, Cleveland RJ, Shreffler J, Schwarz TA, Schoster B, Randolph R, et al. Associations of educational attainment, occupation and community poverty with knee osteoarthritis in the Johnston County (North Carolina) Osteoarthritis Project. Arthritis research & therapy. 2011; 13(5):R169. [PubMed: 22011570]

16. Jordan JM, Luta G, Renner JB, Linder GF, Dragomir A, Hochberg MC, et al. Self-reported functional status in osteoarthritis of the knee in a rural southern community: the role of sociodemographic factors, obesity, and knee pain. Arthritis Care Res. 1996; 9(4):273–278. [PubMed: 8997916]

17. Knight JB, Callahan LF, Luong ML, Shreffler J, Schoster B, Renner JB, et al. The association of disability and pain with individual and community socioeconomic status in people with hip osteoarthritis. The open rheumatology journal. 2011; 5:51–58. [PubMed: 22046207]

18. Woo J, Lau E, Lau CS, Lee P, Zhang J, Kwok T, et al. Socioeconomic impact of osteoarthritis in Hong Kong: utilization of health and social services, and direct and indirect costs. Arthritis and rheumatism. 2003; 49(4):526–534. [PubMed: 12910559]

19. Tepper S, Hochberg MC. Factors associated with hip osteoarthritis: data from the First National Health and Nutrition Examination Survey (NHANES-I). American journal of epidemiology. 1993; 137(10):1081–1088. [PubMed: 8317437]

20. Luong ML, Cleveland RJ, Nyrop KA, Callahan LF. Social determinants and osteoarthritis outcomes. Aging Health. 2012 (in press).

21. Callahan LF, Shreffler J, Siaton BC, Helmick CG, Schoster B, Schwartz TA, et al. Limited educational attainment and radiographic and symptomatic knee osteoarthritis: a cross-sectional analysis using data from the Johnston County (North Carolina) Osteoarthritis Project. Arthritis research & therapy. 2010; 12(2):R46. [PubMed: 20298606]

22. Grotle M, Hagen KB, Natvig B, Dahl FA, Kvien TK. Prevalence and burden of osteoarthritis: results from a population survey in Norway. The Journal of rheumatology. 2008; 35(4):677–684. [PubMed: 18278832]

23. Brennan SL, Stanford T, Wluka AE, Henry MJ, Page RS, Graves SE, et al. Cross-sectional analysis of association between socioeconomic status and utilization of primary total hip joint replacements 2006–7: Australian Orthopaedic Association National Joint Replacement Registry. BMC musculoskeletal disorders. 2012; 13:63. [PubMed: 22546041]

24. Brennan SL, Turrell G. Neighborhood disadvantage, individual-level socioeconomic position, and self-reported chronic arthritis: a cross-sectional multilevel study. Arthritis care & research. 2012; 64(5):721–728. [PubMed: 22232068]

25. Adler NE, Boyce WT, Chesney MA, Folkman S, Syme SL. Socioeconomic inequalities in health. No easy solution. JAMA : the journal of the American Medical Association. 1993; 269(24):3140–3145. [PubMed: 8505817]

26. Callahan LF, Shreffler J, Mielenz T, Schoster B, Kaufman JS, Xiao C, et al. Arthritis in the family practice setting: associations with education and community poverty. Arthritis and rheumatism. 2008; 59(7):1002–1008. [PubMed: 18576292]

27. Canizares M, Power JD, Perruccio AV, Badley EM. Association of regional racial/cultural context and socioeconomic status with arthritis in the population: a multilevel analysis. Arthritis and rheumatism. 2008; 59(3):399–407. [PubMed: 18311772]

28. Diez Roux AV, Merkin SS, Arnett D, Chambless L, Massing M, Nieto FJ, et al. Neighborhood of residence and incidence of coronary heart disease. The New England journal of medicine. 2001; 345(2):99–106. [PubMed: 11450679]

29. Diez-Roux AV, Nieto FJ, Muntaner C, Tyroler HA, Comstock GW, Shahar E, et al. Neighborhood environments and coronary heart disease: a multilevel analysis. American journal of epidemiology. 1997; 146(1):48–63. [PubMed: 9215223]
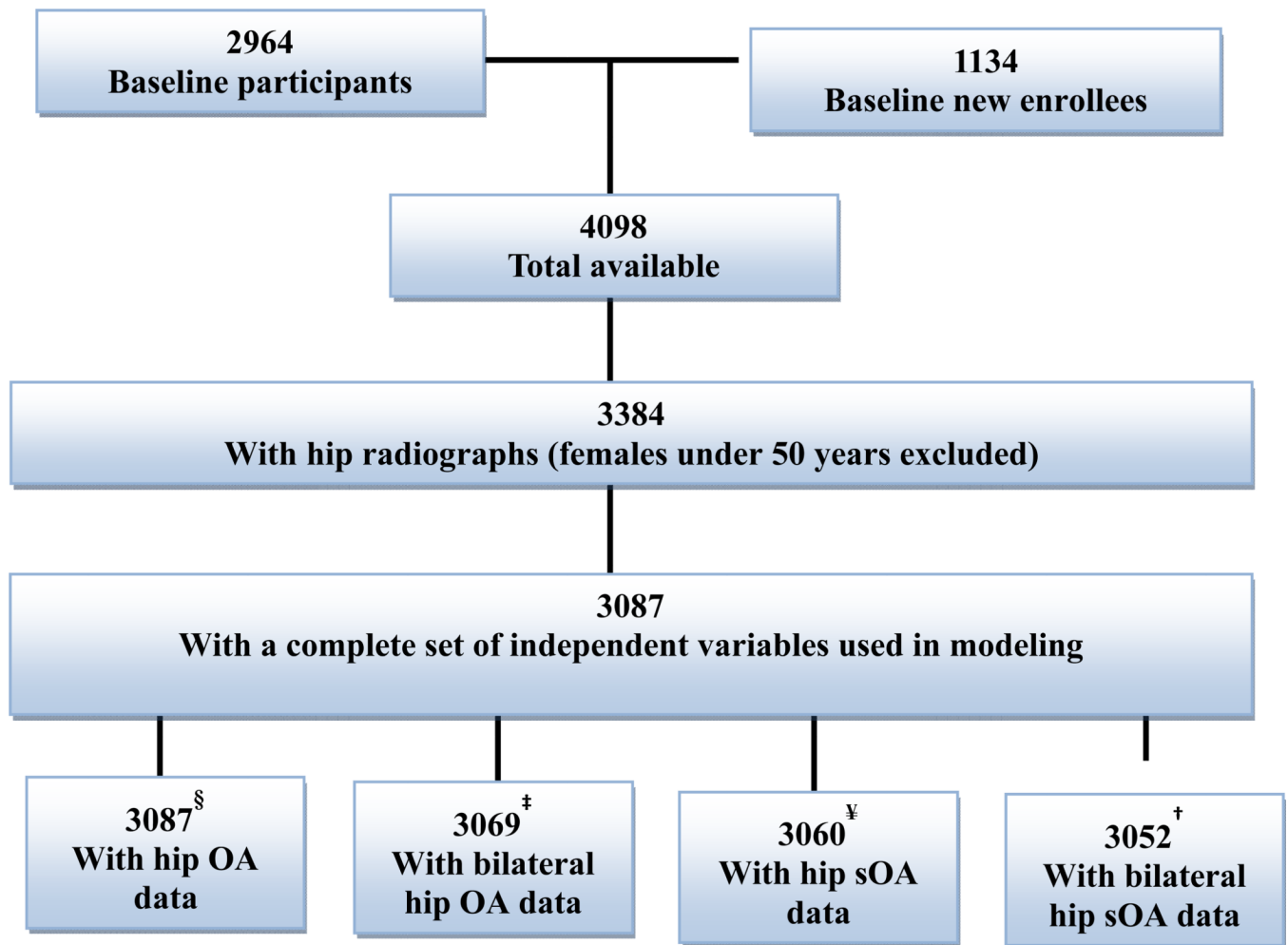
30. Wang PP, Badley EM. Consistent low prevalence of arthritis in quebec: findings from a provincial variation study in Canada based on several canadian population health surveys. The Journal of rheumatology. 2003; 30(1):126–131. [PubMed: 12508401]

31. Robert SA. Socioeconomic position and health: The independent contribution of community socioeconomic context. Annual Review of Sociology. 1999; 25:489–516.

32. Jordan JM, Linder GF, Renner JB, Fryer JG. The impact of arthritis in rural populations. Arthritis Care Res. 1995; 8(4):242–250. [PubMed: 8605262]

33. United States. Bureau of the Census. 1990 census of population and housing. classified index of industries and occupations. Washington, DC: U.S. Dept. of Commerce, Economics and Statistics Administration; 1992. For sale by the Supt. of Docs., U.S. G.P.O.

34. Krieger, N.; Zierler, S.; Hogan, JW.; Waterman, P.; Chen, J.; Lemieux, K., et al. Geocoding and measurement of neighborhood socioeconomic position: a US perspective. In: Kawachi, I.; Berkman, LF., editors. Neighborhoods and Health. New York: Oxford University Press; 2003. p. 147-178.

35. Hosmer, DW.; Lemeshow, S. Applied logistic regression. New York: John Wiley & Sons, Inc.; 2000.

36. Doubeni CA, Schootman M, Major JM, Torres Stone RA, Laiyemo AO, Park Y, et al. Health Status, Neighborhood Socioeconomic Context, and Premature Mortality in the United States: The National Institutes of Health-AARP Diet and Health Study. American journal of public health. 2011

37. Callahan LF, Martin KR, Shreffler J, Kumar D, Schoster B, Kaufman JS, et al. Independent and combined influence of homeownership, occupation, education, income, and community poverty on physical health in persons with arthritis. Arthritis care & research. 2011; 63(5):643–653. [PubMed: 21225675]

38. Glymour MM, Mujahid M, Wu Q, White K, Tchetgen Tchetgen EJ. Neighborhood disadvantage and self-assessed health, disability, and depressive symptoms: longitudinal results from the health and retirement study. Annals of epidemiology. 2010; 20(11):856–861. [PubMed: 20933193]

39. Jorgensen KT, Pedersen BV, Nielsen NM, Hansen AV, Jacobsen S, Frisch M. Socio-demographic factors, reproductive history and risk of osteoarthritis in a cohort of 4.6 million Danish women and men. Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society. 2011; 19(10):1176–1182.

40. Dixon T, Urquhart DM, Berry P, Bhatia K, Wang Y, Graves S, et al. Variation in rates of hip and knee joint replacement in Australia based on socio-economic status, geographical locality, birthplace and indigenous status. ANZ journal of surgery. 2011; 81(1–2):26–31. [PubMed: 21299795]

41. Nevitt, MC. Risk factors for knee, hip and hand osteoarthritis. In: Arden, N.; Cooper, C., editors. Osteoarthritis handbook. London: Taylor & Francis; 2006. p. 23-48.

42. Lievense A, Bierma-Zeinstra S, Verhagen A, Verhaar J, Koes B. Influence of work on the development of osteoarthritis of the hip: a systematic review. The Journal of rheumatology. 2001; 28(11):2520–2528. [PubMed: 11708427]

43. Paeratakul S, Lovejoy JC, Ryan DH, Bray GA. The relation of gender, race and socioeconomic status to obesity and obesity comorbidities in a sample of US adults. International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity. 2002; 26(9):1205–1210. [PubMed: 12187397]

44. Krieger N, Williams DR, Moss NE. Measuring social class in US public health research: concepts, methodologies, and guidelines. Annual review of public health. 1997; 18:341–378.

45. Lynch JW, Kaplan GA, Salonen JT. Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse. Social science & medicine. 1997; 44(6):809–819. [PubMed: 9080564]

46. Tunstall HV, Shaw M, Dorling D. Places and health. Journal of epidemiology and community health. 2004; 58(1):6–10. [PubMed: 14684719]

47. Ang DC, Ibrahim SA, Burant CJ, Kwoh CK. Is there a difference in the perception of symptoms between african americans and whites with osteoarthritis? The Journal of rheumatology. 2003; 30(6):1305–1310. [PubMed: 12784407]

48. Jordan JM, Luta G, Renner JB, Dragomir A, Hochberg MC, Fryer JG. Ethnic differences in self-reported functional status in the rural south: the Johnston County Osteoarthritis Project. Arthritis Care Res. 1996; 9(6):483–491. [PubMed: 9136292]

Significance and Innovations

- Osteoarthritis of the hip is a leading cause of disability in older adults.

- Few studies have examined how and individual's socioeconomic status affects hip osteoarthritis outcomes.

- In our study, we found that education and community poverty were associated with hip osteoarthritis.

- Understanding the role of individual and community attributes could help policymakers develop targeted programs toward reducing hip OA.

**2964
Baseline participants**

**1134
Baseline new enrollees**

**4098
Total available**

**3384
With hip radiographs (females under 50 years excluded)**

**3087
With a complete set of independent variables used in modeling**

**3087§
With hip OA
data**

**3069‡
With bilateral
hip OA data**

**3060$^{¥}$
With hip sOA
data**

**3052†
With bilateral
hip sOA data**

Figure 1.
Participant Flow Chart
§sample excludes those without radiographic data for at least one hip
‡sample excludes those without radiographic data for both hips
$^{¥}$sample excludes those without radiographic and pain data for at least one hip
†sample excludes those without radiographic and pain data for both hips

Table 1

Participant characteristics by hip osteoarthritis (OA) subtype

	All Subjects (N=3,087)	Any Hip rOA[†] (n=835)	Bilateral Hip rOA[†] (n=327)	Symptomatic Hip rOA[†] (n=298)	Bilateral Symptomatic Hip rOA[†] (n=65)
Demographic characteristics					
Age (Mean ± SD)	62.7 (9.86)	65.2 (10.3)	66.8 (10.2)	65.9 (9.95)	64.9 (9.52)
Female, %	56.8	57.1	59.0	60.1	50.8
Black race, %	31.8	32.1	33.3	31.2	33.8
BMI [*] (Mean ± SD)	29.2 (5.95)	28.9 (5.9)	29.3 (6.2)	29.9 (6.3)	29.8 (6.3)
Obesity, %	38.4	38.4	41.9	46.3	52.3
Smoking Now, %	20.6	18.4	17.1	20.8	24.6
Hip Injury, %	6.2	6.9	7.0	11.7	9.2
High occupational activity, %	46.6	47.7	44.3	47.7	49.2
SES characteristics					
Less than 12 yrs education, %	36.1	42.3	47.7	49.0	53.8
Non-managerial Occupation, %	42.7	41.0	37.9	37.9	33.8
Poverty (Mean ± SD)	19.6 (10.3)	20.2 (10.3)	20.5 (10.4)	20.5 (10.3)	19.8 (11.0)
Block group poverty					
Low (<12%), %	21.5	19.9	18.3	18.8	23.1
Medium (12–25%), %	56.3	52.8	49.8	54.4	53.8
High (>25%), %	22.2	27.3	31.8	26.8	23.1

[*] BMI=body mass index

[†] rOA=radiographic osteoarthritis

Table 2

Age-adjusted odds ratios (OR) and 95% confidence intervals (CI) for the association between individual socioeconomic (SES) variables and hip osteoarthritis (OA) outcomes

SES characteristics	Any Hip rOA[¥‡]	Any Hip rOA[¥§]	Symptomatic Hip rOA[¥‡]	Symptomatic Hip rOA[¥§]
Education				
12 years or more	1.00	1.00	1.00	1.00
Less than 12 years	1.17 (0.98–1.39)	1.13 (0.93–1.36)	1.50 (1.16–1.94)	1.44 (1.09–1.91)
Occupation				
Managerial	1.00	1.00	1.00	1.00
Non-Managerial	1.10 (0.93–1.29)	0.99 (0.83–1.19)	1.24 (0.97–1.58)	1.03 (0.79–1.36)
Block group poverty rate				
Poverty rate 12%	1.00	1.00	1.00	1.00
Poverty rate 12–25%	1.02 (0.83–1.26)	1.01 (0.82–1.25)	1.14 (0.83–1.57)	1.10 (0.80–1.52)
Poverty rate >25%	1.53 (1.20–1.94)	1.50 (1.18–1.92)	1.47 (1.02–2.11)	1.37 (0.95–1.98)

[¥] rOA=radiographic osteoarthritis

[‡] SES predictors considered separately in individual logistic regression models for each hip OA measure

[§] SES predictors considered together in the same logistic regression model for each hip OA outcome

Table 3

Age-adjusted odds ratios and 95% confidence intervals for the association between individual socioeconomic (SES) variables[‡] and hip osteoarthritis (OA) laterality

SES characteristics	Any Hip rOA[¥]		Symptomatic Hip rOA[¥]	
	Unilateral *vs.* None	Bilateral *vs.* None	Unilateral *vs.* None	Bilateral *vs.* None
Education				
12 years or more	1.00	1.00	1.00	1.00
Less than 12 years	1.10 (0.89–1.36)	1.32 (1.03–1.70)	1.37 (1.02–1.82)	2.01 (1.19–3.39)
Occupation				
Managerial	1.00	1.00	1.00	1.00
Non-Managerial	1.02 (0.84–1.24)	1.25 (0.98–1.59)	1.16 (0.87–1.53)	1.48 (0.88–2.49)
Block group poverty rate				
Poverty rate 12%	1.00	1.00	1.00	1.00
Poverty rate 12–25%	0.97 (0.76–1.25)	1.05 (0.76–1.44)	1.22 (0.84–1.77)	0.92 (0.50–1.69)
Poverty rate >25%	1.27 (0.95–1.70)	1.96 (1.38–2.77)	1.57 (1.04–2.38)	1.02 (0.50–2.11)

[¥] rOA=radiographic osteoarthritis

[‡] SES predictors considered separately in individual logistic regression models for each hip OA measure

Table 4

Age-adjusted odds ratios and 95% confidence intervals for the association of three socioeconomic (SES) variables simultaneously[§] and hip osteoarthritis (OA) laterality

SES characteristics	Any Hip rOA[¥]		Symptomatic Hip rOA[¥]	
	Unilateral *vs.* None	Bilateral *vs.* None	Unilateral *vs.* None	Bilateral *vs.* None
Education				
12 years or more	1.00	1.00	1.00	1.00
Less than 12 years	1.11 (0.88–1.40)	1.23 (0.93–1.61)	1.32 (0.96–1.82)	1.91 (1.08–3.39)
Occupation				
Managerial	1.00	1.00	1.00	1.00
Non-Managerial	0.95 (0.76–1.18)	1.05 (0.80–1.38)	0.99 (0.73–1.35)	1.16 (0.65–2.06)
Block group poverty rate				
Poverty rate 12%	1.00	1.00	1.00	1.00
Poverty rate 12–25%	0.97 (0.75–1.24)	1.02 (0.75–1.41)	1.19 (0.82–1.72)	0.86 (0.46–1.59)
Poverty rate >25%	1.26 (0.94–1.70)	1.87 (1.32–2.66)	1.50 (0.99–2.29)	0.89 (0.43–1.86)

[¥] rOA=radiographic osteoarthritis

[§] SES predictors considered together in the same logistic regression model for each hip OA outcome