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# Point prevalence of Hip Symptoms, Radiographic, And Symptomatic OA at Five Time Points: The Johnston County Osteoarthritis Project, 1991–2018

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Competing interest statement

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LBM was, and CGH is, an employee of the Centers for Disease Control and Prevention.
The other authors (DH, LA, CA, RJC, TAS, JBR, JMJ) declare no competing interests.

Data statement

Deidentified individual data that support the results will be shared beginning 9 to 36 months following publication provided the investigator who proposes to use the data has approval from an Institutional Review Board (IRB), Independent Ethics Committee (IEC), or Research Ethics Board (REB), as applicable, and executes a data use/sharing agreement with UNC and the Johnston County Osteoarthritis Project PIs.

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## Abstract

**Objective:** To describe the point prevalence of hip symptoms, radiographic hip osteoarthritis (rHOA), severe rHOA, and symptomatic rHOA (sxHOA) at five time points in the longitudinal, population-based Johnston County Osteoarthritis Project (JoCoOA).

**Design:** Data were from 3068 JoCoOA participants who attended up to five study visits (1991–2018). Standardized supine pelvis radiographs were read by a single, expert musculoskeletal radiologist with high reliability. The four outcomes were: 1) self-reported hip symptoms: "On most days, do you have pain, aching, or stiffness in your right/left hip?"; 2) rHOA: Kellgren-Lawrence grade (KLG) of 2–4; 3) severe rHOA: KLG of 3–4; and 4) sxHOA: both symptoms and rHOA in the same joint. Weighted point prevalence and 95% confidence intervals (CI) were generated overall and by age group (45–54, 55–64, 65–74, 75+ years), sex, race (Black/White), and body mass index (BMI; 18.5–24.9; 25–29.9; 30+ kg/m$^2$).

**Results:** At the most recent follow-up (2017–2018), the point prevalence (%) of hip symptoms, rHOA, severe rHOA, and sxHOA were 30% (95% CI 25%, 35%), 53% (95% CI 48%, 58%), 9% (95% CI 6%, 12%), and 15% (95% CI 11%, 19%), respectively. RHOA and severe rHOA were most prevalent in those 75+ years. Women were more likely than men to have hip symptoms and sxHOA. No consistent trends were noted by race or BMI.

**Conclusion:** These updated point prevalence estimates demonstrate a large and increasing burden of HOA in the general population, particularly with aging. Black and White individuals were affected similarly in this cohort.

### Keywords

Hip osteoarthritis; prevalence; sex differences; radiography

Hip osteoarthritis (HOA), although relatively common, has not been studied as intensively as knee OA, and trends in its prevalence over time are not known. We have previously estimated the lifetime risk of developing symptomatic radiographic HOA (rHOA) at 25%, meaning that nearly 1 in 4 adults in the United States will be affected by age 85 years[1]. The lifetime risk was similar by sex, race, and body mass index (BMI), suggesting that these important risk factors for knee OA[2] are not as relevant for OA at the hip[1]. Over a decade ago, a systematic review of radiographic HOA (rHOA) prevalence including 23 studies reported a range of estimates from 1–27% with a mean of 8%, with substantial geographic variation[3]. The 2010 Global Burden of Disease study reported a global age-standardized prevalence of HOA of 0.85%, stable from 1990 to 2010, and higher in women[4]. Depending on the age of the cohort and the HOA definition used, the prevalence can vary, with hip symptoms (e.g., pain, aching, stiffness consistent with OA) being the highest, followed by rHOA, and then symptomatic HOA (sxHOA)[5].

Population-based studies are needed to produce generalizable estimates of disease prevalence at a given time (e.g., point prevalence). The point prevalence of rHOA in

adults over 50 years of age in the Framingham OA Study (2002–2005, using standing anteroposterior long limb films) was 19.6% and was more common in men; sxHOA was less frequent at 4%[6]. We have previously published prevalence data from the baseline (T0) visit of the Johnston County OA Project (JoCoOA, 1991–1997), when the point prevalence estimates of hip symptoms, rHOA, severe rHOA, and sxHOA were 36%, 28%, 2.5%, and 10%, respectively[7]. Few population-based cohort studies exist with longitudinal OA prevalence data to allow updated estimation of the point prevalence of HOA, which is needed for estimating burden of disease on healthcare systems and society, as well as informing policy decisions. Therefore, the purpose of this manuscript is to describe the point prevalence of four hip outcomes (symptoms, rHOA, severe rHOA, and sxHOA) at all five available time points, from 1991 to 2018, in a large longitudinal U.S. population-based cohort of Black and White men and women (JoCoOA).

## Participants and Methods

The JoCoOA, a prospective population-based cohort of Black and White men and women who were residents of six townships in Johnston County, North Carolina and were 45 years of age and older at baseline, has been described in detail previously[7]. All participants gave written informed consent prior to participation. The JoCoOA has been continuously approved by the Centers for Disease Control and Prevention and University of North Carolina IRBs (#92–0583).

For the current analysis, data were collected from all JoCoOA time points: baseline (T0): 1991–7, n=3068; first follow-up (T1): 1999–2003, including cohort enrichment (T1*): 2003–4, total n=2573; second follow-up (T2): 2006–11, n=1595; third follow-up (T3): 2013–15, n=785); and fourth follow-up (T4): 2017–2018, n=506 (Table 1). All visits included standardized anteroposterior supine pelvis radiographs obtained with the feet in 15 degrees internal rotation; all radiographs were read by a single, experienced musculoskeletal radiologist (JBR) with high reliability ($\kappa$=0.86 and 0.89 for inter- and intra-rater reliability, respectively)[8]. Per study protocol, women under 50 years of age at the time of assessment did not undergo pelvis radiography. The T0 estimates were reported previously[7] but are included here for completeness and ease of comparison.

For this study, there were four outcomes of interest defined as: 1) hip symptoms, using the question “On most days, do you have pain, aching, or stiffness in your right/left hip?”; 2) rHOA, a Kellgren-Lawrence grade (KLG)[9] of 2 or more; 3) severe rHOA, KLG of 3 or more; and 4) sxHOA, the presence of both symptoms and rHOA as above, in the same hip. Both hips were considered; rHOA was defined if criteria were met in one or both hips, and hip symptoms were similarly defined. Less than 5% of hips at any time point (i.e., T0: n=26 [0.8%]; T1/T1*: n=40 [1.6%]; T2: n=56 [3.5%]; T3: n=36 [4.6%]; T4: n=24 [4.7%]) had undergone replacement, so this outcome was not analyzed separately; however, these individuals were included in the sxHOA category. Participants self-reported sex, age, and race; BMI (kg/m$^2$) was calculated from height and weight measured during clinical visits.

### Statistical analysis

Cross-sectional, person-based, weighted point prevalence analyses were performed using the SURVEYFREQ procedure in SAS version 9.4, taking the complex sampling design, including sampling weights, into account, as detailed below. Sampling weights were calibrated separately for each actual collection time point to the respective U.S. Census population counts for Johnston County to reflect the changing population demographics, as described below. Streets (defined as the full length of a named thoroughfare from start to end) were considered the primary sampling unit. The stratification of the streets and the sampling rates differed by township depending on relative size, racial makeup, rural/urban status, and socioeconomic status, with the goal of oversampling of Black participants.

Each set of cross-sectional survey weights was constructed using a three-step process, detailed previously[10] and summarized here. First, the inverse of the probability of selection, as determined by the sampling scheme at T0, the time of enrollment, was taken as the raw weight for T0; raw weights were set to 1 for the supplemental sample (T1*) drawn to enrich the size of the cohort, as this was considered a convenience sample. Second, the raw weights from T0 were adjusted for non-response (i.e., those participants who were selected but did not participate in interviews or clinic visits) at T0 and at T1 using logistic regression; T1* weights were not adjusted for non-response. Third, all adjusted weights were calibrated to the nearest US Census population values by a post-stratification adjustment. These values were from 1990 for T0; from 2000 for T1; and from 2010 for T2–T4. The weights were calibrated on four stratifying variables: age group (45–54, 55–64, 65–74, 75+ years), sex, race, and township of residence. This re-calibration to the Census at each time point re-weights the sample to reflect the population at each cross-sectional time point. Finally, point prevalence estimates and corresponding 95% confidence intervals for each of the four hip outcomes separately at each time point were generated for the overall sample and by age group, sex, race, and BMI category (normal weight: 18.5–24.9 $kg/m^2$; overweight: 25–29.9 $kg/m^2$; obese: 30 $kg/m^2$ and higher[11]). Individuals in the underweight category (BMI < 18.5 $kg/m^2$) are included in the sample description (Table 2) but are not included in analyses due to non-estimable variance (due to strata with a single cluster and comprising only 1% of the sample). To provide values that are standardized to the same US Census (and therefore providing comparability across time), a sensitivity analysis calibrating all time points to a common US Census (i.e., the 2010 US Census) was also performed.

## Results

As shown in Table 2, about 2/3 of the sample were women and 1/3 were Black, proportions which remained fairly stable over the study period. At four of five time points, the mean BMI was in the obese range, and the vast majority of participants were overweight or obese, also stable over time. The patterns of aging by 10-year age group are provided; there were no cohort members in the youngest age group for the last two follow-up periods due to aging of the cohort. The unweighted percentages for unilateral rHOA by time point (T0, T1, T2, T3, T4, respectively) were: 18%, 18%, 22%, 27%, and 30%; while for bilateral rHOA these were 12%, 15%, 17%, 19%, and 21%.

As expected, the overall prevalence of rHOA, severe rHOA, and sxHOA increased with aging of the cohort (Figure 1); however, hip symptoms were relatively stable over time. In contrast to earlier time points, the last two (T3 and T4) visits were closer in time and therefore the changes were less marked. At the most recent follow-up time point (T4: 2017–2018), the overall point prevalence estimates (%) of hip symptoms, rHOA, severe rHOA, and sxHOA were 30%, 53%, 9%, and 15%, respectively. For comparison, these values at baseline (T0: 1991–1997) were 36%, 28%, 2.5%, and 10%, respectively.

The weighted point prevalence estimates for the radiographic outcomes, rHOA and severe rHOA, overall and by age, sex, race, and BMI are shown in Table 3. The highest prevalence estimates for both rHOA and severe rHOA were noted among those 75 years of age and older at each time point, with lower prevalence among younger groups. Outcomes were generally similar by sex, race and BMI without consistent differences across time points.

The weighted point prevalence estimates for the symptomatic outcomes, hip symptoms and sxHOA by subgroups of age, sex, and race are shown in Table 4. Hip symptoms were relatively stable by age group across time points. The prevalence of sxHOA increased by age group at most time points, with the highest prevalence in the group that was 75 years of age and older at all time points. Compared with men, women were more likely to report hip symptoms and to have sxHOA across all time points. There were no consistent differences by race for either hip pain or sxHOA, although the latter was slightly less prevalent among Black individuals, particularly at later time points. This indicates that the prevalence of these outcomes was similar among Black and White participants. Additionally, no consistent trends by BMI were noted for sxHOA, although hip symptoms were somewhat more prevalent in the obese group compared to the normal and overweight groups at most time points.

In the sensitivity analysis, estimates generated using recalibration of the weights using the common population distribution from the 2010 US Census for all timepoints did not produce appreciably different results (data not shown).

## Discussion

We report weighted point prevalence estimates for four hip outcomes in a large, population-based longitudinal cohort of Black and White men and women with up to 26 years of follow-up. The prevalence of rHOA, severe rHOA, and sxHOA are high and increasing among this representative group. Older adults, particularly 75 years of age and older, had the highest prevalence of radiographic outcomes. Compared with men, women had a higher prevalence of symptomatic outcomes. All outcomes were similar by race. Consistent with the literature, and in contrast with knee OA outcomes[12], hip OA outcomes were not consistently higher among those with obesity[13]; however, symptoms were more common among participants with obesity. As mentioned above, fewer than 5% of hips at any time point had undergone THR and these were not analyzed separately. While this estimate may seem low, this is a combination of the type of study and characteristics of the cohort. Other population-based, rather than clinical or at-risk studies, have estimated the frequency of THR around 1% (in 2010[14]), with increasing frequency among younger individuals[14, 15]. As

a community-based cohort, the JoCoOA is likely more generalizable to the U.S. population as it includes Black and White men and women with a range of insurance coverage, access to care, and socioeconomic status.

Data collection in the JoCoOA began in 1991 with a younger group (mean ~61 years of age at T0) than many other studies and continued to 2018 (mean age ~73). Across these time points, several trends were noted. There were dramatic increases in HOA by age group, particularly for rHOA and severe rHOA. Although sxHOA was also more prevalent in the oldest groups, the difference was less marked than for radiographic outcomes, likely due to relative stability of hip pain over time and across age groups. Symptoms and sxHOA were more prevalent among women, although rHOA was not. The lack of differences by race reinforces the fact, as noted in the baseline JoCoOA paper in 2009, that Black individuals are at least as likely as Whites to be affected by HOA, not less so as had been described in the older literature[16–19]. There were no strong trends by BMI for rHOA outcomes, although symptoms were more prevalent among obese individuals.

As noted in the introduction, the prevalence of rHOA in the population-based Framingham OA Study was around 1 in 5 but was more common in men (25% versus 14% in women); the prevalence of sxHOA in that study was 4% (3% in women versus 5% in men), and more women reported hip symptoms (25% versus 15% in men)[6]. The baseline prevalence estimates of rHOA in the JoCoOA were substantially higher at 28% for rHOA (30% in women versus 25% in men) and 10% for sxHOA (11% in women versus 8% in men)[7]. These differences were further amplified in the most recent follow-up of the JoCoOA where the point prevalence estimate for rHOA increased to 53% (51% in women versus 57% in men), and sxHOA to 15% (16% in women versus 12% in men). Key differences between these two cohorts beyond geography include, but are not limited to, differences in radiographic acquisition (standing long-limb in Framingham vs supine pelvis in JoCoOA), timing (only 2002–2005 included in Framingham estimates), BMI, and population diversity (both racial and socioeconomic). Few longitudinal cohort studies exist with which to compare the current results. Data from the Study of Osteoporotic Fractures found that in older White women the prevalence estimates of rHOA increased from 8% at baseline (1986–1988) to 11% after 8 years (1995–1996)[20]. Although that study also used supine radiographs, more stringent criteria were applied for rHOA, similar to the prevalence estimates for severe rHOA among women in the present work (9% and 11% at T3 and T4, respectively).

As noted in the introduction, estimates of rHOA prevalence vary widely, from 1% to 27%, with lower frequencies in Asian (1.4%) and African (2.8%) compared to North American (7.2%) and European populations (10.1%), higher frequencies in men and with increased age[3]. While the prevalence in the Global Burden of Disease (GBD) study suggested a lower burden of disease than these estimates[4], a validation study of the severity questions used in the GBD analysis found that in a French population-based cohort of individuals with OA, a higher proportion of respondents (10–17%) classified their hip or knee OA as “severe” compared with only 2% in the GBD, suggesting underestimation of the proportion of OA patients with severe disease[21].

Since the 2009 review noted above, several cross-sectional studies (summarized below) have provided updated estimates of hip OA frequency in a similar range (1–28%) in a variety of populations. A small convenience sample based in Mexico City (n=204, mean age 57 years, 61% women) reported the frequency of clinical HOA (by American College of Rheumatology [ACR] criteria), rHOA (KLG≥2), or both, as 18%, 27%, and 15%, respectively[22]. A population-based study in Spain among individuals aged 40 years and older estimated the prevalence of sxHOA (defined as clinical [ACR] and radiographic [KLG≥2]) at 5%, associated with overweight/obesity and female sex[23]. The frequency of sxHOA according to a small study (n=522, age 40+) in Turkey was 1% and equal by sex[24]. Similarly, in a cross-sectional study in Greece (mean age 47), the prevalence of sxHOA was 0.9% overall, higher in women (1.5%) than men (0.3%) and with age and obesity[25]. The age-standardized prevalence of sxHOA among adults in France aged 40–75 was estimated at 1.9% in men and 2.5% in women[26].

The overall prevalence of hip OA in Asian populations is often substantially lower than those in other groups. Using data from the Korean National Health and Nutrition Examination Surveys, among over 11,000 individuals age 50 and older, only 1% had rHOA and 0.2% had sxHOA, although it was more common with increasing age and in men[27]. A slightly higher prevalence estimate (2%) was seen in a random sample of Korean individuals over the age of 65 (KLoSHA)[28]. A study in the Shanxi province of China reported that rHOA was infrequent at 0.6%[29], while the population-based Beijing OA study (n=1500) reported a prevalence estimate of rHOA of 0.9% in women and 1.1% in men, with only one case of sxHOA[30]. In contrast, the prevalence of rHOA in Japan approaches that in U.S. cohorts, estimated as 18% in men and 14% in women using baseline data from the ROAD study, while severe and sxHOA were less common (1.3% and 2.5%; 0.3% and 1%, respectively)[31]. These various estimates of point prevalence highlight the need for standardized assessment of HOA in a variety of populations, and separately by sex, to fully characterize the burden of this condition.

Another way to consider public health burden is through registry estimates of disease frequency. Data from electronic medical records or registries, although not directly comparable to our estimates of point prevalence, support the growing burden of OA. Data from the UK Clinical Practice Research Datalink (which includes medical codes) estimate the frequency of hip OA to be 1.5% (although nearly 8% had “unspecified OA” in that paper)[32]. A German study using 2014 insurance claims data including over 7 million adults (mean age 75 years, 70% women), estimated the frequency of hip or knee OA at 21%[33]. Using Global Burden of Disease data for six Nordic countries (Denmark, Finland, Greenland, Iceland, Norway, and Sweden), the frequency of hip and knee OA was noted to have increased by 43% to over 1.5 million adults from 1990–2015[34].

As with any longitudinal study, the main limitation of this work is loss to follow-up (although primarily due to death, as would be expected in this aging cohort over a lengthy period of follow-up). Notably, this is a study of point prevalence, not of cumulative incidence, and as such does not account for competing risks over time, although this is a planned future analysis. As it currently stands, there is no methodology that can produce reliable estimates of cumulative incidence incorporating both the complex survey features

and interval censoring inherent in this longitudinal study. As we and others have noted[1], the question regarding hip symptoms is not specific and may reflect more generalized symptoms (particularly from the lower back). Per protocol, women potentially of reproductive age did not undergo pelvis radiography, limiting the available information for these participants. The unique strengths of this study include the large, longitudinal population-based JoCoOA cohort with detailed follow-up over up to 26 years, the inclusion of Black and White men and women from a range of socioeconomic backgrounds, and the high reliability of the radiographic reads ($\kappa \geq 0.86$, all performed by a single expert musculoskeletal radiologist). By accounting for the complex sampling strategy and weighting to the corresponding US Census population figures (thus re-calibrating the sample to best reflect the population), we were able to provide more generalizable estimates of population point prevalence than studies without such a sampling strategy.

In conclusion, we provide longitudinal and updated person-based estimates of the point prevalence of hip symptoms, rHOA, severe rHOA, and symptomatic rHOA in the JoCoOA. As with our baseline (T0) study[7], these estimates are higher than in other populations, suggesting a particular burden of HOA in this group which includes Black and White men and women with a variety of comorbid conditions[35] and diverse socioeconomic status. These high prevalence figures support the large and increasing burden of hip pain and OA in this and other similar populations.

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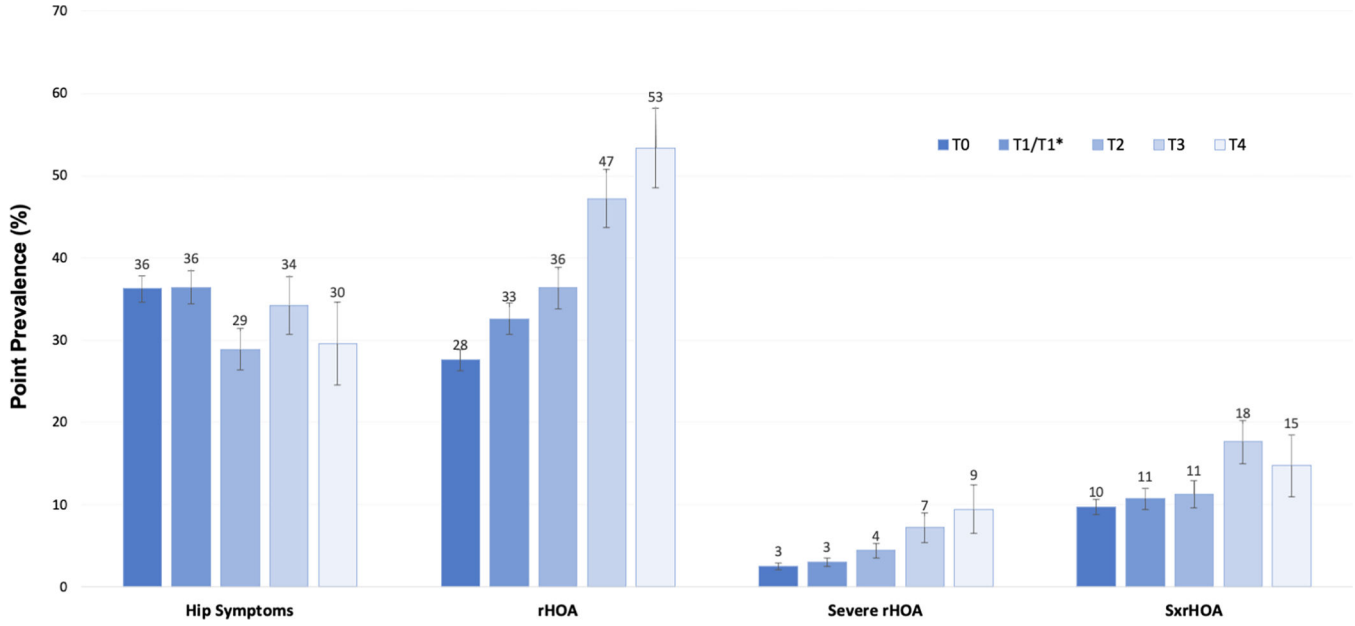


**Figure 1.**

Weighted point prevalence estimates of four hip outcomes (% with 95% confidence interval) in the overall cohort for 5 time points (1991–2018) *.

*Timepoints in the JoCoOA: Baseline (T0), 1991–7; First follow-up (T1)/Cohort enrichment (T1*), 1999–2004; Second follow-up (T2), 2006–2011; Third follow-up (T3), 2013–2015; Fourth follow-up (T4), 2017–2018.

**Table 1.**

Details of death and other reasons for loss to follow-up (LTF) in the Johnston County Osteoarthritis Project baseline (T0) through T3[a] follow-up time points.

| | T0 | T1/T1* | T2 | T3[a] |
|---|---|---|---|---|
| | | n (% of starting number) | | |
| *(alive + enrichment – LTF by next visit=)* | | *2519 + 983 – 929=* | *2206 – 611=* | *1319 – 534=* |
| 1. **Starting number** | **3068** | **2573** | **1595** | **785** |
| 2. **Died by next visit**[b] | 549 (17.9%) | 434 (16.9%) | 276 (17.3%) | -- |
| *(starting number – died by next visit + returning=)* | *3068 – 549=* | *2573 – 434 + 67=* | *1595 – 276 + 0=* | |
| 3. **Alive by next visit** | **2519** | **2206** | **1319** | -- |
| 4. **Total LTF by next visit** | 929 (30.3%) | 611 (23.7%) | 534 (33.5%) | -- |
| *Reason for LTF* | | | | |
| *Not interested* | 437 (14%) | 168 (7%) | 125 (8%) | |
| *Physically or mentally unable* | 153 (3%) | 124 (5%) | 164 (10%) | |
| *Moved out of the county* | 134 (4%) | 131 (5%) | 41 (3%) | |
| *No clinic visit* | 125 (4%) | 39 (2%) | 91 (6%) | |
| *Unable to contact* | 80 (3%) | 149 (6%) | 113 (7%) | |
| 5. **Retention for next visit** | 1590 (52%) | 1528 (59%) | 785 (49%) | 506 (64%) |
| *Within age group (years)* | | | | |
| *45–54* | 56% | 61% | 53% | n/a[c] |
| *50–64* | 59% | 68% | 61% | 86% |
| *65–74* | 48% | 64% | 54% | 69% |
| *75 and older* | 32% | 34% | 25% | 47% |

[a] T3 is the last time point for which National Death Index data were available at the time of this analysis

[b] Died by next visit: defined as having died by next visit (or end of observation) if they died by the end of the time frame of the next possible timepoint period (i.e., 10/28/2004 for T1/T1*; 11/04/2010 for T2; 8/7/2015 for T3)

[c] At follow-up time points T3 and T4, no members of the cohort remained in the <55 years age group by design

**Table 2.**

Unweighted sample characteristics across time points *.

| Characteristic | Time point, years, n | | | | |
|---|---|---|---|---|---|
| | **T0** | **T1/T1*** | **T2** | **T3** | **T4** |
| | **1991–1997** | **1999–2004** | **2006–2011** | **2013–2015** | **2017–2018** |
| | ***n=3068*** | ***n=2573*** | ***n=1595*** | ***n=785*** | ***n=506*** |
| Age, Mean ± SD (range) | 61.2 ± 10.6 (45–93) | 63.8 ± 10.6 (45–102) | 68.7 ± 9.2 (50–95) | 71.7 ± 7.7 (55–94) | 73.5 ± 7.4 (59–95) |
| Age Group, years (n, %) | | | | | |
| 45–54 | 1008, 33% | 627, 24% | 74, 4% | 0, 0% | 0, 0% |
| 55–64 | 885, 29% | 837, 33% | 586, 35% | 140, 18% | 55, 11% |
| 65–74 | 794, 26% | 664, 26% | 571, 34% | 383, 49% | 237, 47% |
| 75+ | 381, 12% | 445, 17% | 430, 26% | 262, 33% | 214, 42% |
| Sex (n, %) | | | | | |
| Men | 1162, 38% | 878, 34% | 537, 33% | 251, 32% | 148, 29% |
| Women | 1906, 62% | 1695, 66% | 1114, 67% | 534, 68% | 358, 71% |
| Race (n, %) | | | | | |
| Black | 999, 33% | 834, 32% | 522, 32% | 245, 31% | 170, 34% |
| White | 2069, 67% | 1739, 68% | 1129, 68% | 540, 69% | 336, 66% |
| BMI †, $kg/m^2$, Mean ± SD (range) | 29.0 ± 6.0 (15–59) | 30.5 ± 6.7 (15–71) | 31.4 ± 7.1 (15–78) | 30.9 ± 6.6 (16–61) | 31.0 ± 6.5 (15–57) |
| BMI †, $kg/m^2$ (n, %) | | | | | |
| Underweight (<18.5) | 34, 1% | 19, 1% | 9, 1% | 6, 1% | 3, 1% |
| Normal (18.5–24.9) | 749, 25% | 471, 18% | 250, 15% | 117, 15% | 88, 17% |
| Overweight (25–29.9) | 1160, 38% | 902, 35% | 543, 33% | 274, 35% | 158, 31% |
| Obese (≥30) | 1112, 36% | 1177, 46% | 847, 51% | 388, 49% | 257, 51% |

* Timepoints in the JoCoOA: Baseline (T0), 1991–7; First follow-up (T1)/Cohort enrichment (T1*), 1999–2004; Second follow-up (T2), 2006–2011; Third follow-up (T3), 2013–2015; Fourth follow-up (T4), 2017–2018

† BMI=body mass index by category

**Table 3.**

Weighted [*] point prevalence estimates (%) and corresponding 95% confidence intervals (CI) for rHOA and severe rHOA by age group, sex, and race, by 5 time points [†], 1991–2018

| | rHOA, % (95% CI) | | | | | Severe rHOA, % (95% CI) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **T0** | **T1** | **T2** | **T3** | **T4** | **T0** | **T1** | **T2** | **T3** | **T4** |
| **Overall** | 28 (26, 29) | 33 (31, 34) | 36 (34, 39) | 47 (44, 51) | 53 (48, 58) | 2.5 (2.1, 3.0) | 3.0 (2.5, 3.6) | 4.4 (3.5, 5.3) | 7.2 (5.4, 9.0) | 9 (6, 12) |
| **Age group (years)** | | | | | | | | | | |
| 45–54 | 21 (19, 24) | 27 (22, 32) | 20 (13, 28) | n/a [‡] | n/a [‡] | 1.4 (0.6, 2.3) | 1.5 (0.5, 2.5) | 6.3 (3, 9.5) | n/a [‡] | n/a [‡] |
| 55–64 | 23 (21, 25) | 27 (24, 30) | 30 (25, 35) | 42 (34, 50) | 33 (19, 46) | 1.1 (0.6, 1.6) | 2.4 (1.4, 3.3) | 1.6 (0.6, 2.6) | 4.8 (1.3, 8.4) | 1.7 (0, 3.5) |
| 65–74 | 31 (28, 34) | 36 (32, 39) | 38 (34, 42) | 45 (39, 51) | 56 (49, 63) | 3.6 (2.5, 4.7) | 3 (1.9, 4.2) | 5.5 (3.8, 7.3) | 5.2 (2.6, 7.7) | 9 (4, 13) |
| 75 and over | 43 (38, 48) | 53 (48, 59) | 55 (50, 59) | 54 (47, 61) | 61 (53, 69) | 5.7 (3.5, 8) | 8 (6, 11) | 10 (7, 13) | 12 (8, 16) | 15 (8, 22) |
| **Sex** | | | | | | | | | | |
| Men | 25 (23, 27) | 33 (30, 37) | 33 (28, 38) | 47 (41, 54) | 57 (47, 67) | 2.6 (1.9, 3.2) | 2.8 (1.8, 3.7) | 3 (1.7, 4.2) | 5.4 (2.8, 8) | 7 (3, 11) |
| Women | 30 (28, 31) | 32 (30, 34) | 39 (37, 42) | 47 (43, 52) | 51 (46, 57) | 2.5 (2, 3.1) | 3.3 (2.5, 4) | 5.7 (4.3, 7.1) | 9 (6, 12) | 11 (7, 15) |
| **Race** | | | | | | | | | | |
| White | 27 (25, 28) | 34 (31, 36) | 38 (35, 42) | 48 (44, 53) | 55 (49, 61) | 2.4 (1.9, 3) | 2.7 (2.1, 3.3) | 4.5 (3.3, 5.7) | 7.3 (5.1, 9.6) | 9 (6, 13) |
| Black | 32 (29, 35) | 28 (24, 33) | 31 (26, 35) | 43 (36, 49) | 46 (38, 55) | 3.1 (2.1, 4.2) | 4.5 (2.8, 6.1) | 4.1 (2.2, 6) | 7 (3, 10) | 10 (6, 14) |
| **BMI [$], kg/m [2]** | | | | | | | | | | |
| Normal (18.5–24.9) | 31 (28, 35) | 35 (29, 40) | 47 (39, 56) | 51 (41, 61) | 52 (39, 65) | 2.2 (1.2, 3.2) | 2.9 (1.2, 4.5) | 5.1 (2.4, 7.8) | 7 (1, 13) | 13 (3, 22) |
| Overweight (25–29.9) | 24 (22, 27) | 36 (32, 40) | 39 (33, 44) | 45 (38, 52) | 47 (38, 56) | 3.0 (2.2, 3.8) | 3.3 (2.3, 4.4) | 4.0 (2.4, 5.6) | 7 (4, 10) | 2.5 (0.8, 4.1) |
| Obese (≥30) | 28 (26, 31) | 29 (26, 32) | 32 (29, 36) | 48 (42, 54) | 57 (50, 64) | 2.2 (1.5, 2.9) | 2.8 (1.9, 3.6) | 4.6 (3.2, 5.9) | 7 (5, 10) | 13 (8, 18) |

[*] Weighted to the respective United States Census for Johnston County, NC

[†] Timepoints in the JoCoOA: Baseline (T0), 1991–7; First follow-up (T1)/Cohort enrichment (T1*), 1999–2004; Second follow-up (T2), 2006–2011; Third follow-up (T3), 2013–2015; Fourth follow-up (T4), 2017–2018

[‡] At follow-up time points T3 and T4, no members of the cohort remained in the <55 years age group by design.

[$] Estimates for the underweight category are not included because they have non-estimable variance due to strata with a single cluster and overall small sample size (1%)

rHOA, radiographic hip osteoarthritis; BMI, body mass index

**Table 4.**

Weighted * point prevalence estimates (%) and corresponding 95% confidence intervals (CI) for hip pain and symptomatic rHOA by age group, sex, and race, by 5 time points †, from 1991–2018

| | Hip Symptoms, % (95% CI) | | | | | Symptomatic rHOA, % (95% CI) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **T0** | **T1** | **T2** | **T3** | **T4** | **T0** | **T1** | **T2** | **T3** | **T4** |
| **Overall** | 36 (35, 38) | 36 (34, 38) | 29 (26, 31) | 34 (31, 38) | 30 (25, 35) | 9.7 (8.8, 10.6) | 11 (9, 12) | 11 (10, 13) | 18 (15, 20) | 15 (11, 19) |
| **Age group (years)** | | | | | | | | | | |
| 45–54 | 31 (28, 33) | 32 (26, 37) | 38 (25, 52) | n/a‡ | n/a‡ | 5.9 (4.3, 7.5) | 8 (5, 11) | 13 (7, 19) | n/a‡ | n/a‡ |
| 55–64 | 36 (33, 39) | 37 (33, 40) | 27 (22, 32) | 35 (28, 41) | 34 (23, 45) | 9 (7, 11) | 9 (7, 11) | 8 (5, 11) | 18 (12, 24) | 9 (1, 18) |
| 65–74 | 41 (37, 44) | 41 (37, 44) | 30 (26, 34) | 35 (29, 40) | 27 (19, 35) | 11 (9, 13) | 13 (10, 16) | 13 (10, 15) | 15 (11, 20) | 12 (6, 17) |
| 75 and over | 42 (37, 48) | 41 (36, 46) | 31 (27, 35) | 33 (27, 39) | 31 (23, 39) | 17 (13, 21) | 19 (15, 23) | 18 (15, 22) | 21 (16, 26) | 23 (14, 31) |
| **Sex** | | | | | | | | | | |
| Men | 32 (30, 34) | 31 (27, 35) | 26 (21, 30) | 28 (22, 34) | 27 (18, 36) | 8.3 (6.9, 9.6) | 9 (7, 11) | 10 (7, 13) | 16 (11, 21) | 12 (6, 17) |
| Women | 40 (37, 42) | 40 (38, 43) | 32 (29, 35) | 40 (35, 44) | 31 (25, 37) | 11 (10, 12) | 12 (11, 14) | 13 (11, 14) | 19 (15, 22) | 16 (11, 21) |
| **Race** | | | | | | | | | | |
| White | 36 (34, 38) | 36 (34, 39) | 29 (26, 33) | 35 (31, 40) | 31 (24, 37) | 9 (8, 10) | 11 (9, 13) | 12 (10, 14) | 18 (15, 22) | 15 (10, 20) |
| Black | 37 (34, 40) | 37 (32, 41) | 27 (22, 33) | 31 (24, 37) | 26 (18, 34) | 12 (10, 14) | 9 (6, 12) | 10 (7, 13) | 16 (10, 21) | 12 (7, 18) |
| **BMI $, kg/m 2** | | | | | | | | | | |
| Normal (18.5–24.9) | 32 (29, 35) | 31 (26, 36) | 32 (23, 40) | 33 (24, 42) | 23 (12, 35) | 10 (7, 12) | 10 (7, 13) | 17 (9, 26) | 21 (12, 30) | 9 (2, 17) |
| Overweight (25–29.9) | 33 (30, 35) | 32 (28, 36) | 23 (19, 26) | 31 (25, 37) | 20 (12, 29) | 8.0 (6.6, 9.5) | 11 (9, 13) | 11 (8, 13) | 14 (10, 18) | 7 (3, 10) |
| Obese (≥30) | 44 (41, 46) | 42 (39, 45) | 32 (28, 36) | 37 (32, 42) | 37 (30, 44) | 12 (10, 13) | 11 (9, 12) | 10 (8, 12) | 19 (15, 24) | 21 (15, 27) |

* Weighted to the respective United States Census for Johnston County, NC

† Timepoints in the JoCoOA: Baseline (T0), 1991–7; First follow-up (T1)/Cohort enrichment (T1*), 1999–2004; Second follow-up (T2), 2006–2011; Third follow-up (T3), 2013–2015; Fourth follow-up (T4), 2017–2018

‡ At follow-up time points T3 and T4, no members of the cohort remained in the <55 years age group by design.

rHOA, radiographic hip osteoarthritis; BMI, body mass index