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Factors Associated with Hip Osteoarthritis: Data from the First National Health and Nutrition Examination Survey (NHANES-I)

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Factors associated with hip osteoarthritis were studied in 2,490 subjects aged 55–74 years using data from the First National Health and Nutrition Examination Survey (NHANES-I). Pelvic radiographs were read for hip osteoarthritis using Kellgren-Lawrence scales; cases were defined by grade ≥2 changes. Subjects with missing radiographs and other data and those with grade 1 radiographic changes (n = 132) were excluded from analyses. Crude and adjusted odds ratios and 95% confidence intervals (CIs) were estimated from logistic regression analyses. Overall, the crude prevalence of hip osteoarthritis was 3.1% (73 of 2,358); 42 cases were unilateral, and 31 cases were bilateral. Age was significantly associated with hip osteoarthritis (adjusted odds ratios = 1.30 (95% CI 0.60–2.81), 1.69 (95% CI 0.83–3.44), and 2.38 (95% CI 1.15–4.92) for ages 60–64, 65–69, and 70–74, respectively). Other sociodemographic factors, obesity, and fat distribution were not associated with hip osteoarthritis. Age and hip trauma were strongly associated with hip osteoarthritis among men; however, among women, no factors were significantly associated with hip osteoarthritis. Hip trauma was significantly associated with unilateral but not bilateral hip osteoarthritis, while obesity was associated with bilateral but not unilateral hip osteoarthritis. These data suggest that etiologic factors associated with hip osteoarthritis may differ for males and females and for unilateral and bilateral hip osteoarthritis. *Am J Epidemiol* 1993;137:1081–8.

hip; obesity; osteoarthritis, etiology; prevalence

Osteoarthritis is the most common form of the arthritic diseases (1, 2). Studies in Europe have estimated that approximately 10–25 percent of Caucasian individuals over the age of 55 years have hip osteoarthritis (3–5). In the United States, hip osteoarthritis is the most common indication for elective total hip replacement among elderly Americans (6).

Many studies have been conducted to investigate the descriptive and analytical epidemiology of hip osteoarthritis in Europe, Asia, and Africa (5, 7–14); however, the relation of the majority of the putative risk factors for hip osteoarthritis is still poorly understood (3, 4). Age has most consistently been found to be associated with hip osteoarthritis (3). The prevalence of hip osteoarthritis appears to be lowest in Asians, followed by African black and Native American populations, and highest in white Europeans (3–5). Data concerning differences in prevalence by sex are conflicting (5, 8, 13–15). A protective role for estrogens until the time of menopause may be involved in the possible sex differences (16). Several studies have indicated an increased

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Abbreviation: NHANES-I, First National Health and Nutrition Examination Survey.

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risk of hip osteoarthritis associated with obesity (17–19), while others have failed to support the association (20–22). Decreased rates of hip osteoarthritis in individuals suffering a femoral neck fracture have been found (23), and increased bone mass has been positively associated with hip osteoarthritis (24, 25). Both trauma and congenital and developmental diseases of the hip have been consistently associated with later hip osteoarthritis (3, 4); however, it is not clear whether these conditions are associated with both bilateral and unilateral disease. It is possible that the discrepancies in results of previous studies may be due to the failure to distinguish between two distinct types of osteoarthritis with different etiopathogenesis (3).

In order to investigate the factors associated with overall as well as unilateral and bilateral hip osteoarthritis, a case-control study was conducted using data from the First National Health and Nutrition Examination Survey (NHANES-I). An attempt was made to determine whether the etiologic factors identified in previous studies were associated with hip osteoarthritis in the United States, as well as whether factors associated with unilateral and bilateral hip osteoarthritis differed.

MATERIALS AND METHODS

This analysis used data from NHANES-I, a multistage, stratified, population-based survey designed to be representative of the civilian noninstitutionalized population of the United States, conducted by the National Center for Health Statistics, from 1971 through 1975 (26). The data set included sociodemographic, medical, nutritional, and anthropometric variables collected through interviews, questionnaires, and examinations. Supplementary data including a detailed arthritis examination were collected on a subsample of adults aged 25–74 years (n = 6,913). Radiographs of the pelvis were to be taken on all male examinees receiving the detailed examination and all females over 50 years of age; however, 6.0 percent of these radiographs were not taken. Each pelvic radiograph was read for changes of osteoarthritis of the hip by two rheumatologists using Kellgren-Lawrence scales (grades 0 = normal, 1 = questionable, 2 = minimal, 3 = moderate, and 4 = severe hip osteoarthritis (27)). If an abnormality was seen by one of the two, a third rheumatologist provided an adjudicated reading (28). Cases were defined by a minimum of grade 2 changes, based on the adjudicated reading, with unilateral hip osteoarthritis defined as osteoarthritis in one hip and bilateral hip osteoarthritis as radiographic changes in both hips.

Since the prevalence of hip osteoarthritis is greatest in individuals over the age of 55 (3, 4), we included only the 2,490 subjects aged 55 years and over in this analysis. We excluded 132 subjects because of race other than black or white, missing data, and questionable radiographic changes (grade 1); this resulted in a final sample of 2,358.

Risk factors thought to be related to osteoarthritis of the hip and available within the data set were examined in this study. These included sociodemographic variables, such as sex, age, marital status, race, family income, and education; obesity-related variables (body mass index and fat distribution); and history of hip trauma. Reproductive history and menopausal history for females were also examined.

Subjects were stratified into four age groups and into quartiles of family income. Marital status was coded into married, unmarried (includes the separated/divorced), and widowed, while education was dichotomized into greater than and into less than or equal to 12 years of school. The body mass index (weight (kg)/height $(m)^2$) was used as a measure of obesity, where overweight was defined in females and males as a body mass index exceeding 27.3 and 27.8, respectively (29). The ratio of subscapular to triceps skinfold was used as an additional measure of body fat distribution, with values of one or greater indicating a centralized rather than a peripheral distribution of fat. Hip trauma was defined as present if it had been reported. Age at menarche for women was trichotomized (<13 years of age, 13–14 years of age, ≥15 years of age), as was age at

menopause (<45 years, 45–49 years, ≥50 years), and parity was dichotomized (positive/negative).

Prevalence rates of hip osteoarthritis were estimated by age and sex. Both univariate and multivariate logistic regression analyses were conducted, from which crude and adjusted odds ratios and 95 percent confidence intervals were computed. Analyses were initially conducted for the entire sample, followed by stratified models by sex and type of hip osteoarthritis (unilateral/bilateral). All analyses presented are model based and do not use the NHANES-I population weights, so the results may not be applicable to the US general population (30).

RESULTS

Of the 2,358 subjects, 73 (3.1 percent) had radiographic osteoarthritis of the hip (table 1). The prevalence of osteoarthritis increased with age, but this was significant only in males (figure 1). Of the 73 cases, osteoarthritis was unilateral in 42 (57.5 percent) and bilateral in 31 (42.5 percent). The numbers of unilateral and bilateral cases were 21 and 15 in women and 21 and 16 in men, respectively.

Univariate logistic regression analyses revealed no significant relation of sex, race, income, or marital status to hip osteoarthritis; however, increasing age was positively associated with hip osteoarthritis (χ^2 test for trend $p = 0.05$) as was higher educational level (table 2). In a multivariate logistic regression model (table 2), increasing age remained positively associated with hip osteoarthritis; however, higher educational level was associated with hip osteoarthritis with borderline statistical significance.

A history of hip trauma significantly increased the odds of hip osteoarthritis. Neither obesity nor a central fat distribution was significantly associated with hip osteoarthritis (table 3).

Because of differences in the pattern of age- and sex-specific prevalence rates, multivariate models were next constructed by sex (tables 4 and 5). Age was significantly associated with hip osteoarthritis in males but not in females (table 4). Hip trauma was positively associated with hip osteoarthritis in both males and females; however, it was statistically significant only in males. Neither of the body composition variables was associated with hip osteoarthritis in either sex. There was no association between any of the reproductive factors with hip osteoarthritis in women (table 5).

Multivariate models were constructed to determine the role of hip trauma and obesity as risk factors for unilateral and bilateral hip osteoarthritis, respectively (table 6). Hip trauma was positively associated with unilateral but not bilateral hip osteoarthritis. Conversely, obesity was positively associated with bilateral but not unilateral hip osteoarthritis. There was no association between central fat distribution and either unilateral or bilateral hip osteoarthritis.

TABLE 1. Prevalence of radiographic osteoarthritis of the hip by age: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975

Age (years)	No.	Cases of osteoarthritis	
		No.	%
55–59	650	13	2.0
60–64	564	15	2.7
65–69	675	23	3.4
70–74	469	22	4.7
Total	2,358	73	3.1

DISCUSSION

These results extend previous studies of hip osteoarthritis to provide insight into the etiopathogenetic role of trauma and obesity and possible differences by sex. There is a positive association between increasing age and hip osteoarthritis, significant only in males. Hip trauma is associated only with unilateral disease and is more strongly associated with hip osteoarthritis in males than females. Obesity is associated with bilateral but not unilateral hip osteoarthritis. Because these data are cross-sectional, they can provide only a suggestion of the etiologic roles

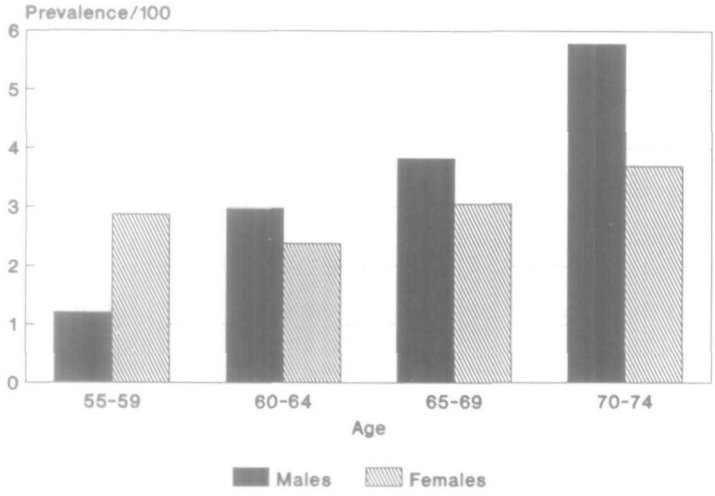

FIGURE 1. Prevalence of hip osteoarthritis by age and sex: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975, $n = 2,358$

TABLE 2. Odds of hip osteoarthritis associated with sociodemographic characteristics: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975 ($n = 2,358$)

Sociodemographic characteristic	Prevalence of hip osteoarthritis by category	Crude odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval*
Sex					
Male	3.2	1.0		1.00	
Female	3.0	1.09	0.68–1.74	1.11	0.69–1.78
Age (years)					
55–59	2.0	1.00		1.00	
60–64	2.7	1.33	0.63–2.83	1.30	0.60–2.81
65–69	3.4	1.72	0.87–3.43	1.69	0.83–3.44
70–74	4.7	2.41	1.19–4.88	2.38	1.15–4.92
Race					
White	3.2	1.00		1.00	
Black	2.5	0.78	0.37–1.65	0.67	0.31–1.45
Marital status					
Unmarried†	2.9	1.00		1.00	
Married	3.1	1.08	0.48–2.41	1.11	0.49–2.54
Widowed	3.0	1.03	0.41–2.58	0.86	0.33–2.20
Education (years)					
<12	2.2	1.00		1.00	
≥12	3.7	1.69	1.01–2.81	1.64	0.95–2.85
Family income					
Low quartile	4.0	1.00		1.00	
Second quartile	3.1	0.77	0.30–1.99	0.69	0.34–1.37
Third quartile	2.7	0.84	0.35–1.99	0.85	0.43–1.65
High quartile	2.8	0.86	0.28–2.63	0.99	0.40–2.44

* Adjusted for all other sociodemographic characteristics.
† Unmarried (includes separated/divorced).

TABLE 3. Adjusted odds of hip osteoarthritis associated with hip trauma and body fat distribution: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975 (n = 2,358)

Variable	Prevalence of hip osteoarthritis by category	Adjusted odds ratio*	95% confidence interval
Hip trauma			
No	3.0	1.00	
Yes	20.0	7.84	2.11–29.10
Body mass index			
Normal	3.1	1.00	
Overweight	3.1	1.02	0.61–1.69
Skinfold ratio			
Normal	2.8	1.00	
Centralized fat distribution	3.3	1.11	0.65–1.89

* Adjusted for sex, age, race, and education.

TABLE 4. Adjusted* odds of hip osteoarthritis associated with sociodemographic characteristics by sex: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975

Sociodemographic characteristics	Males		Females	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Age (years)				
55–59	1.00		1.00	
60–64	2.94	0.87–9.92	0.73	0.25–2.07
65–69	5.15	1.52–17.30	0.91	0.34–2.42
70–74	8.00	2.37–26.91	0.94	0.32–2.76
Race				
White	1.00		1.00	
Black	0.96	0.38–3.48	0.30	0.07–1.28
Education (years)				
<12	1.00		1.00	
≥12	2.18	0.95–4.96	1.32	0.62–2.78

* Adjusted for other variables in table.

of hip trauma in unilateral, and obesity in bilateral, hip osteoarthritis.

Davis et al. (31) found that obesity was more strongly associated with bilateral than unilateral knee osteoarthritis and that knee injury was more strongly associated with unilateral than bilateral knee osteoarthritis. They suggested that obesity is linked to bilateral knee osteoarthritis by biomechanical factors (32); this hypothesis may be applicable for hip osteoarthritis as well. Obesity is positively associated with bone mineral density and inversely associated with osteoporosis and hip fracture (33). Higher bone mass has been found in patients with hip osteoarthritis than in hip fracture patients or age-matched controls (23, 24), and it has been suggested that the failure of dense subchondral bone to absorb forces of impact loading in weight-bearing joints leads to increased cartilage damage and osteoarthritis in these sites (34). Thus, obesity may be an important risk factor for the development of bilateral hip osteoarthritis by maintaining bone mineral density and preventing osteoporosis.

TABLE 5. Adjusted* odds of hip osteoarthritis associated with hip trauma, body fat distribution by sex, and reproductive factors in women: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975

Variable	Males		Females	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Hip trauma				
No	1.00		1.00	
Yes	24.2	3.84–153.10	4.17	0.50–34.71
Body mass index				
Normal	1.00		1.00	
Overweight	0.96	0.39–2.36	1.16	0.57–2.35
Skinfold ratio				
Normal	1.00		1.00	
Centralized fat distribution	0.97	0.41–2.30	1.16	0.57–2.35
Parity				
No pregnancies			1.00	
≥1 pregnancies			0.57	0.28–1.16
Age at menarche (years)				
<13			1.00	
13–14			1.03	0.47–2.21
≥15			0.86	0.34–2.16
Age at menopause (years)				
<45			1.00	
45–49			0.84	0.36–1.95
≥50			0.71	0.31–1.58

* Adjusted for age, race, and education.

TABLE 6. Adjusted* odds of unilateral and bilateral hip osteoarthritis associated with hip trauma and body mass index: First National Health and Nutrition Examination Survey (NHANES-I), 1971–1975 (n = 2,358)

Variable	Unilateral (n = 42)		Bilateral (n = 31)	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Hip trauma				
No	1.00		—†	
Yes	13.74	3.69–51.13	—	
Body mass index				
Normal	1.00		1.00	
Overweight	0.54	0.26–1.16	2.00	0.97–4.15
Skinfold ratio				
Normal	1.00		1.00	
Centralized fat distribution	0.94	0.51–1.74	1.53	0.73–3.23

* Adjusted for sex, age, race, and education.
† —, no values computed because no hip trauma among those with bilateral hip osteoarthritis

These results suggest two distinct subsets of hip osteoarthritis. The majority of cases of hip osteoarthritis (42 cases (57.5 percent)) in the present study had unilateral disease.

This is consistent with other population-based studies wherein unilateral disease accounted for between 56 and 69 percent (7–9). Previous studies suggest that the majority of unilateral hip osteoarthritis results from congenital subluxation/dislocation of the hip, acetabular dysplasia, Legg-Calvé-Perthes disease, and slipped capital femoral epiphysis (3, 4, 35–37). The present study extends these risk factors to include hip trauma. Bilateral hip osteoarthritis may be part of the syndrome of generalized osteoarthritis (3, 4, 38, 39) and is associated with obesity as is bilateral knee osteoarthritis. This etiopathogenetic construct may explain conflicting results of previous epidemiologic studies.

We found no difference in the prevalence of hip osteoarthritis by race as contrasted with a higher prevalence of knee osteoarthritis in African American compared with Caucasian females (40). Previous studies in African and Afro-Caribbean populations report a similar prevalence of hip osteoarthritis to that reported in the present study, which is lower than among European Caucasian populations (3–5). This may be the result of the higher prevalence of congenital and/or developmental disease and differences in occupational risk factors, including farming, in European Caucasians (3, 4).

There are several potential limitations in our analysis that may affect the inferences derived from these data. First, cases of hip osteoarthritis were defined based on adjudicated readings using Kellgren-Lawrence scales. Recently, alternative classification scales for hip osteoarthritis have been developed by Croft et al. (41) and Lane et al. (42) that rely more on joint space narrowing than on osteophyte formation. Studies using both the traditional Kellgren-Lawrence and newer individual features scales will allow for the comparison of risk factors by variation in case definition.

Second, the NHANES-I data set has inherent limitations including its cross-sectional nature, especially in regard to inferences of causality for obesity and bilateral hip osteoarthritis. Only participants with a history of hip pain were asked about hip trauma, which could have biased the results of the association of hip trauma and hip osteoarthritis. Furthermore, the radiographs were not assessed for the presence of congenital (i.e., acetabular dysplasia) or developmental (i.e., "pistol grip" deformity) changes. Thus, the complete unbiased assessment of all possible risk factors for both unilateral and bilateral hip osteoarthritis could not be performed.

Finally, the analysis was limited by a relatively small number of cases that affected our power to demonstrate significant associations, especially when dealing with subgroups (females, bilateral disease) and categorical independent variables. With regard to the former, an analysis of hip osteoarthritis in female participants in the Multicenter Study of Osteoporotic Fractures will provide adequate power to investigate risk factors in a sample of approximately 10,000 Caucasian women aged 65 years and above. With regard to the latter, analyses of the relation of continuous variables, such as obesity, with hip osteoarthritis showed no difference in the results of those using categorical variables (data not shown).

In summary, our results support the existence of two distinct subsets of hip osteoarthritis with different patterns of risk factors: trauma for unilateral and obesity for bilateral hip osteoarthritis. Initiatives and interventions focused on the prevention of trauma and obesity, as well as screening for and treatment of congenital and developmental hip diseases, are indicated in the primary prevention of hip osteoarthritis (43).

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