Risk Factors for Incident Self-Reported Arthritis in a 20 Year Followup of the Alameda County Study Cohort

WILLIAM G. SEAVEY, JOHN H. KURATA, and RICHARD D. COHEN

ABSTRACT. ***Objective.*** This longitudinal study examined the following variables as possible risk factors for self-reported arthritis: age, sex, race, body mass index (BMI), depressive symptoms, leisure-time physical activity, cigarette use, alcohol, hypertension, diabetes mellitus, education, income, and hard physical work.

Methods. Altogether, 1149 women and 964 men from the Alameda County Study Cohort without self-reported arthritis in 1974 were assessed for incident self-reported arthritis in 1994.

Results. In a multivariate model, the following variables were associated with increased odds of incident arthritis: increasing age (age 45–49, odds ratio 2.00, 95% confidence interval 1.40–2.85; age 50+, OR 3.13, 95% CI 2.32–4.22), BMI for women only (4th quintile, OR 1.65, 95% CI 1.05–2.60; 5th quintile, OR 1.88, 95% CI 1.19–2.95), female sex (OR 1.48, 95% CI 1.20–1.83), and ≥ 5 depressive symptoms (OR 1.53, 95% CI 1.12–2.10). Leisure-time physical activity in the highest quartile was protective (OR 0.69, 95% CI 0.51–0.95). All other factors were not associated with arthritis.

Conclusion. This study indicates that depressive symptoms, as well as age, sex, and BMI, are independent risk factors for arthritis. This is the first longitudinal population based study to examine and establish that prior depressive symptoms are a risk factor for arthritis. (J Rheumatol 2003;30:2103–11)

Key Indexing Terms:
SELF-REPORTED ARTHRITIS BODY MASS INDEX DEPRESSIVE SYMPTOMS
LONGITUDINAL STUDIES PHYSICAL ACTIVITY

Arthritis is self-reported by 16.1% of the total US population and by 52.9% of those older than 65 years of age[1]. Limitation in function due to arthritis is reported by 2.9% and 12.7% of those groups, respectively[1]. In 1992, arthritis accounted for an estimated $15 billion US of health care costs and $50 billion of indirect costs[2]. Moreover, these figures underestimate true indirect costs, as they only account for lost wages and neglect other activities such as work in the home or caretaking functions that are not easily translated into economic terms. Modeling has shown that a biannual 1% reduction in the prevalence of arthritis would achieve a greater reduction in functional limitation than the same reduction in the prevalence of any of 5 of the other most disabling or fatal conditions, namely coronary disease, stroke, diabetes mellitus, cancer, and confusion[3]. Identifying modifiable risk factors for arthritis is essential to decreasing resultant arthritis associated pain and disability.

Arthritis subsumes more than 100 different entities, but the most common form is osteoarthritis (OA), which accounts for over 80% of diagnoses in all age groups[4] and an even larger percentage in those over 55 years of age[5]. Arthritis has been defined on the basis of different criteria in epidemiological studies such as self-report, self-report physician-diagnosed, clinical examination, and radiographs. Risk factors consistently established in studies of self-reported arthritis include female sex[1,6], increasing body mass index (BMI)[6-9], and increasing age[1,6,7]. These same risk factors have been established in longitudinal studies of tibiofemoral[10-13] and hand OA[14], whereas sex and BMI effects are less pronounced in hip OA[15].

Other factors such as race, educational attainment, physical activity, cigarette use, hypertension, fasting blood glucose, and alcohol intake have been inconsistently identified as risk factors in studies of both self-reported arthritis and OA of specific joints. Depressive symptoms, a common condition, has not been explored as a risk factor for either incident self-reported arthritis or OA.

To evaluate potential risk factors for self-reported arthritis, we studied a population based group in Alameda County, California. We assessed participants without arthritis

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at baseline in 1974 for the potential risk factors discussed above and evaluated them for incident arthritis in 1994.

MATERIALS AND METHODS

The Alameda County Study (ACS) is an ongoing longitudinal study of the effect of social, psychological, behavioral, and demographic factors on the health and mortality of a population based sample of men and women[16]. In 1965, a stratified random sample of households was used to recruit a representative sample of the noninstitutionalized population of Alameda County, California. The initial cohort consisted of 6928 adults, aged 16–94 years of age, who answered a mailed questionnaire. In 1974, 4864 surviving members of the initial cohort returned a second questionnaire. In 1983, a 50% sample of surviving members was obtained, with 1798 responding. In 1994, a fourth set of data was obtained from 2729 surviving members of the 1974 cohort. Response rates in the 4 cycles of data collection have varied between 85% and 93%[17]. Questionnaires were similar in content and style at each survey. Details of the design and sampling procedures have been reported[16,18]. The research protocol was approved by the California Health and Welfare Agency Committee for the Protection of Human Subjects and conducted in accord with their guidelines regarding informed consent for participation in research in which the sole form of data collection is via mailed surveys.

Study sample. Subjects were considered for these analyses if they responded to the ACS surveys in 1965, 1974, and 1994 and did not report arthritis in both 1965 and 1974 (n = 2194). Persons with missing arthritis status in 1994 were excluded (n = 18), as were persons who gave an inconsistent pattern of response by answering "yes" in 1983 and "no" in 1994 (n = 63). After these 81 exclusions, a cohort of 2113 persons remained.

We studied a time interval of 20 years (1974–94) because this allowed us to confirm the absence of arthritis at 2 time points (1965, 1974) and provided a reasonable time interval in which arthritis could develop without being so long that risk factors would change greatly during that period.

Incident self-reported arthritis. Presence of arthritis at each survey time was determined from answers to the question: "Have you had arthritis or rheumatism in the past 12 months?" Members were classified as incident cases if they answered "yes" in 1994 (n = 514) and classified as not having arthritis if they answered "no" in 1994 (n = 1599). Although this single question has not been validated, a similar question — "During the past 12 months, did you have arthritis of any kind or rheumatism?" — has shown good validity[19]. In that study, with further questioning, interviewers were subsequently able to identify a condition meeting criteria for *International Classification of Disease*-coded arthritis in 93.8% of people who said "yes" to that direct question, while the other 6.2% had ICD codes for soft tissue and other nonarthritic conditions. In turn, 99.6% of those who answered "no" did not have ICD-coded arthritis[19].

Validation of self-reported arthritis. To confirm the face validity of our single-item question for arthritis, we analyzed accompanying questions from the 1994 survey for affected body locations, medical care, and functional disability consistent with arthritis. This information was not available in previous surveys.

Use of medical resources was assessed by asking persons reporting arthritis whether they had ever seen a doctor about their arthritis and whether they had ever taken medications prescribed for it. We describe the percentage of persons reporting incident arthritis who used each of these resources.

Location of arthritis was defined by answers to 2 questions: "Do you have arthritis in your hands?" and "Do you have arthritis in your knees?" We describe the percentage of persons reporting incident arthritis who specified these locations.

Functional disability was evaluated for 6 activities[20-22] — stooping, crouching, or kneeling; lifting or carrying weights over 10 pounds, like a heavy bag of groceries; doing heavy housework; walking 1/4 mile; standing up after sitting in a chair; and writing or handling small objects — which are commonly impaired in persons with knee[23,24] or hand OA[25]. Participants were asked how difficult it is to perform each activity by themselves. For each question, the following responses could be given: no difficulty, some difficulty, a lot of difficulty, or, can only do with help from a person or equipment. Responses were dichotomized into no versus any difficulty. These questions do not attribute disability to arthritis or any other specific condition. For each activity, we calculated the odds ratio for presence of any difficulty in the activity comparing those with and without arthritis in a multivariate model that included age, sex, race, BMI, and ≥ 5 depressive symptoms.

Risk factors. Risk factors for incident arthritis were based on self-reported information from the 1974 survey.

Alcohol consumption (number of drinks per month) was calculated from the answers to questions concerning the frequency (occasions per week) of drinking wine, beer, and "liquor" and the number of drinks of each kind consumed at one sitting. The products of frequency and number of servings for each type of beverage were summed to yield a score that ranged from 0 to 270. This score was then divided into 3 categories: 0, 1–45, and > 45 drinks per month[26].

Body mass index (BMI) was calculated from self-reported height and weight in kg/m^2. The distributions of BMI for men and women were divided into sex-specific quintiles. The quintiles for males were: 17.97–22.59, 22.65–24.17, 24.21–25.18, 25.23–26.95, and 26.96–44.63. Quintiles for females were: 15.33–20.09, 20.11–21.41, 21.45–22.86, 22.89–25.58, and 25.60–54.81.

Cigarette use was classified as current, former, or never smoker.

Depressive symptoms were measured by the Human Population Laboratory Depression Scale, an 18 item scale developed by Roberts and colleagues[27] that assesses mood disturbances, negative self-concept, loss of energy, problems with eating and sleeping, and psychomotor retardation or agitation. Each question was scored 1 for a "depressed" response or 0 otherwise, and the scores were summed. Item-total correlations for the scale range from 0.18 to 0.45 with a Cronbach alpha of 0.77, indicating good internal consistency. A score ≥ 5 indicates a high level of depressive symptoms, although not necessarily clinical depression. The symptoms do not fully operationalize the *Diagnostic and Statistical Manual of Mental Disorders*, revised 4th edition (DSM-IV) criteria for a major depressive episode. However, the cutoff of ≥ 5 symptoms to define cases has proven reliability[27-29], is conceptually similar to other brief symptom checklists such as the Center for Epidemiologic Studies Depression Scale (CES-D)[30], and has shown validity by correlating well with the number of "depressed" responses on the Beck Depression Inventory (r = 0.66) in an outpatient clinic population[28] and predicting mortality from stroke[31].

Diabetes was based on the question, "Have you had diabetes in the last 12 months?"

Years of education was grouped into 4 categories: < 12 years, 12 years, 13–16 years, and more than 16 years.

High blood pressure was based on the question, "Have you had high blood pressure in the past 12 months?"

Annual total family income before taxes was reported in 14 categories ranging from under $2000 to $25,000 or more. These categories were then collapsed into 5 groupings: < $10,000, $10–14,999, $15–19,999, $20–24,999, and $25,000 or more.

A leisure-time physical activity index was created from the answers to questions on frequency of participation in 5 types of activity: active sports, swimming or taking long walks, hunting or fishing, working in the garden, and doing physical exercises. For each activity a response of often, sometimes, or never could be given, which was scored as 4, 2, and 0, respectively, for active sports, swimming, or taking long walks and doing physical exercises, and scored as 2, 1, and 0, respectively, for hunting or fishing and working in the garden. Scores for the 5 items were summed, yielding an index that could range from 0 to 16. For purposes of analysis, the index was divided into approximate quartiles. Although this index has not been compared to more recognized indices of physical activity, it has been shown in previous research to be associated with mortality from all causes[32]

and from ischemic heart disease[33]. A 3 item version has shown similar associations[17].

Participation in hard physical work was assessed by the question, "How much hard physical work do you do on your job?" The responses were little, some, and quite a lot. Little was used as the reference category with 2 dummy variables.

Race was classified as White, Black, Hispanic, and Asian/Other.

Age was classified as < 35, 35–39, 40–44, 45–49, and 50+ years.

Statistical methods. Risk factor distributions of age, alcohol consumption, BMI, depressive symptoms scale, and physical activity index for persons with and without incident arthritis were compared using the Wilcoxon rank-sum test[34]. Unadjusted associations between incident arthritis and each risk factor were assessed by calculating odds ratios and approximate confidence intervals[35]. Adjusted associations between incident arthritis and each risk factor were assessed in a series of logistic regression models with an equal 20 year period of followup for all participants that included age, sex, and race as covariates. Because many of the risk factors were multicategorical, they were represented in the models by sets of dummy variables. The log-likelihood ratio test was used to test the contribution of each set of dummy variables to a baseline model containing only age, sex, and race[35]. All variables with significant log-likelihood contributions as well as age, sex, and race were included in the final multivariate model. This model was stratified by sex to evaluate effect modification of sex on BMI and other factors.

Sensitivity analysis. Because of the limitations of our single-item question for arthritis, we performed 2 sensitivity analyses of our multivariate model. In the first, we limited incident arthritis cases to persons who reported seeing a doctor for that problem. In the second, we analyzed persons reporting knee and hand arthritis separately to see if risk factors differed for the 2 locations.

RESULTS

In 1974 there were 3356 persons without arthritis. Of these subjects, 769 died prior to followup in 1994 and 474 who remained alive did not participate. Compared with participants in the followup examination, nonparticipants were significantly more likely to be older, to report ≥ 5 depressive symptoms, to report less leisure-time physical activity, to drink less alcohol, to have diabetes and hypertension, and to be of lower educational attainment and income. They were borderline more likely to be smokers. Nonparticipants and participants were similar in terms of sex and BMI.

Demographic data and potential risk factors measured in 1974 are presented in Table 1. The average age in 1974 was 43.0 years, and 54.4% of the population were women. Participants were primarily White (83.2%), and 85.5% had completed at least 12 years of education. The mean BMI was 24.0. The mean number of depressive symptoms was 1.8, and 11.0% of participants had ≥ 5 depressive symptoms.

Incident arthritis was reported by 514 (24.3%) persons. The majority of persons with arthritis reported physician visits (81.7%) and medication use (61.7%) for their arthritis, and nearly 93% reported location of arthritis in either their hands or knees (Table 2). Persons with arthritis were significantly more likely to report difficulty with 6 functional activities than persons without arthritis after adjustment for age, sex, race, BMI, and depressive symptoms (Table 3).

Table 4 shows the univariate association between continuous variables and incident arthritis. Persons with incident arthritis were significantly older, had more depressive symptoms, and reported less leisure-time physical activity than those without arthritis. Women, but not men, with incident arthritis had a significantly higher BMI than those without incident arthritis.

Table 5 shows the association of risk factors with arthritis after adjustment for age, sex, and race. The Wald statistic, which indicates the significance of adding a given risk factor to the model containing age, sex, and race, was significant for leisure-time physical activity (p = 0.03), BMI (p = 0.0045), and 5 or more depressive symptoms (p = 0.0002). A test for trend using mean category values was insignificant for income (p = 0.43) and borderline significant for alcohol (p = 0.11) and education (p = 0.11).

Table 1. Characteristics of 2113 study participants at baseline.

Age, yrs, %	
< 35	25.6
35–39	18.1
40–44	14.8
45–49	14.1
50 +	27.4
Females. %	54.4
BMI, mean (SD), kg/m^2	24.0 (3.9)
Race, %	
African American	7.0
Hispanic	4.0
Asian/other	5.8
White	83.2
Education, %, yrs	
< 12	14.5
12	30.7
13–16	34.9
> 16	19.9
Income, 1974 dollars, %	
< $10,000	17.1
$10–14,999	27.0
$15–19,999	23.7
$20–24,999	15.5
> 24,999	16.7
Leisure-time physical activity score, %	
0–4 (low)	21.2
5–7	32.3
8–9	23.2
10–16 (high)	23.2
Depressive symptoms, 5 or more, %	11.0
Alcohol consumption, drinks/mo	
None	13.8
1–45	66.2
> 45	20.0
Cigarette use, %	
Current	34.0
Former	24.3
Never	41.7
Diabetes, %	1.9
Hypertension, %	9.4

BMI: body mass index. Quintiles for men: 17.97–22.59, 22.65–24.17, 24.21–25.18, 25.23–26.95, 26.96–44.63. Quantiles for women: 15.33–20.09, 20.11–21.41, 21.45–22.86, 22.89–25.58, 25.60–54.81.

Table 2. Reported use of medical care and location of arthritis in persons (n = 514) with self-reported arthritis.

Medical care, %	
Seen a doctor about arthritis?	81.7
Taken medicines prescribed for arthritis?	61.7
Location of arthritis, %	
Knees	47.3
Hands	33.3
Knees and hands	12.3
Neither hands nor knees	7.2

Table 6 shows parameter estimates from the full multivariate model that contains all of the significant risk factors from Table 5. Female sex, increasing age and BMI, and 5 or more depressive symptoms carried increased odds of arthritis, while leisure-time physical activity in the highest quartile was protective. The sex-stratified models show that BMI was a risk factor only for women. When added to the model (results not shown), an interaction term between age and depressive symptoms was insignificant (p = 0.41).

Parameter estimates and significance levels for our multivariate model did not vary for age, sex, or depressive symptoms when incident cases of arthritis were limited in either of the 3 following ways: those who saw a physician, those with arthritis in the hands only, or those with arthritis in the knees only (results not shown). BMI in the highest 2 quintiles was a risk factor for knee arthritis (4th quintile, OR 1.67, 95% CI 1.07–2.62; 5th quintile, OR 2.44, 95% CI 1.58–3.77), but not for hand arthritis (4th quintile, OR 1.19, 95% CI 0.81–1.75; 5th quintile, OR 1.20, 95% CI 0.81–1.77). Leisure-time physical activity in the highest quartile was protective for hand arthritis (OR 0.67, 95% CI 0.45–0.97) but not knee arthritis (OR 0.74, 95% CI 0.49–1.12).

In addition, we established that the association between depressive symptoms and arthritis was unlikely to be due to attrition bias. Given that 5 or more depressive symptoms were more common in persons lost to followup (14.4%)

Table 3. Prevalence of functional disability* and adjusted odds ratios comparing persons with and without self-reported arthritis.

Activity	Arthritis, n = 514, %	No Arthritis, n = 1599, %	Adjusted OR†	95% CI
Do heavy housework	40.7	16.0	2.75	2.17, 3.48
Walk one-quarter mile	19.8	7.6	2.14	1.58, 2.91
Lift or carry 10 pounds	45.2	13.7	4.30	3.38, 5.47
Stand after sitting in a chair	33.7	10.8	3.56	2.76, 4.59
Stoop, crouch, or kneel	59.7	20.4	4.93	3.93, 6.18
Write or handle small objects	20.0	4.3	4.58	3.26, 6.42

* Disability was dichotimized as no difficulty vs some, a lot, or only can do it with help of a person or equipment. † Adjusted for age, race, sex, body mass index, and 5 or more depressive symptoms.

Table 4. Mean values of selected risk factors at baseline (1974) for persons with and without incident self-reported arthritis in 1995, all participants and stratified by sex.

	No Arthritis	Incident Arthritis	p†
All			
Age, yrs	41.9	46.5	0.0001
BMI, kg/m^2	23.8	24.6	0.002
Leisure-time physical activity score	7.4	6.6	0.0001
No. of depressive symptoms	1.7	2.2	0.0002
No. of alcoholic drinks	27.4	28.2	0.5
Female			
Age, yrs	41.2	46.1	0.0001
BMI, kg/m^2	22.7	24.3	0.0001
Leisure-time physical activity score	7.0	6.3	0.0005
No. of depressive symptoms	1.7	2.3	0.002
No. of alcoholic drinks	20.1	22.2	0.8
Male			
Age, yrs	42.7	47.2	0.0001
BMI, kg/m^2	24.9	25.1	0.5
Leisure-time physical activity score	7.7	7.0	0.01
No. of depressive symptoms	1.7	2.1	0.04
No. of alcoholic drinks	35.3	37.7	0.7

BMI: body mass index. † Wilcoxon rank-sum tests.

Table 5. Association between individual risk factors and incidence of self-reported arthritis adjusted for age, sex, and race.

	OR	95% CI
BMI quintiles, vs 1st quintile (referent)		
2nd	0.85	0.60, 1.20
3rd	0.91	0.65, 1.29
4th	1.28	0.92, 1.78
5th (high)	1.44	1.04, 2.01
LTPA, vs 1st quartile (referent)		
2nd quartile	0.72	0.55, 0.95
3rd quartile	0.70	0.51, 0.94
4th quartile (high)	0.61	0.45, 0.83
Depressive symptoms, ≥ 5 vs < 5 (referent)	1.72	1.27, 2.35
Hard physical work, vs little (referent)		
Some	0.77	0.49, 1.20
A lot	1.30	0.84, 2.02
Income, vs < $10,000 (referent)		
$10–14,999	1.14	0.79, 1.65
$15–19,999	1.08	0.78, 1.51
$20–24,999	1.09	0.78, 1.52
> 24,999	0.97	0.67, 1.42
Education, vs high school (referent)		
< 12 years	1.07	0.78, 1.47
13–16	0.86	0.67, 1.11
> 16	0.82	0.60, 1.13
Cigarette use, vs never (referent)		
Current	1.15	0.91, 1.46
Former	1.07	0.82, 1.40
Alcohol consumption, vs none (referent)		
1–45 drinks/mo	1.07	0.78, 1.45
> 45 drinks/mo	1.30	0.90, 1.88
Diabetes, vs no diabetes (referent)	1.49	0.74, 2.97
Hypertension, vs no hypertension (referent)	1.04	0.74, 1.45

BMI: body mass index, LTPA: leisure-time physical activity. Quintiles for men: 17.97–22.59, 22.65–24.17, 24.21–25.18, 25.23–26.95, 26.96–44.63. Quintiles for women: 15.33–20.09, 20.11–21.41, 21.45–22.86, 22.89–25.58, 25.60–54.81.

than participants (11.0%), we calculated that, regardless of the incidence of arthritis in persons lost to followup, the relationship between 5 or more depressive symptoms and arthritis in those lost to followup would have had to be protective in order for there to be no relationship between depressive symptoms and arthritis in the cohort as a whole. For example, assuming the same incidence of arthritis in persons lost to followup as in participants, the odds ratio for developing incident arthritis comparing those with and without 5 or more depressive symptoms would have been 0.43. Such a reverse protective relationship in persons lost to followup is unlikely.

DISCUSSION

This study suggests that the following risk factors increase the risk of incident self-reported arthritis — female sex, increasing age, increasing BMI, 5 or more depressive symptoms, and low leisure-time physical activity. This study is the first longitudinal population based study to examine and establish that prior depressive symptoms are a risk factor for subsequent incident self-reported arthritis.

Depressive symptoms. The adverse health effects of depressive symptoms are increasingly recognized[31,36,37]. This study adds to this literature by finding that 5 or more depressive symptoms was a risk factor for increased odds of incident arthritis after multivariate adjustment for age, sex, race, physical activity, and BMI. As discussed above, we established that this association was due neither to an interaction between age and depressive symptoms nor to attrition bias.

There are many possible hypotheses to explain this association. Depressive symptoms may increase reporting of arthritis by increasing the perception of pain due to arthritis or lowering the threshold for reporting arthritis. This is supported by cross-sectional studies that found that psychological factors that relate to depressive symptoms such as state anxiety[38-40], lower learned resourcefulness[38], helplessness[39], feeling in low spirits[23], and feeling depressed[38,39] are significantly associated with the reporting of knee pain in persons with knee OA after controlling for numerous factors including radiographic severity. Alternatively, depressive symptoms can be accompanied by an increased reporting of somatic symptoms, particularly in the elderly, that if misidentified as arthritis could lead to an association between depressive symptoms and self-reported arthritis[41].

Although we controlled for baseline BMI and leisure-time physical activity, depressive symptoms may have led to knee arthritis through subsequent weight gain. Unmeasured confounders such as the use of antidepressant medications or comorbidities may also be related to the increased rate of arthritis in persons with depressive symptoms. Lastly, depressive symptoms may cause arthritis through as-yet unexplained neurohormonal mechanisms similar to the association of depressive symptoms with all-cause and cardiovascular mortality[31,36,37] or the association of clinical depression with decreased bone mineral density[42].

Leisure-time physical activity. In the multivariate model for men and women combined, persons in the highest leisure-time physical activity quartile had decreased odds of incident arthritis compared to those in the lowest leisure-time physical activity quartile. When stratified by body location, this protective role was in persons with hand arthritis, while in persons with knee arthritis there was an insignificant trend. To our knowledge, only one study has looked at the relation of physical activity to self-reported arthritis. This study of self-reported, physician diagnosed knee or hip OA defined physical activity as the weekly number of miles jogged or walked. It found an increased risk of arthritis only in the most active subset of men under 50 years of age that walked or jogged more than 20 miles per week[9]. There was no association in the rest of the population. For comparison, studies of tibiofemoral OA from the Framingham[43] and Chingford[12] cohorts found no association with physical activity, while a later study from the Framingham cohort[11]

Table 6. Multivariate association between risk factors* and incidence of self-reported arthritis.

	Females, n = 1148		Males, n = 963		All, n = 2111	
	OR	95% CI	OR	95% CI	OR	95% CI
Age in 1974						
< 35	1.0	—	1.0	—	1.0	—
35–39	1.17	0.74, 1.84	1.25	0.69, 2.25	1.19	0.83, 1.70
40–44	1.14	0.70, 1.84	1.83	1.00, 3.33	1.39	0.96, 2.01
45–49	2.23	1.43, 3.47	1.72	0.94, 3.17	2.00	1.40, 2.85
50 +	2.78	1.90, 4.07	3.55	2.15, 5.87	3.13	2.32, 4.22
Male	—	—	—	—	1.0	—
Female	—	—	—	—	1.48	1.20, 1.83
Race						
White	1.0	—	1.0	—	1.0	—
Black	1.03	0.64, 1.68	1.59	0.84, 3.02	1.20	0.82, 1.76
Hispanic	0.85	0.42, 1.76	0.19	0.05, 0.82	0.57	0.31, 1.04
Asian/other	0.52	0.27, 1.00	0.79	0.37, 1.68	0.60	0.37, 0.99
BMI quintile						
Quintile 1 (low)	1.0	—	1.0	—	1.0	—
Quintile 2	1.10	0.70, 1.75	0.62	0.36, 1.06	0.88	0.62, 1.24
Quintile 3	0.94	0.58, 1.51	0.93	0.57, 1.53	0.94	0.67, 1.33
Quintile 4	1.65	1.05, 2.60	0.94	0.57, 1.56	1.30	0.93, 1.80
Quintile 5 (high)	1.88	1.19, 2.95	0.94	0.57, 1.57	1.41	1.01, 1.96
Leisure-time physical activity quartile						
1st quartile (low)	1.0	—	1.0	—	1.0	—
2nd quartile	0.80	0.56, 1.14	0.74	0.47, 1.17	0.76	0.58, 1.01
3rd quartile	0.79	0.53, 1.20	0.76	0.47, 1.24	0.77	0.56, 1.05
4th quartile (high)	0.76	0.50, 1.16	0.66	0.40, 1.08	0.69	0.51, 0.95
5 or more depressive symptoms						
No	1.0	—	1.0	—	1.0	—
Yes	1.59	1.06, 2.37	1.40	0.82, 2.39	1.53	1.12, 2.10

* Adjusted for all factors in the table. Separate models for males, females, and all subjects. BMI: body mass index. Quintiles for men: 17.97–22.59, 22.65–24.17, 24.21–25.18, 25.23–26.95, 26.96–44.63. Quintiles for women: 15.33–20.09, 20.11–21.41, 21.45–22.86, 22.89–25.58, 25.60–54.81.

found an increased risk of OA with increasing physical activity measured 10 years earlier, but not at 20 or 40 years prior. Studies of hand OA have identified trauma and repetitive motion as risk factors, but have not examined leisure-time physical activity[44,45].

Interpretation of this literature is complicated by the variety of different physical activity measures used in different studies, such as leisure-time physical activity in this study, amount of jogging or walking[9], and amount of activity accrued in 24 hours of daily life activity[11,43]. The protective role of leisure-time physical activity in our study may be due to associated weight maintenance or associated improved flexibility and periarticular muscle strength[46-48].

Body mass index. In agreement with other studies of self-reported arthritis[6-9], increasing BMI was a risk factor for incident self-reported arthritis in our population. However, when stratified by body location and sex, this relationship was true only for women and for arthritis of the knee. There was only a slight trend for increased risk of hand arthritis with increasing BMI. For comparison, studies of tibiofemoral OA consistently identify increasing BMI as a risk factor[10-12] and, as in our study, some find this association to be much stronger in women than in men[11]. Support for a link between obesity and hand OA comes from one longitudinal study[14] and some cross-sectional studies[49,50], but not others[51,52].

Whether obesity is a risk factor for tibiofemoral OA alone or hand OA as well, the attributable risk of arthritis due to obesity may be growing quickly, given that the prevalence of obesity in the United States has increased by 30% between 1980 and 1994[53]. In addition, obesity is associated with increasing disability in persons with tibiofemoral OA[54].

Other risk factors. Age and female sex were risk factors for arthritis in this study, in agreement with cross-sectional and longitudinal studies of both self-reported arthritis[1,6,7,9], tibiofemoral OA[10,12,55-57], and hand OA[14]. Current cigarette use was not a risk factor for arthritis in our study compared to 2 national studies of self-reported physician diagnosed arthritis: one found an increased risk[8] and the other no association[7]. For comparison, studies of tibiofemoral OA have found a decreased risk[11] and no significant association[12,49].

Although alcohol consumption could be a risk factor for OA, given evidence from the Framingham cohort that alcohol consumption is associated with increased bone mineral density[58], this association has only been examined in a recent prospective study based on a referral population.

This study found an increased risk of self-reported, physician diagnosed knee or hip OA with alcohol consumption, but only in men under age 50, suggesting that, in that population, alcohol was a marker for an unmeasured lifestyle risk factor for arthritis[9]. In our study, we found no association between alcohol consumption of 1.5 or more alcoholic drinks per day and arthritis.

Lower attained education was not a risk factor for arthritis in our study, but was a risk factor for incident self-reported physician diagnosed arthritis in 2 others[7,8]. Our inability to find an association between education and arthritis may be due to a lack of power: only 14.2% of persons in this study had less than high school education compared to over 30% in the above studies.

Limitations. The single-item question we used to identify arthritis is limited in specificity and sensitivity compared to series of questions often used in current self-reported arthritis epidemiology, which can include questions about site, duration, chronicity, severity, type of arthritis, and medical care sought for joint symptoms. Nevertheless, a similar single-question showed good validity, with 93.8% of persons answering positively meeting criteria for ICD-coded arthritis on further questioning[19]. In addition, we used additional questions in our dataset to validate the presence of arthritis. Involvement of the hands or knees was specified by 92.8% of persons reporting arthritis. Hands were more commonly involved than the knees, consistent with national prevalence studies of OA[59]. In addition, persons with arthritis were significantly more likely to report disability in activities that have been impaired specifically in persons with hand[25] and tibiofemoral OA[23,24,60]. Lastly, arthritis was of sufficient severity that 82% of persons had sought medical care for that problem. This pattern of care use agrees with national data that, although using a different definition of self-reported arthritis, indicated 84% of persons with self-reported arthritis had sought medical care for that problem[61].

Type of arthritis could not be assessed, although it has been shown that OA accounts for over 80% of diagnoses for persons self-reporting arthritis in all age groups[4] and an even larger percentage in those over 55 years of age[5]. Thus it is likely that the majority of arthritis in our study was OA. This is supported by the fact that persons with arthritis in our study reported sites of involvement and disabilities typically found in OA. Nevertheless, because the diagnosis of arthritis was self-reported and was not confirmed by independent physical examination or radiographs, we cannot exclude that persons reporting arthritis were suffering from generalized musculoskeletal pain or fibromyalgia and our results must be interpreted with these limitations in mind.

Self-reported arthritis is limited by the lack of objective radiographic diagnostic confirmation. However, definitions based on radiographs also have limitations. First, arthroscopically evident and symptomatic arthritis can be present without radiographic changes. Second, choice of radiographic views, grading scale, and consistency of radiographic interpretation can vary between studies. Third, symptomatic OA does not necessarily have radiographic findings, while at the same time, radiographic abnormalities can be asymptomatic with no associated disability[23]. For example, in the Framingham cohort, only 40% of those with Kellgren-Lawrence radiographic changes of grade 3 and above had pain[56]. In addition, disability is greater in persons with knee pain without radiographic OA than in those with painless radiographic OA[23,24]. For these reasons, symptom-based criteria are relevant as well as radiographic criteria.

A last limitation of self-reported arthritis is that the symptoms on which the definition is based can wax and wane. Inconstant symptoms at the time of baseline measurements could lead to bias if persons with quiescent arthritis were more likely to be depressed, inactive, or overweight. We minimized this potential bias by only entering subjects into the analysis who denied arthritis in both 1965 and 1974. Waxing and waning of arthritis status at the time of outcome measurement in 1994 would lead to nondifferential misclassification of arthritis status.

Our definition of a mood disturbance, 5 or more depressive symptoms, does not represent clinical depression, nor does it fully operationalize the DSM-IV criteria for a major depressive episode. However, this definition has confirmed reliability[27-29], is conceptually similar to other brief symptom checklists such as the CES-D scale[30], correlated well with the number of "depressed" symptoms on the Beck Depression Inventory ($r = 0.66$) in an outpatient clinic population[28], and predicted mortality from stroke[31].

We were unable to examine the contribution of occupation to arthritis because job descriptions were not sufficient to indicate specific activities. We did evaluate a single question about "the amount of involvement in hard physical work," but found no significant association with arthritis. We did not have baseline information on joint injury, which is a risk factor for subsequent OA[62].

Strengths. Strengths of our study include that it was a large, population based cohort with 20 years of followup. The data were collected prospectively, before onset of disease, which minimizes the possible bias found in studies in which participants are asked to recall risk factors after the onset of disease. In addition, although self-reported arthritis has the disadvantage of lack of radiographic or clinical confirmation, it has the advantage of capturing the roughly 16% of the population with arthritis who have not sought medical care[61]. Lastly, self-reported arthritis is relevant to public health research and surveillance. Like early efforts at describing the epidemiology of other chronic diseases such as cardiovascular disease, there is value in understanding arthritis in broad terms that can be measured easily at a population level until more disease-specific measures are available.

Arthritis is a disease of public health importance because of its prevalence and associated disability. A single-item definition of self-reported arthritis identified commonly recognized risk factors for arthritis such as sex, age, and increasing BMI for women. In addition, it identified persons with increased odds of functional disability commonly found in persons with tibiofemoral and hand OA. The importance of including information about joint of involvement in definitions of self-reported arthritis is shown by the fact that increasing BMI was only a significant risk factor for arthritis of the knee. This agrees with the OA literature, which indicates that increasing BMI is a stronger risk factor for tibiofemoral OA than either hip or hand OA. Low leisure-time physical activity was a significant risk factor for arthritis as a whole and hand arthritis, but not knee arthritis. Five or more depressive symptoms were a risk factor for arthritis regardless of location. It is unclear whether the presence of depressive symptoms affects the development of self-reported arthritis through weight change or metabolic effects. Alternatively, it may influence reporting by lowering the threshold for reporting arthritis, increasing the perception of pain due to arthritis, or causing overreporting of somatic symptoms in general.

Our study confirms the importance of weight control, particularly for self-reported arthritis of the knees in women. More research is needed to define what quantity and type of physical activity either protect or put people at risk for arthritis of different joints. Evaluation of depressive symptoms is warranted in future longitudinal studies of self-reported arthritis and osteoarthritis.

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