Arthritis and Mortality in the Epidemiological Follow-up to the National Health and Nutrition Examination Survey I

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Abstract. *Subsets were analyzed of respondents from the Epidemiological Follow-up to the National Health and Nutrition Examination Survey I (NHANES I) who (1) answered a general arthritis question reflecting whether a doctor told the respondent that she or he had arthritis, (2) answered seven pain, swelling, and stiffness questions, and (3) had radiographs of knees and hips assessed for osteoarthritis at the time of the initial survey during the early 1970s. Data for the follow-up were collected between 1982 and 1984 and included 1,491 fatalities in the largest subsample analyzed here. The dependent variable was months of survival after the initial interview. No distinction was drawn between rheumatoid arthritis versus osteoarthritis. The NHANES I contained only limited information on rheumatoid arthritis versus osteoarthritis. Additional covariates included age, age squared, education, race, marital status, diastolic blood pressure, and body mass. After adjusting for age, no statistically significant associations emerged between answers to the general arthritis questions or any of the seven pain questions on the one hand, and mortality on the other. Similar statistically insignificant results were found when the association between radiographic diagnoses of osteoarthritis in the hips and months of survival was considered after adjusting for age. These statistically insignificant results persisted in repeated testing, which alternately included and excluded a number of covariates, and in separate subsamples of women, men, and persons older and younger than age 50. Some evidence was found, however, for a negative, statistically significant association between radiographic knee diagnoses of osteoarthritis and survival, especially among women, even after adjusting for covariates. These mixed results (1) do not discredit findings elsewhere suggesting that rheumatoid arthritis is associated with early death, since it is likely that the great majority of respondents answering in the affirmative to the general arthritis or seven pain questions in the NHANES I had osteoarthritis, and (2) suggest that future surveys should make greater attempts to distinguish between rheumatoid arthritis and osteoarthritis.*

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Osteoarthritis (OA) and rheumatoid arthritis (RA) are major causes of disabilities, especially among senior citizens.[1] Until recently, however, conventional medical opinion held that neither form of arthritis was life-threatening. Evidence is now accumulating that RA either directly or indirectly increases mortality,[2-8] although the new view that RA kills is not universally accepted.[9]

Little evidence exists for OA's role in relation to mortality, and the evidence that does exist is conflicting, but at least three studies suggest a weak to modest association between OA and premature death.[10-12] The scant research attention to OA is unfortunate because far more people suffer from OA than from RA, and because medical opinion supports the view that RA can shorten life span.

This study considers whether statistical associations between arthritis measured during the early 1970s are correlated with survival and mortality through the early 1980s. Subsamples are drawn and cohorts are constructed from the Epidemiological Follow-up to the National Health and Nutrition Examination Survey I sample (NHEFS) who answered the general arthritis question or seven pain, swelling, and stiffness questions, or who provided information on radiographic readings of knees and hips in the early 1970s. The sample size of the largest cohort was 9,117. This appears to be the first extensive analysis of arthritis and mortality using the NHEFS in which (1) a variety of measures of arthritis are considered and (2) several confounding covariates are accounted for. (Two prior studies considered univariate and age-adjusted mortality and arthritis association as part of larger efforts to assess statistical relationships involving pain and arthritis of the knee.) Arthritis investigators may have overlooked the National Health and Nutrition Examination Survey (NHANES) I because in the largest subsamples, such as those used in this report, no distinction is drawn between OA and RA. Nevertheless, because the NHANES I and NHEFS are highly regarded by investigators in a variety of fields and because the data are easily accessible, a preliminary multivariate analysis is warranted.

Materials and Methods

Data

Subsets of respondents were selected from the NHANES I and NHEFS who answered either the broad arthritis question or seven pain, swelling, and stiffness questions, or who provided information on radiographic readings of the knees and hips at the time of the initial interview during 1971 to 1975.

NHANES I represents a probability sample of the US noninstitutionalized population during 1971 to 1975.[13] NHEFS is a follow-up survey conducted during 1982 to 1984.[14] NHEFS investigators attempted to survey 14,407 subjects from the original NHANES I. Their success was remarkable: 13,380 were traced and accounted for. Of the 13,380 who were traced, 10,523 agreed to participate and were reinterviewed, 835 refused to participate, and 2,022 were found to have died. Thus, a total of 12,545 subjects were available for analysis.

Our largest subsample consisted of 9,117 respondents: 7,626 who were reinterviewed for the Follow-up (NHEFS) and 1,491 who died before the Follow-up interview. Our largest sample size is smaller than the total of 12,545 available in the NHEFS because only persons from the NHANES I who answered the general arthritis question were selected for the first analysis. The additional eight analyses relied on smaller samples of people who provided answers to the seven pain, swelling, and stiffness questions and information on radiographic readings of the knees and hips.

Our dependent variable was the number of months survived after the initial interview. Because most people did not die over the 10 to 14 years, our dependent variable was right-censored with a maximum value of 168 ($= 12 \times 14$).

The first independent variable was constructed using answers to this question: "Has a doctor ever told you that you have arthritis, and, if so, do you still have it?" Responses for the entire NHANES I sample who received this question are shown in Table I. If respondents in the subsample answered either 1, 3, or 4, then they

TABLE I
RESPONSES TO 10 ARTHRITIS QUESTIONS AND VARIABLES IN NHANES I

1. Has a doctor ever told you that you have arthritis? (General Arthritis Question)	
1) Condition still present	n = 3,505
2) Never had condition	n = 15,135
3) Had condition, not present now	n = 176
4) Had condition, do not know if present	n = 109
Blank	n = 13
2. Have you ever had pain in or around either hip joint including the buttock, groin, and side of the upper thigh on most days for at least 1 month? (hip pain)	
1) Yes	n = 400
2) No	n = 2,658
Blank	n = 3,855
3. Have you ever had pain in or around the knee including the back of the knee on most days for at least 1 month? (knee pain)	
1) Yes	n = 453
2) No	n = 2,605
Blank	n = 3,855
4. Have you ever had swelling of a joint with pain present in the joint on most days for at least 1 month? (joint swelling)	
1) Yes	n = 797
2) No	n = 6,103
Blank	n = 13
5. Have you ever had stiffness in the joints and muscles when getting out of bed in the morning lasting for at least 15 minutes? (muscles stiff)	
1) Yes	n = 1,404
2) No	n = 5,498
Blank	n = 11
6. Have you ever had pain or aching in any of your joints on most days for at least 1 month? (joint pain)	
1) Yes	n = 1,888
2) No	n = 5,013
Blank	n = 12
7. Have you ever had pain in your neck or back on most days for at least 1 month? (neck pain)	
1) Yes	n = 1,473
2) No	n = 5,427
Blank	n = 13
8. Have you ever had pain in or around either hip joint or knee on most days for at least 1 month? (hip/knee pain)	
1) Yes	n = 772
2) No	n = 3,072
Blank	n = 3,069
9. Doctors' radiograph readings of knees.	
1) Normal	n = 6,286
2) Questionable	n = 275
3) Minimal	n = 119
4) Moderate	n = 44
5) Severe	n = 11
6) Blank	n = 178
10. Rheumatologists' radiograph readings of hips.	
1) Normal	n = 4471
2) Questionable	n = 157
3) Minimal	n = 35
4) Moderate	n = 16
5) Severe	n = 17
6) Blank	n = 2217

were counted as having arthritis. Respondents answering with 2 were assumed not to have arthritis. Persons responding with 5 (or blank) were excluded from the first analysis.

The seven specific pain, swelling, and stiffness questions and their corresponding answers are also listed in Table I (items 2 through 8). Persons who did not answer a particular question or who were never asked (blank) were omitted from the analysis of that question, but not necessarily omitted from analysis of any of the other questions. The large number of blank responses is due primarily to the NHANES I interviewers who submitted these seven questions to only a limited number of people in the subset of persons in the "General Medical History Supplement."

The ninth and tenth independent variables were binary and indicated a doctor's reading of radiographs of respondents' knees or hips. Only a subset of the NHANES I underwent radiography: 3,491 women and 3,119 men. Doctors scored radiographs as normal, questionable, minimal, moderate, severe, and blank (Table I). Only persons whose radiographs were diagnosed as normal received a 0 for the binary variable reflecting doctors' diagnoses of arthritis of the knees or the hips; persons with questionable to severe radiographs received a 1 for the binary arthritis for the knees and hips variables. Persons with blanks were omitted. Only 7.9% of the women and 5.3% of the men received a 1 for the knees variable and 5.1% of women and 3.6% of men for the hips variable.

Eleventh and twelfth independent variables were constructed, which included questionable with normal as a 0 in a binary variable reflecting OA of the knees or hips. Preliminary attempts to analyze these independent variables confirmed results found with the ninth and tenth independent variables.

The first eight NHANES I arthritis questions and variables are clearly deficient in that no distinction is drawn between OA and RA. Variables using knee and hip radiographs attempted to provide diagnosis of OA for either the knees or hips, but none of our 10 variables attempted a diagnosis of RA. The NHANES I investigators did interview a small subset ($n = 6,913$) of the original NHANES I respondents, to whom arthritis and musculoskeletal

TABLE II
DESCRIPTIVE STATISTICS IN FIRST ANALYSIS USING THE GENERAL ARTHRITIS QUESTION

	Mean and (SD, Where Appropriate)	
	Women	**Men**
Dependent Variable		
1. Number of deaths	876	615
Independent Variables		
2. Has a doctor ever told you that you had arthritis? No distinction between RA and OA	0.2098 (0.4072)	0.166 (0.372)
3. Age	40.170 (18.317)	42.5 (19.89)
4. Age squared	1949 (1612)	2205 (1725)
5. Years of schooling completed	11.1309 (3.0919)	10.69 (3.603)
6. Percent black race	0.1695 (0.3752)	0.1546 (0.3616)
7. Percent married, spouse present	0.576 (0.431)	0.656 (0.475)
8. Percent widows or widowers	0.112 (0.3159)	0.032 (0.177)
9. Diastolic blood pressure	77.39 (13.907)	79.101 (14.779)
10. Body mass (= weight/height^2)	0.00247 (0.000567)	0.00247 (0.00045)

questions with greater detail were asked.[15] Unfortunately, few responses were recorded. The number of answers to questions pertaining to doctors' diagnoses of rheumatoid arthritis, osteoarthritis, and rheumatism were 57, 170, and 28.

Additional covariates included age, age squared, years of schooling, black race, married spouse present, widow or widower, diastolic blood pressure, and body mass. Descriptive statistics on all variables in the largest subsample are presented in Table II. No variables had missing values except diastolic blood pressure, which was missing in about 4% of the responses. Mean values were substituted when missing values were encountered for diastolic blood pressure.

Statistics

Three statistical techniques were applied. The first was unweighted multiple regression, in which months of survival was the dependent variable. Unweighted multiple regression may not be the most desirable technique, however. First, the dependent variable is right-censored so that multiple regression will produce biased coefficient estimates.[16] Second, NHANES I is a cluster

sample and if unobserved variables are correlated within geographic clusters, multiple regression will generate inefficient estimates.[17, 18]

The first problem was addressed by applying accelerated failure time models, which assume a Weibull distribution.[19, 20] Accelerated failure time models were constructed to account for right-censoring as is present in survival data. Failure time models do not suffer from the bias problems of multiple regression involving censored data. We used the Weibull distribution because it measures the extent of variation in the probability of dying with the length of survival, and because it is "the most widely used lifetime distribution model" in the literature.[20(p15)] Unweighted multiple regression and Weibull failure time models were run with SAS software.[21]

The second problem was addressed by running weighted multiple regressions, which account for possible error correlations within geographic clusters.[17, 18] These error components techniques were applied using PCCARP.[22]

Because this study searched for risk factors for early death, failure time models and multiple regression techniques were more appropriate than recursive partitioning.[23]

Separate analyses were conducted on women and men, persons aged 12 to 74, 12 to 49, and 50 to 74 at the time of the initial NHANES I interview.

Results

Results on the first analysis of the general arthritis question are presented in Tables II, III, and IV. Table II provides a list of variables and corresponding descriptive statistics. More women (n = 5,408) than men (n = 3,731) were available for the first analysis. Roughly 16.5% of the men and 16.0% of the women died during the follow-up period. Women more frequently reported a doctor's diagnosis of arthritis than men: 21% compared to 16.5%. These percentages were similar to other estimates for the US adult population.[24] The sampled men are older and more likely to be

TABLE III
WEIBULL REGRESSION RESULTS EXPLAINING LOG (MONTHS OF SURVIVAL): WOMEN ONLY, AGES 12 TO 74 IN EARLY 1970s*

	Parameter Estimates and (*P* Values in a Two-tailed Test) for Regression Number				
	1	2	3	4	5
Independent Variables					
1. Intercept	6.8765	6.860	6.972	6.894	6.922
	(.0000)	(.0000)	(.0000)	(.0000)	(.0001)
2. Doctor diagnosed arthritis?	−0.1139	−0.0315	−0.0386	−0.0414	−0.0375
	(.1566)	(.6179)	(.5407)	(.5129)	(.5553)
3. Age		−0.0239	−0.0213	−0.0179	−0.0177
		(.0015)	(.0059)	(.0412)	(.0480)
4. Age squared		0.00023	0.00019	0.00015	0.00015
		(.0059)	(.0237)	(.1281)	(.1390)
5. Years of schooling			−0.0133	−0.0099	−0.01007
			(.1011)	(.2317)	(.2323)
6. Black				0.05849	0.0610
				(.3931)	(.3761)
7. Married, spouse present				0.0125	0.0153
				(.8454)	(.8110)
8. Widow				0.0822	0.0826
				(.4146)	(.4126)
9. Diastolic blood pressure					0.0039
					(.2128)
10. Body mass					−18.66
					(.6776)
11. σ, scale factor					
Parameter estimate	0.7439	0.7438	0.7438	0.7430	0.7429
SE	0.0185	0.0185	0.0185	0.0189	0.0190
Log of likelihood for Weibull	−2,998	−2,991	−2,990	−2,988	−2,985
Sample size of women only	5,408	5,408	5,408	5,408	5,408

* Source: NHEFS.

married with spouse present than the women. The men have a lower average level for years of education but a higher standard deviation, again consistent with other national surveys.[25] While the men had higher average blood pressures than the women, body mass was virtually identical for women and men. As mentioned above, unweighted and weighted regression techniques and Weibull survival models were used to analyze the relationships. Because *t* statistics and *P* values for almost all independent variables were so similar regardless of the regression technique attempted, only one set of results is presented. The Weibull model results were selected for presentation here because of the

TABLE IV
WEIBULL REGRESSION RESULTS EXPLAINING LOG (MONTHS OF SURVIVAL): MEN ONLY, AGES 12 TO 74 IN EARLY 1970s*

	Parameter Estimates and (*P* Values in a Two-tailed Test) for Regression Number				
	1	2	3	4	5
Independent Variables					
1. Intercept	6.9398	6.6784	6.551	6.6100	6.8172
	(.0000)	(.0000)	(.0000)	(.0001)	(.0001)
2. Doctor diagnosed arthritis?	−0.0689	−0.0262	−0.0019	−0.0124	−0.0084
	(.5347)	(.7521)	(.8855)	(.8813)	(.9193)
3. Age		−0.0174	−0.0239	−0.0337	−0.0305
		(.0365)	(.0061)	(.0045)	(.0110)
4. Age squared		0.00019	0.00027	0.0003	0.00034
		(.0460)	(.0071)	(.006)	(.0126)
5. Years of schooling			0.0204	0.0227	0.0232
			(.0208)	(.0133)	(.0116)
6. Black				0.1524	0.1477
				(.0807)	(.0926)
7. Married spouse present				0.1755	0.1891
				(.0439)	(.0307)
8. Widower				−0.0682	−0.0575
				(.6863)	(.7329)
9. Diastolic blood pressure					−0.0028
					(.4583)
10. Body mass					−94.0725
					(.1797)
11. σ, scale factor	0.7032	0.7032	0.7031	0.7031	0.7024
Parameter estimate	0.7032	0.7032	0.7031	0.7031	0.7024
Standard error	0.0121	0.0121	0.0123	0.0122	0.0126
Log of likelihood for Weibull	−2,217	−2,107	−2,104	−2,100	−2,095
Sample size of men only	3,731	3,731	3,731	3,731	3,731

* Source: NHEFS.

popularity of failure time regression models when the dependent variable is survival time.[2-8,20,26,27] Results from the other two techniques are available from the authors.

Tables III and IV present Weibull regression results, which treated the log of months of survival as the dependent variable. Table III contains results for women and Table IV, results for men. The first model (column 1) included only responses to the general arthritis question as a covariate. The second model (column 2) added age and age squared. The third model added education. The fourth added black race, married spouse present, and widow or widower. Blood pressure and body mass were added last in the models.

Results from row 2 in each column of both Tables III and IV suggest that no statistically significant correlation could be discovered between the NHANES I answers to the simple arthritis question in 1971 to 1975 and subsequent survival time into the early 1980s. These statistically insignificant results for women and men were apparent regardless of which covariates were controlled for, whether samples were restricted to the 12 to 74, 12 to 49, or 50 to 74 age groups, and regardless of the multivariate technique used.

Estimated coefficients from the Weibull models (divided by the scale factor) indicate the association between a 1-unit change in the independent variable and a percent change in the dependent variable.[28] Consider, for example, the statistically significant schooling coefficient in model 3 of Table IV: 0.0204. Dividing 0.0204 by the scale factor 0.7031 equals 0.0290. This number, 0.029, indicates that 1 more year of schooling is associated with a 0.29% average increase in length of survival.

Table V presents abbreviated results from 90 Weibull regressions. The 90 regressions correspond to the combinations of nine additional independent variables (hip pain, knee pain, joint swelling, muscles stiff, joint pain, neck pain, hip/knee pain, and doctors' knee and hip radiograph readings), five sets of covariates indicated in columns 1 through 5 in Table IV, and two genders ($7 \times 5 \times 2 = 70$). Each triplet of numbers in each cell in Table V corresponds to one of the 90 regressions. Consider the first cell for men. The first number, -0.165, is the estimated Weibull regression coefficient. Since the sign is negative, this indicates that reporting hip pain is negatively associated with survival. After dividing -0.165 by the scale factor 0.94, we calculated that those not reporting hip pain live approximately 1.76% longer than those reporting hip pain. The second number, .042, is the probability of a type 1 error in a two-tailed test. Because this P value is $>.05$, there is some statistical evidence that the negative hip pain-survival association is not merely due to chance. The last number, 1,305, is the sample size for this regression. These numbers, -0.165, .042, and 1,305 only correspond to regression number 1, which assumes a univa-

TABLE V

SUMMARY OF 90 WEIBULL REGRESSION RESULTS EXPLAINING LOG (MONTHS OF SURVIVAL) FOR SEVEN SPECIFIC PAIN, SWELLING, AND STIFFNESS QUESTIONS AND RADIOGRAPH READINGS OF KNEES: WOMEN AND MEN, AGES 12 TO 74 IN EARLY 1970s*

	Women			Men		
Question and Regression Column Number From Tables III and IV	**Est Coefficient**	***P* value**	**Sample Size**	**Est Coefficient**	***P* value**	**Sample Size**
2. Hip pain regression number						
1)	−0.145	.164	1,723	−0.165	.042	1,305
2)	0.445	.191	1,723	0.099	.546	1,305
3)	0.496	.149	1,723	0.142	.499	1,305
4)	0.484	.186	1,723	0.167	.322	1,305
5)	0.421	.216	1,723	0.144	.511	1,305
3. Knee pain regression number:						
1)	−0.394	.189	1,723	−0.437	.086	1,332
2)	−0.038	.897	1,723	−0.169	.484	1,332
3)	−0.010	.973	1,723	−0.142	.341	1,332
4)	−0.011	.982	1,723	−0.149	.402	1,332
5)	−0.011	.967	1,723	−0.175	.522	1,332
4. Joint swelling regression number:						
1)	−0.281	.051	3,731	−0.226	.065	1,399
2)	0.022	.873	3,731	−0.087	.828	1,399
3)	0.078	.571	3,731	−0.084	.729	1,399
4)	0.055	.622	3,731	−0.075	.846	1,399
5)	0.034	.808	3,731	−0.092	.764	1,399
5. Muscles stiff regression number:						
1)	−0.409	.0006	3,731	−0.279	.013	3,162
2)	−0.111	.325	3,731	0.061	.568	3,162
3)	−0.067	.559	3,731	0.069	.504	3,162
4)	−0.082	.461	3,731	0.073	.497	3,162
5)	−0.091	.430	3,731	0.053	.622	3,162
6. Joint pain regression number:						
1)	−0.412	.0003	3,731	−0.300	.003	3,162
2)	−0.095	.380	3,731	−0.050	.602	3,162
3)	−0.061	.572	3,731	−0.031	.753	3,162
4)	−0.082	.641	3,731	−0.044	.684	3,162
5)	−0.091	.401	3,731	−0.059	.537	3,162
7. Neck pain regression number:						
1)	−0.227	.061	3,731	−0.192	.087	3,162
2)	−0.022	.850	3,731	0.016	.878	3,162
3)	−0.019	.865	3,731	0.032	.764	3,162
4)	−0.025	.892	3,731	0.028	.759	3,162
5)	−0.014	.902	3,731	0.014	.893	3,162
8. Hip/knee pain regression number:						
1)	−0.283	.036	3,008	−0.351	.004	1,830
2)	−0.053	.680	3,008	−0.114	.321	1,830
3)	−0.075	.565	3,008	−0.102	.385	1,830
4)	−0.088	.592	3,008	−0.198	.477	1,830
5)	−0.092	.776	3,008	−0.244	.511	1,830

TABLE V—continued

Question and Regression Column Number From Tables III and IV	Women			Men		
	Est Coefficient	*P* value	Sample Size	Est Coefficient	*P* value	Sample Size
9. Readings of knee radiographs regression number:						
1)	−0.9517	.0001	3,600	−0.4009	.0043	3,114
2)	−0.3866	.0027	3,600	−0.2408	.0941	3,114
3)	−0.3572	.0055	3,600	−0.1257	.3817	3,114
4)	−0.3384	.0097	3,600	−0.1240	.4928	3,114
5)	−0.3072	.0168	3,600	−0.1174	.7652	3,114
10. Readings of hip radiographs regression number:						
1)	−0.4540	.0334	1,592	−0.8289	.0001	3,097
2)	−0.2878	.1675	1,592	−0.2036	.2051	3,097
3)	−0.2865	.1682	1,592	−0.1578	.3239	3,097
4)	−0.2850	.1696	1,592	−0.1427	.4686	3,097
5)	−0.2564	.2157	1,592	−0.1160	.7724	3,097

Covariates in regression 1 include: intercept only.
Covariates in regression 2 include: intercept, age, and age squared.
Covariates in regression 3 include: intercept, age, age squared, and years of schooling.
Covariates in regression 4 include: intercept, age, age squared, years of schooling, black, married, and widower.
Covariates in regression 5 include: intercept, age, age squared, years of schooling, black, married, widower, diastolic blood pressure, and body mass.
* Source: NHEFS.

riate relation, i.e., no covariates enter regression number 1. Regression number 1 corresponds to column 1 in Table IV. The statistically significant *P* value, .042, therefore, should be viewed with caution. It is likely that hip pain is correlated with age. When age is entered as a covariate in regression 2, the *P* value increases substantially to .546. All other *P* values in the hip pain male sample are much greater than .05. Moreover, notice that the sign becomes positive in models 2 through 5, suggesting that those with hip pain live longer than those without.

This pattern is repeated in virtually every combination for women and men and for each of the seven specific pain, swelling, and stiffness questions. Univariate correlations (regression 1) between some measures of pain, swelling, or stiffness and survival are negative and frequently statistically significant at the .05 level or better. Statistical significance evaporates as soon as age is

entered into the regression as a covariate, however. None of the pain, swelling, or stiffness variables achieve statistical significance in regressions 2 through 5 for men or women. Again, frequently the sign changes, suggesting that those with pain live longer than those without.

Analysis of the ninth independent variable (knee radiograph readings) produced a finding similar to those for the first eight independent variables. Among women, a questionable to severe reading was negatively associated with survival in univariate and multivariate designs. Statistically insignificant relations remained the norm for men, however, in the multivariate regression.

Analysis of the tenth independent variable (hip radiograph readings) fit the pattern of the first eight variables. Univariate associations indicated statistical significance but multivariate association did not.

Similar patterns were discovered in separate samples that restricted attention to respondents over age 49.

Results for the control variables can be summarized simply. (1) Years of completed schooling drew a statistically significant (at the .05 level or better) estimated coefficient for every male regression attempted, while no female regression produced a statistically significant coefficient on years of schooling. The estimated male coefficient entered with a positive sign, while the female coefficient entered with a negative sign. Increased education was positively associated with longer survival for men but not for women. (2) *P* values for black race never achieved statistical significance at the .05 level for women or men. (3) Married spouse present consistently drew a positive and statistically significant coefficient on every male multivariate model attempted. It never achieved statistical significance in any of the female multivariate models, however. (4) Being a widow or widower did not achieve statistical significance in any regression or survival model attempted for either men or women. (5) Blood pressure and body mass did not achieve statistical significance in the regressions or survival models considered when the independent variable was derived from the

general arthritis question. They frequently achieved statistical significance in the 80 regressions from Table V.

Discussion

Most of the existing literature[2-9] suggests that RA is a risk factor for early death. Three studies with which we are familiar suggest that OA may have an association with premature death.

This study combines the responses of persons with RA and OA into a single "Yes" or "No" general arthritis question and seven "Yes/No" pain, swelling, and stiffness questions and one "Yes/No" radiographic reading of the knees. No statistically significant correlations were found between answers to the NHANES I general arthritis question and length of survival until the follow-up. No statistically significant correlations were found between answers to the seven pain, swelling, and stiffness questions on the one hand and survival on the other, provided age was included as a covariate. Moreover, signs or coefficients frequently indicated that increased pain, stiffness, and swelling were associated with longer survival. Because it is likely that fewer than 10% of the persons stating "Yes" to the general arthritis question or the seven pain, swelling, or stiffness questions had RA,[24] we conclude that the findings apply to OA.

Our findings pertaining to radiographic readings of women's knees stand in contrast to the findings for men's knees, as well as to women and men for the first eight dependent variables, and to the tenth variable reflecting x-ray readings of hips.

The NHANES I did not have detailed data to allow a large group of persons to be identified with RA as opposed to OA. Whether RA was a risk factor for mortality using the data available in NHANES I could not be tested.

The one prior 1976 study that indicated a modest association between OA and premature death was limited by the small number of covariates: only age was considered as a possible confounding variable. Our findings for women's knees are consistent with the two prior NHEFS studies. The two prior NHEFS studies are

also limited, however, by their lack of adjustment for additional covariates and lack of attention to the general arthritis question and to all of the seven pain, swelling, and stiffness questions.

It is difficult, if not impossible, to prove that a given independent variable is *not* related to the dependent variable. Nevertheless, it is worth emphasizing that the *P* values for the general arthritis variable in Tables III and IV, the seven pain, swelling, and stiffness variables, and the hip radiograph variable in Table V, using the Weibull regressions and in all other regressions attempted, were among the highest of all *P* values for any of the covariates. This evidence suggests that the presence of OA neither lengthens nor shortens life expectancy in the US population at large, which the NHEFS was designed to represent. But the evidence is not uniform. Women who were suspected of having OA of the knee did not live as long as those in whom OA of the knee was not diagnosed. Moreover, evidence in an earlier study[11] suggested that OA of the knee and early mortality were not influenced by treatment effects.

Two additional results emerged from this analysis and warrant comment. Marital status is widely believed to predict mortality. Individuals never married or divorced, and widows and widowers, have been found to have higher mortality rates than married people with spouses present.[28, 29]

The results in Tables II and III suggest two things: (1) only married men with a spouse present live longer than other men, and (2) widows and widowers do not live fewer months than persons in the omitted categories—separated, divorced, and never married. The first result may be explained by the traditional role of husbands and wives in families during the 1970s. While increasing numbers of women were working for pay outside the home, inside the home in most families, women more than men were expected to be nurses and caregivers during the 1970s.[30, 31]

A similar conclusion follows from the interpretation of the association between education and mortality. Evidence from medical investigators, epidemiologists, economists, and sociologists suggests that education is a powerful predictor of mortality.[32-38]

But none of the published studies with which we are familiar conducted separate analyses on women versus men. These results suggest that this distinction may be crucial.

The education-mortality link may be less strong for women than men if (1) education influences health only through encouraging people to adopt healthy habits, and (2) women already have adopted far more healthy habits than men. Mounting evidence suggests that education is correlated with healthy habits[32, 38] and that women are much more likely than men to drink in moderation, fasten seat belts, avoid tobacco and not use guns.[33, 38-40]

In conclusion, no evidence was found for a statistically significant link between answers to the general arthritis question or seven pain, swelling, and stiffness questions, or a variable reflecting OA of the hips based on radiographic readings in the 1971 to 1975 NHANES I, and survival (or mortality), as measured between 1971 to 1984. Because the arthritis questions combine information on RA and OA, and because fewer than 10% of persons suffering from arthritis have RA, it is tempting to conclude that OA is *not* a risk factor for mortality. But results for radiographic readings of women's knees are in contrast to the other results reported here. Before the strong claim that OA does not shorten life expectancy can be made, additional data should be gathered to address the OA of the knee and mortality association. Finally, future national longitudinal data sets should allow investigators to distinguish between RA and OA.

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