

Effect of Arthritis in Middle Age on Older-Age Functioning

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OBJECTIVES: To examine whether symptomatic arthritis in middle age predicts the earlier onset of functional difficulties (difficulty with activities of daily living (ADLs) and walking) that are associated with loss of independence in older persons.

DESIGN: Prospective longitudinal study.

SETTING: The Health and Retirement Study, a nationally representative sample of persons aged 50 to 62 at baseline who were followed for 10 years.

PARTICIPANTS: Seven thousand five hundred forty-three subjects with no difficulty in mobility or ADL function at baseline.

MEASUREMENTS: Arthritis was measured at baseline according to self-report. The primary outcome was time to persistent difficulty in one of five ADLs or mobility (walking several blocks or up a flight of stairs). Difficulty with ADLs or mobility was assessed according to subject interview every 2 years. Analyses were adjusted for other comorbid conditions, body mass index, exercise, and demographic characteristics.

RESULTS: Twenty-nine percent of subjects reported arthritis at baseline. Subjects with arthritis were more likely to develop persistent difficulty in mobility or ADL function over 10 years of follow-up (34% vs 18%, adjusted hazard ratio (HR) = 1.63, 95% confidence interval (CI) = 1.43–1.86). When each component of the primary outcome was assessed separately, arthritis was also associated with persistent difficulty in mobility (30% vs 16%, adjusted HR = 1.55, 95% CI = 1.41–1.71) and persistent difficulty in ADL function (13% vs 5%, adjusted HR = 1.85, 95% CI = 1.58–2.16).

CONCLUSION: Middle-aged persons who report a history of arthritis are more likely to develop mobility and ADL

difficulties as they enter old age. This finding highlights the need to develop interventions and treatments that take a life-course approach to preventing the disabling effect of arthritis. *J Am Geriatr Soc* 56:23–28, 2008.

Key words: arthritis; ADL; mobility

Loss of the ability to perform basic functional tasks such as activities of daily living (ADLs) or walk short distances increases markedly with age.^{1–10} When elderly people lose their independence in these tasks, they lose the ability to live alone and must be dependent on caregivers or live in a long-term care setting. Although loss of independence in these tasks is common in old age and rare in middle age, life-course views of disability and successful aging are increasingly recognizing that the antecedents of late-life disability may occur earlier in life.^{11,12}

It is widely agreed that arthritis is an important contributor to disability in elderly people. Evidence for this comes from cross-sectional studies that demonstrate that elderly people with arthritis are much more likely to have limitations in mobility and ADLs.^{13–17} Also, several longitudinal studies, most of short duration, show that elderly people with arthritis are more likely to develop new disabilities.^{18–21} However, arthritis complaints frequently develop in mid-life, long before the disabilities of late life present. Although it has been demonstrated that middle-aged persons with arthritis are more likely to experience work disability, it is not known whether those with arthritis complaints in mid-life are at higher risk for developing the types of task difficulties that are most likely to lead to loss of independence in older populations.^{22–25} Because the effects of arthritis are generally insidious, there is strong theoretical support for the hypothesis that arthritis in mid-life may lead to late-life disability, although few studies have had sufficiently long follow-up to test this hypothesis.

To test whether arthritis in mid-life leads to earlier onset of late-life disabilities, a study was conducted using subjects enrolled in the Health and Retirement Study (HRS). The HRS is an ideal cohort in which to address this question, because it enrolled subjects between the ages of 50 and 62, an age range in which arthritis is common but

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before the disabilities of old age become common. Over 10 years of subsequent follow-up, the relationship between arthritis and incident difficulty in activities important for independent functioning in older people was determined.⁸

METHODS

Subjects

Subjects enrolled in 1992 in the first wave of the HRS²⁶ were used. The HRS is a nationally representative study of community-living adults born between 1931 and 1941 (aged 50–62 at enrollment). The HRS interviewed subjects every 2 years with the goal of examining changes in wealth and health as people transitioned from work to retirement and into old age.

Nine thousand seven hundred fifty subjects were enrolled in the 1992 wave of HRS. Because the current study was examining the development of incident functional difficulties, subjects who already had reported difficulty with ADLs or walking ($n = 1,846$) were excluded. This excluded subjects who at baseline already met criteria for one of the functional difficulty outcome measures. Fifty-three subjects who had died by the next wave (1994) were also excluded. Therefore 7,851 subjects were eligible for the analytical cohort. Of these, 308 (4%) were excluded, because they did not have follow-up data on functional outcomes, leaving a final sample size of 7,543 subjects.

Measures

Symptomatic Arthritis

To identify subjects with a history of arthritis, subjects were asked, “Have you ever had, or has a doctor ever told you that you have, arthritis or rheumatism?” To limit the definition of arthritis to those currently having symptoms, subjects were classified as having symptomatic arthritis only if they reported that they sometimes had pain or stiffness or swelling in their joints, were currently taking medications or other treatments for their arthritis or rheumatism, or had seen a doctor for their arthritis or rheumatism in the previous 12 months. Ninety percent of subjects who reported a history of arthritis met at least one of these criteria for current symptoms.

The self-report measure of arthritis may or may not correspond to the diagnostic criteria for rheumatological conditions such as osteoarthritis. Instead, the measure is consistent with the approach generally followed in public health surveys, in which the goal is to measure the frequency of symptomatic conditions severe enough for the person to see a physician or have a complaint. The construct validity of the measure of arthritis has been validated in surveys that show relationships between this measure and lost time from work, health costs, and bed-days.^{16,22–24,27–31}

Mobility/ADL Difficulty

The outcome measure was persistent difficulty with basic mobility and ADL tasks. These two domains of functioning were chosen, because difficulty with these tasks is widely viewed as a threat to the independence of older persons. Subjects were classified as having a mobility difficulty if they reported difficulty walking several blocks or climbing one flight of stairs. Subjects were classified as having difficulty with ADLs if they reported difficulty with bathing,

dressing, transferring from a bed to a chair or out of a chair, using a toilet, or eating. The primary outcome was persistent difficulty with mobility or an ADL. Because these functional difficulties are often transient, subjects were classified as having a persistent difficulty only if they reported the difficulty on two consecutive waves. Subjects who had difficulty on one wave and died before the next wave were also classified as having a persistent difficulty.³²

Other Measures

Demographic characteristics such as age, race, and education level were measured according to self-report. Other chronic conditions such as hypertension and diabetes mellitus were measured by asking the subject whether a doctor had ever told them they had the condition. Depressive symptoms were measured using the Center for Epidemiologic Studies Depression scale.³³ Subjects were classified as engaging in frequent physical activity if they reported engaging in light physical activity or vigorous exercise three or more times per week. Subjects were also asked whether they had difficulty with several higher-level measures of functioning, including the ability to jog a mile or climb several flights of stairs.

Analysis

The analyses used the sampling and design weights provided by the HRS to account for the probability of selection and clustering in HRS sample selection.

Kaplan–Meier curves were constructed to compare the time to persistent difficulty with mobility or ADL function in subjects with and without arthritis at baseline. Although subjects were not classified as having persistent difficulty unless they reported difficulty on two consecutive waves, mobility or ADL difficulty was classified as having occurred in the wave in which it was first reported. Subjects who died without previously reporting difficulty were censored on the last wave in which they were interviewed. Subjects who were lost to follow-up before the final interview (2002) were also censored as of the last wave in which they were interviewed. One thousand eighty-nine (14%) subjects were censored before 2002.

Proportional hazards survival analysis was used to calculate the unadjusted and adjusted hazard ratios for the association between arthritis and subsequent mobility or ADL difficulty. Plots of Schoenfeld residuals against time suggested good model fit. Results were similar when the analyses were repeated using modeling approaches that accounted for follow-up occurring at discrete time intervals. To determine the independent association between arthritis and mobility or ADL difficulty, age; sex; race; whether the subject was employed at least 20 hours a week; income; net worth; the presence of hypertension, diabetes mellitus, chronic lung disease, history of myocardial infarction (MI), congestive heart failure (CHF), and stroke; body mass index (BMI; 4 categories); current smoking; depression; significant physical activity; difficulty jogging 1 mile; and difficulty climbing several flights of stairs were adjusted for. These analyses were repeated for each component (mobility difficulty and ADL difficulty) of the outcome. To determine whether the development of new comorbid conditions in subjects with arthritis accounted for the relationship between arthritis and functional difficulties, the analysis was

Table 1. Baseline Characteristics of Study Subjects with and without Arthritis at Baseline

Characteristic	No Arthritis (n = 5,341)	Arthritis (n = 2,202)	P-Value
Demographics			
Age, mean \pm standard deviation	55.8 \pm 3.2	56.3 \pm 3.2	<.001*
Age, %			
50–55	50	42	<.001 [†]
56–61	50	58	
Female, %	47	61	<.001 [†]
Race, %			
White	83	84	.16 [†]
Black	9	9	
Hispanic	6	5	
Other	2	2	
Socioeconomic status measure			
<12 years education, %	20	24	.001 [†]
Employed at least 20 h/wk, %	75	69	<.001 [†]
Income, \$, median (IQR)	44,000 (25,000–69,000)	39,000 (23,000–61,000)	<.001* [‡]
Net worth, \$, median (IQR)	131,000 (52,000–278,000)	111,000 (40,000–246,000)	.003* [‡]
Comorbid conditions, %			
Hypertension	32	40	<.001 [†]
Diabetes mellitus	6	8	<.001 [†]
Cancer	4	6	<.001 [†]
Chronic lung disease	4	9	<.001 [†]
Myocardial infarction, %	4	4	.12 [†]
Congestive heart failure, %	1	1	.62 [†]
Stroke, %	1	1	.14 [†]
Obesity, %	17	23	<.001 [†]
Current smoker, %	25	25	.69 [†]
Depression (Center for Epidemiologic Studies Depression Scale score \geq 9), %	10	16	<.001 [†]
Body mass index			
<25.0	41	35	
25.0–29.9	42	42	<.001 [†]
30.0–34.9	14	17	
\geq 35.0	3	6	
Exercise, %			
3 times/wk	60	58	.16 [†]
Mobility difficulties			
Jog 1 mile	58	72	<.001 [†]
Climb several flights of stairs	11	21	<.001 [†]

P-value according to

* chi-square test for categorical variables and

[†] *t*-test for continuous variables.

[‡] Based on log-transformed values for those with positive income and net worth.

IQR = interquartile range.

repeated including time-dependent terms for the comorbid conditions. These results were not significantly different from the primary results. Finally, to compare the effect of arthritis with that of other chronic conditions, subjects were classified into four mutually exclusive categories: those with arthritis but no other chronic condition (hypertension, diabetes mellitus, cancer, chronic lung disease, MI, CHF, stroke, or obesity), those without arthritis but with at least one of the other chronic conditions, those with arthritis and one of the other chronic conditions, and those with neither arthritis nor one of the other chronic conditions. The time to development of mobility or ADL difficulty of

these groups was compared in bivariate and multivariate analyses.

RESULTS

Characteristics of Subjects with and without Arthritis

At baseline, 29% of subjects reported arthritis (Table 1). Subjects with arthritis were slightly older and more likely to be female; had lower socioeconomic status and higher BMI; and were more likely to have hypertension, diabetes mellitus, cancer, lung disease, and depressive symptoms (Table 1).

Table 2. Relationship Between Arthritis and the Development of Mobility and Activity of Daily Living (ADL) Difficulty

Outcome	Group	Outcome Rate, %	Hazard Ratio (95% Confidence Interval)	
			Unadjusted	Adjusted*
Mobility or ADL difficulty	No significant arthritis (n = 5,341)	18	1.00	1.00
	Significant arthritis (n = 2,202)	34	2.15 (1.89–2.44)	1.63 (1.43–1.86)
Mobility difficulty	No significant arthritis (n = 5,341)	16	1.00	1.00
	Significant arthritis (n = 2,202)	30	2.09 (1.83–2.40)	1.55 (1.41–1.71)
ADL difficulty	No significant arthritis (n = 5,341)	5	1.00	1.00
	Significant arthritis (n = 2,202)	13	2.61 (2.20–3.09)	1.85 (1.58–2.16)

* Adjusted for age, sex, race, education <12 years, employed <20 h/wk, income, net worth, body mass index, hypertension, diabetes mellitus, cancer, chronic lung disease, myocardial infarction, congestive heart failure, stroke, obesity, current smoker, Center for Epidemiologic Studies Depression Scale score ≥ 9 , exercise ≥ 3 times per week, difficulty jogging 1 mile, difficulty climbing one flight of stairs.

Relationship Between Arthritis and Functional Difficulties

Subjects with arthritis were more likely to reach the primary outcome measure of persistent difficulty with mobility or difficulty with ADL function (Table 2, Figure 1) (34% vs 18%, HR = 2.15, 95% CI = 1.89–2.44). As seen in the parallel Kaplan–Meier curves, the risk was relatively constant throughout the 10 years of follow-up. After adjusting for age, sex, measures of socioeconomic status, comorbid conditions, BMI, smoking, depression, physical activity, difficulty jogging 1 mile, and difficulty climbing several flights of stairs, the risk was attenuated but still substantial (HR = 1.63, 95% CI = 1.43–1.86).

Of those reaching the primary endpoint of persistent mobility difficulty or persistent ADL difficulty, 65% had mobility difficulty without ADL difficulty, 10% had ADL difficulty without mobility difficulty, and 25% had both mobility and ADL difficulty. Arthritis was also associated with persistent ADL difficulty (13% vs 5%, adjusted HR = 1.85, 95% CI = 1.58–2.16) and persistent mobility difficulty (30% vs 16%, adjusted HR = 1.55, 95% CI = 1.41–1.71) when each of these components of the primary outcome was examined separately.

The effect of arthritis on the development of functional difficulty (mobility or ADL difficulty) was also compared with the effect of other chronic conditions (Table 3). Thirty-

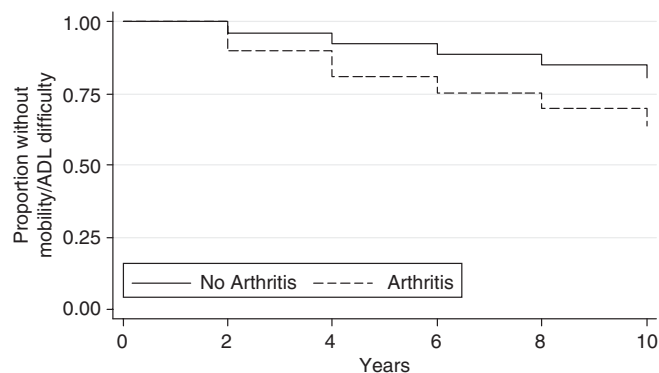


Figure 1. Time to difficulty with activities of daily living (ADLs) or mobility (difficulty walking several blocks or up a flight of stairs) in subjects with and without arthritis.

five percent of subjects had neither arthritis nor another chronic condition (hypertension, diabetes mellitus, cancer, chronic lung disease, MI, CHF, stroke, or obesity), 11% had arthritis without any other chronic condition, 36% had one of the chronic conditions without arthritis, and 18% had arthritis and one of the other chronic conditions. Subjects with arthritis without another chronic condition (adjusted HR = 1.91, 95% CI = 1.59–2.44) and subjects with another chronic condition but without arthritis (adjusted HR = 1.74, 95% CI = 1.46–2.08) were at greater risk for developing mobility or ADL difficulty than subjects with neither arthritis nor a chronic condition. Subjects with both arthritis and another chronic condition were at markedly greater risk for developing mobility or ADL difficulty (adjusted HR = 2.79, 95% CI = 2.31–3.38).

DISCUSSION

Loss of the ability to perform ADLs and mobility functions often leads to the loss of an older person's ability to live independently.⁶ It was found that, in middle-aged subjects with arthritis, persistent difficulty in these tasks was substantially more likely to develop over 10 years of follow-up. The association between arthritis and functional difficulties was not explained after adjustment for other chronic conditions and other measures of baseline functioning. The majority of elderly people who lose the ability to independently perform ADL and mobility tasks first report difficulty with these tasks.⁸ Therefore, the results suggest that middle-aged people with symptomatic arthritis are at substantially higher risk for developing the common disabilities of later life at earlier ages and losing their independence at earlier ages.

Older people who become disabled generally follow one of two pathways.^{34,35} In the first pathway, generally referred to as the catastrophic pathway, disability develops suddenly. The most common causes of catastrophic disability are stroke and hip fracture. The second pathway, often referred to as the insidious pathway, is more common in elderly people. Elderly people who follow this pathway slowly accumulate functional deficits that, over time, become severe enough to result in the loss of independence. Generally, elderly people will first report difficulty in higher-level functional tasks such as walking long distances or doing heavy housework. This progresses to difficulty with

Table 3. Effect of Arthritis Compared with That of Other Chronic Conditions on the Development of Mobility or Activity of Daily Living (ADL) Difficulty

Group	Mobility/ADL Difficulty, %	Hazard Ratio (95% Confidence Interval)	
		Unadjusted	Adjusted
No arthritis or other chronic condition (n = 2,658) [†]	11	1.00	1.00
Arthritis, no other chronic condition (n = 853)	23	2.10 (1.66–2.66)	1.91 (1.59–2.44)
No arthritis, at least one other chronic condition present (n = 2,683)	24	2.30 (2.00–2.66)	1.74 (1.46–2.08)
Both arthritis and at least one other chronic condition (n = 1,349)	43	4.76 (4.14–5.46)	2.79 (2.31–3.38)

*Adjusted for age, sex, race, education <12 years, employed <20 h/wk, income, net worth, body mass index, exercise ≥ 3 times per week, difficulty jogging 1 mile, difficulty climbing one flight of stairs.

[†]Other chronic conditions were hypertension, diabetes mellitus, cancer, chronic lung disease, myocardial infarction, congestive heart failure, stroke, and obesity.

more-basic functional tasks such as ALDs or walking short distances. Finally, the elderly person will lose the ability to perform these basic tasks without assistance and will become dependent on others.

Insidious disability, like most geriatric syndromes, is usually the result of multiple impairments that weaken the reserve capacity of an elderly person and lessen the ability to respond to stressors.³⁶ In elderly people, arthritis, particularly osteoarthritis, is seldom the sole explanation for disability, but because it directly impairs the upper and lower extremity functions necessary for integrative tasks such as ADLs and mobility, it is not surprising that it is a frequent contributor to disability and an accelerator of its progression. Because arthritis is so common, even a modest effect on disability progression may have great public health effect.

Prior research has documented that arthritis is associated with disability in elderly people.^{13–17} In addition, short-term studies have demonstrated that older persons with arthritis are more likely to become disabled over a course of several years,^{18–21} although few studies have followed middle-aged subjects for long periods of time to examine whether they are at higher risk for developing the functional difficulties that lead to loss of independence in old age. Because of the decade-long follow-up of the current study, the results add to prior research by suggesting that arthritis significantly accelerates the development of the mobility and ADL difficulties that most commonly lead to loss of independence in elderly people.

In addition to the long follow-up, an important strength of this study was the ability to adjust for other determinants of disability such as other chronic conditions and baseline functional impairment. This decreases the likelihood that confounding factors explain the association between arthritis and later mobility and ADL difficulty, although several factors should be considered in interpreting the results.

First, the measure of arthritis was self-report of symptomatic arthritis. This measure is designed to capture the public health effect of symptomatic conditions bothersome enough to subjects to report symptoms to a physician or seek treatment. However, the self-report of arthritis does not necessarily correspond to the diagnostic criteria for rheumatological conditions. Although osteoarthritis is likely the most common etiology, given its high prevalence, the differential diagnosis of arthritis is quite broad. For exam-

ple, other causes of arthritis include rheumatoid arthritis, gout, podiatric conditions, and nonspecific musculoskeletal conditions. These conditions may be highly variable in terms of their effect on functional difficulties, as well as the extent to which they can be remediated. Second, the measure of arthritis did not account for the severity of arthritis, and the effect of arthritis on task difficulty almost certainly varies with its severity. It is possible that this association is not linear and that there is a threshold at which more-severe arthritis results in functional difficulties. Third, it is likely that physical activity modulates the association between arthritis and functional difficulty. The measure of physical activity was probably not sensitive enough to test this hypothesis adequately. Finally, the outcome measure was persistent difficulty in mobility or ADLs rather than the need for assistance in these tasks, the traditional marker of loss of independent functioning in elderly people. As a result, an association between midlife arthritis and loss of independent functioning in later life has not been fully established, although the results make it highly likely that such an association exists. In noncatastrophic disability, difficulty in ADL and mobility function generally precedes dependence. Based on known trajectories of functioning in elderly people, it is unlikely that high rates of difficulty in functioning do not lead to high rates of dependence and loss of independence.⁸

In conclusion, it was found that middle-aged persons with arthritis were at higher risk for developing mobility and ADL difficulties that lead to loss of independence in late life. This finding highlights the need for efforts to develop treatments and interventions that prevent the disabling effect of arthritis.

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Dr. Gill serves on a Scientific Advisory Board for Daiichi-Asubio Pharmaceuticals, Inc.

Author Contributions:

Covinsky: study concept and design; acquisition of data; analysis and interpretation of data; preparation of manuscript. Lindquist: acquisition of data; analysis and interpretation of data; preparation of manuscript. Dunlop and Yelin: study concept and design; analysis and interpretation of data; preparation of manuscript. Gill: analysis and interpretation of data; preparation of manuscript.

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