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Original Contribution

Age at Retirement and Mortality in a General Population Sample

The Greek EPIC Study

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Investigation of the health effects of retirement and age at retirement is limited, but the issue is particularly important given the pressure for an increase in the retirement age in Europe. In the Greek segment of the European Investigation into Cancer and Nutrition study, 16,827 men and women enrolled from 1994 to 1999 were either gainfully employed or had retired from such employment at enrollment; had not previously been diagnosed with stroke, cancer, coronary heart disease, or diabetes mellitus; and had complete information on important covariates and documented survival status as of July 2006. All-cause and cause-specific mortality in relation to employment status and age at retirement (among retirees) was analyzed through Cox regression models, controlling for potential confounders. In comparison to subjects still employed, retirees had a 51% increase in all-cause mortality (95% confidence interval: 16, 98). Among retirees, a 5-year increase in age at retirement was associated with a 10% decrease in mortality (95% confidence interval: 4, 15). Findings were more evident for cardiovascular than for cancer mortality, whereas, for injury mortality, there was no evidence of association. Results indicate that early retirement may be a risk factor for all-cause and cardiovascular mortality in apparently healthy persons.

cohort studies; retirement; survival

Abbreviation: EPIC, European Prospective Investigation into Cancer and Nutrition.

Retirement and age at retirement have been the object of many discussions over the years. The increase in the population of aging people in developed countries has motivated national governments and supranational bodies such as the European Union to develop policies for encouraging the labor force participation of older workers and eliminating mandatory retirement (1). There is also pressure for an increase in age at retirement because the pension system is threatened, particularly in countries such as Greece, where the reproduction rates are low (2). In light of these promoted new policies, clarifying the health consequences of such contemplated changes becomes very important.

There is a perception that early retirement is associated with better quality of life and perhaps even with increased survival, as quoted by Tsai et al. in 2005 (3). However, a gain in life expectancy for people who retire earlier compared with those who retire later has not being established. In fact, the few studies that have investigated the impact of retirement on survival have indicated that early retirement may be associated with increased mortality (3–8). These authors mainly attributed the survival differential to poor health associated with early retirement, although, in the seminal study by Morris et al. (6), health status at baseline was accounted for. Moreover, with the exception of the study

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by Morris et al., these studies have generally relied on specific occupational cohorts. Lastly, earlier studies used different contrasts (early compared with normal or late retirees, early retirees compared with those still employed) and used variable definitions of early retirement (different cutoff values of age at retirement), whereas information about health status of the study population at age at retirement was generally limited.

The purpose of this study was to determine whether early retirement is a risk factor for all-cause and cause-specific mortality in apparently healthy retirees.

MATERIALS AND METHODS

The European Prospective Investigation into Cancer and Nutrition study

The study population consisted of the participants in the Greek component of the European Prospective Investigation into Cancer and Nutrition (EPIC) study. EPIC is a prospective cohort study conducted in 23 research centers across 10 European countries. Participants were recruited on the basis of practical and logistic considerations to obtain high participation rates and long-term follow-up (9). The aim of EPIC is to elucidate the role that biologic, dietary, lifestyle, and environmental factors play in the etiology of cancer, but individual centers can undertake analyses with a different focus (9–11).

In Greece, a total of 28,572 (men and women) apparently healthy volunteers aged 20–86 years were recruited from all regions of the country during 1994–1999. All procedures were in line with the Helsinki declaration for human rights, all volunteers signed informed consent forms, and the study protocol was approved by ethical committees at the International Agency for Research on Cancer and at the University of Athens Medical School.

At enrollment, a dietary and a lifestyle questionnaire were administered to each participant by specially trained interviewers. Anthropometry measurements were also undertaken.

Data on retirement

Information on employment status and, for those not employed at enrollment, on the last year of gainful employment was recorded in the lifestyle questionnaire. Subjects were categorized as home workers, retirees, unemployed, students, and combination or ill defined (‘‘other’’). Duration of retirement (in years) was calculated as the difference between the year of enrollment and the last year of gainful employment.

Lifestyle, anthropometric, dietary, and medical history data

The frequency and duration of participation in occupational and leisure-time physical activities were recorded for each participant (12), and a metabolic equivalent task index was computed by assigning a multiple of resting metabolic rate to each activity (13). Time spent on each activity was multiplied by the metabolic equivalent task value of the activity, and all metabolic equivalent task–hour products were summed to produce an estimate of daily physical activity, indicating the amount of energy per kilogram of body weight expended during an average day.

Information on smoking status was collected through a smoking history questionnaire. Subjects were categorized as never, current, and former smokers as of the date of enrollment. For current and former smokers, the average number of cigarettes smoked per day was recorded (14).

Anthropometric measurements were obtained by using standardized procedures (15). Body mass index was derived as the ratio of weight in kilograms divided by the square of height in meters. Waist-to-hip ratio was also calculated.

Usual dietary intake over the year preceding enrollment was assessed by a validated, semiquantitative food frequency questionnaire (16). For each participant, grams per day of intake of various food groups and ethanol, as well as total energy intake (in kilojoules), were calculated.

Participants were also asked whether they had ever had a medical diagnosis (made by a physician) of diseases such as stroke, cancer, myocardial infarction, angina pectoris, and diabetes mellitus.

Study participants and follow-up

The 28,572 Greek EPIC participants were actively followed up until July 2006. We excluded 4,289 subjects who reported at enrollment a previous medical diagnosis of stroke, cancer, coronary heart disease (myocardial infarction or angina), or diabetes mellitus and the few who did not complete the relevant part of the questionnaire. For an additional 1,180 participants who lived in remote areas of Greece, did not respond, or were not traced during follow-up, vital status had not been ascertained as of July 2006. Of the remaining 23,103 study participants, 5,544 indicated that they were working at home (mostly women), whereas 261 were students, unemployed, or ‘‘other.’’ These persons were also excluded from further analyses since they could not be classified as ‘‘still employed’’ or as ‘‘having retired’’ at enrollment. Also excluded were 277 retirees who provided conflicting statements as to the last year of gainful employment and 194 study participants for whom values for one or more of possible confounding variables were missing. Thus, the final sample used for the analysis reported in this paper consisted of 16,827 study participants who had been gainfully employed at a certain stage of their lives and who, at enrollment, were either employed or had retired; who had not previously been diagnosed as having stroke, cancer, coronary heart disease, or diabetes mellitus; for whom vital status at follow-up had been ascertained; and for whom all the required information was available.

The median duration of follow-up for the 16,827 study participants was 7.7 years, with a range of 10 days (a participant who died soon after enrollment) to 12.5 years. Date and cause of death were obtained from death certificates and other official sources, and trained physicians coded the cause of death according to the *International Statistical Classification of Diseases and Related Health Problems,* Tenth Revision (17). We investigated mortality from all causes, from diseases of the circulatory system (codes I 00–I 99 and R 96, R 98), from cancer (codes C 00–D 48), from injuries and external causes (codes S 00–T 98), from respiratory (codes J 44.8, J 44.9, J 84.1, J 96.9, J 98.9) or renal (codes N 18.0, N 18.9) failure, from liver diseases (codes K 70.3, K 72.0, K 72.9, K 73.9, K 74.1, K 74.6), and from all other causes or from poorly identified underlying causes of death.

Statistical analysis

All analyses were performed by using STATA statistical software (18). Statistical significance was inferred at two-sided $p < 0.05$. In this paper, descriptive information is presented through cross-tabulations. For retirees, age at last gainful employment and duration of retirement as of the date of enrollment are presented as means and standard deviations.

All-cause and cause-specific mortality in relation to employment status (retired vs. still working at enrollment) was analyzed with proportional hazards (Cox) regression models. In these models, the time variable was the interval between the date of enrollment and the date of last active follow-up or date of death, whichever occurred first. Subjects who were alive as of the date of last follow-up (in analyses of all-cause mortality) or had not died from the studied cause of death (in analyses of cause-specific mortality) or were lost to follow-up were considered censored as of the date of last contact. The proportionality assumption was checked with the log-log plots.

In the survival analyses, the impact of having retired on the hazard of death was assessed through two variables: one indicator variable denoting whether a subject was a retiree when enrolled in the study (1 = retiree, 0 = no retiree) and one continuous variable denoting the age at retirement among retirees, in the way that this information was recorded at the date of enrollment (19). The former variable was included in Cox regression models of all subjects (retirees and those still employed at enrollment) and denotes the effect on the hazard of death of being a retiree compared with still being employed at enrollment. The latter variable was used to evaluate the effect of age at retirement among retirees in Cox regression models of retirees only.

In all analyses, we controlled for age at enrollment (<45, 45–54, 55–64, ≥65 years; categorically except when assessing age at retirement, where continuously), thus minimizing the possibility of a generation effect. In addition, we also adjusted for education (none/elementary school degree, secondary school or technical school degree, university degree or higher; categorically), smoking status (never, former, and 1–10 cigarettes per day, 11–20 cigarettes per day, 21–30 cigarettes per day, 31–40 cigarettes per day, ≥41 cigarettes per day; ordered), metabolic equivalent task score (quintiles; ordered), total energy intake (quintiles; ordered) and ethanol intake (<10 g/day for men and <5 g/day for women, 10–50 g/day for men and 5–25 g/day for women, >50 g/day for men and >25 g/day for women; categorically), waist-to-hip ratio (quintiles; ordered), and body mass index (quintiles; ordered) (both anthropometric variables were considered because they express different aspects of overweight). All analyses were stratified by gender.

RESULTS

All study participants were Caucasian. There were 12,953 subjects (7,119 men and 5,834 women) who were employed and 3,874 subjects (1,819 men and 2,055 women) who had already retired at the time of enrollment in the EPIC study. Their distribution by gender, age at enrollment, and baseline sociodemographic, anthropometric, and lifestyle characteristics is shown in table 1. The distributions serve only descriptive purposes (because confounding was not accounted for), but they still indicate the prevalence of important risk factors for mortality among employed and retired subjects in the Greek EPIC cohort. As expected, the proportion of retirees increased dramatically with increasing age, with the vast majority of retired men and women being age 65 years or older at enrollment. For these older subjects, the distributions were generally similar among retirees and employed subjects except for physical activity and ethanol intake, retired participants being less active and consuming less alcohol than their still-employed counterparts. Lower educational levels were evident among men who retired early (younger than age 55 years), whereas the opposite was true among women who retired early.

For study participants who were retired at enrollment, table 2 shows the mean (standard deviation) age at retirement, as well as duration of retirement until enrollment, by age and gender. Among retirees, the mean duration of retirement by the time of enrollment in the EPIC study was 8.17 years for both men and women. Mean age at retirement was 59.37 years for men and 56.79 years for women.

Deaths, by cause, of participants still employed and retired at enrollment are shown in table 3. Overall, 404 deaths occurred among the 3,874 retirees and 215 deaths among the 12,953 subjects still employed at enrollment. These data are suggestive rather than directly interpretable since confounding and time-to-event aspects were not accounted for. Nevertheless, as expected, the proportion of death was higher among older individuals and higher among men than among women. The proportion of deceased men and women appeared to be higher among retirees than among participants still employed at enrollment. This pattern applied to all-cause and cause-specific mortality, with the exception of mortality from injuries and external causes.

Table 4 shows all-cause and cause-specific mortality ratios associated with retirement and with age at retirement. In comparison to subjects still employed, those who had already retired at enrollment had a 51 percent increase in all-cause mortality (two-sided $p = 0.002$, likelihood ratio test, fully adjusted model). Among retirees, an increase by 5 years in the age at retirement was associated with a 10 percent decrease in mortality (two-sided $p = 0.003$, likelihood ratio test). The mortality ratios of 1.51 and 0.90 are not directly comparable because they refer to different groups, but they complement each other in that the former indicates the increase, on average, in mortality among retirees relative to subjects with similar characteristics but still employed,

TABLE 1. Distribution of 12,953 employed and 3,874 retired healthy* subjects by age, gender, and socioeconomic, anthropometric, and lifestyle variables, the Greek European Prospective Investigation into Cancer and Nutrition cohort study, 1994–2006

	Age at enrollment (years)											
	Men						Women					
	<55		55–64		≥65		<55		55–64		≥65	
	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired
Education												
None/elementary school degree (no.)	1,391	23	967	264	216	1,232	1,413	38	755	251	157	1,240
%	25.4	42.6	69.6	66.8	85.7	89.9	30.0	14.7	78.6	52.1	94.6	94.4
Secondary school or technical school degree (no.)	2,389	23	238	88	18	105	1,542	125	100	133	6	52
%	43.6	42.6	17.1	22.3	7.1	7.7	32.8	48.2	10.4	27.6	3.6	4.0
University degree or higher (no.)	1,698	8	184	43	18	33	1,752	96	106	98	3	22
%	31.0	14.8	13.3	10.9	7.1	2.4	37.2	37.1	11.0	20.3	1.8	1.7
Smoking status												
Current smoker (no.)	2,731	17	473	117	64	307	1,564	59	58	48	3	30
%	49.9	31.5	34.1	29.6	25.4	22.4	33.2	22.8	6.0	10.0	1.8	2.3
Former smoker (no.)	1,404	19	481	147	96	618	592	43	48	40	4	38
%	25.6	35.2	34.6	37.2	38.1	45.1	12.6	16.6	5.0	8.3	2.4	2.9
Never smoker (no.)	1,343	18	435	131	92	445	2,551	157	855	394	159	1,246
%	24.5	33.3	31.3	33.2	36.5	32.5	54.2	60.6	89.0	81.7	95.8	94.8
Body mass index†												
≤25 (no.)	1,116	13	223	78	60	303	1,921	96	163	95	31	150
%	20.4	24.1	16.1	19.8	23.8	22.1	40.8	37.1	17.0	19.7	18.7	11.4
>25–<30 (no.)	3,000	28	731	198	113	643	1,689	103	364	218	63	478
%	54.8	51.9	52.6	50.1	44.8	46.9	35.9	39.8	37.9	45.2	37.9	36.4
≥30 (no.)	1,362	13	435	119	79	424	1,097	60	434	169	72	686
%	24.9	24.1	31.3	30.1	31.4	31.0	23.3	23.2	45.2	35.1	43.4	52.2

Table continues

whereas the latter evaluates the actual reduction in mortality gained with an extra 5 years in age at retirement. Exclusion of deaths that occurred during the first 2 years of follow-up had little effect on the point estimate of the mortality ratio associated with being a retiree (1.46, 95 percent confidence interval: 1.09, 1.94; data not shown) and on the mortality ratio associated with a 5-year increase in age at retirement (0.93, 95 percent confidence interval: 0.86, 0.99; data not shown). In an analysis limited to study participants who, at enrollment, were age 55 years or older, the mortality ratio associated with retirement was 1.34 (95 percent confidence interval: 1.01, 1.78; data not shown), whereas the mortality ratio associated with being 5 years older at retirement was 0.91 (95 percent confidence interval: 0.85, 0.97; data not shown).

Because we had no information as to whether retirement was mandatory or voluntary, we assumed that retirement at the age of 65 years or older was indicative of being mandatory, whereas retirement before the age of 65 years was indicative of being voluntary (65 is the standard age at retirement in Greece), and we repeated the analyses for people who retired before the age of 65 years and for those who retired at 65 years of age or older. We found no evidence for effect modification (two-sided $p = 0.65$, likelihood ratio test). We also used as a cutoff the age of 60 years (around the mean age at retirement in our study), but again we found no evidence of effect modification (two-sided $p = 0.38$, likelihood ratio test).

In cause-specific mortality analyses, patterns were similar to those for overall mortality, for mortality from diseases of the circulatory system, and for cancer mortality, although not significant in the latter case. With respect to mortality from diseases with a frequently prolonged clinical course (respiratory and renal failure, liver diseases), the association with retirement status was more striking, the mortality ratio being 6.43 (two-sided $p = 0.006$, likelihood ratio test), but the number of deaths from these causes was small. Results concerning mortality ratios from accidents and external causes were imprecise because there were relatively few deaths in this category, but there was no indication that

TABLE 1. Continued

	Age at enrollment (years)											
	Men						Women					
	<55		55–64		≥65		<55		55–64		≥65	
	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired
Waist-to-hip ratio												
≤0.90 (no.)	1,526	13	158	55	28	187	4,449	241	749	413	130	951
%	27.9	24.1	11.4	13.9	11.1	13.7	94.5	93.1	77.9	85.7	78.3	72.4
>0.90–<0.95 (no.)	1,712	15	340	101	67	328	157	14	137	34	18	221
%	31.3	27.8	24.5	25.6	26.6	23.9	3.3	5.4	14.3	7.1	10.8	16.8
≥0.95 (no.)	2,240	26	891	239	157	855	101	4	75	35	18	142
%	40.9	48.2	64.2	60.5	62.3	62.4	2.2	1.5	7.8	7.3	10.8	10.8
Physical activity (MET‡-hours/day)												
<35.14 (no.)	2,697	43	524	331	85	1,176	1,768	122	207	306	46	1,092
%	49.2	79.6	37.7	83.8	33.7	85.8	37.6	47.1	21.5	63.5	27.7	83.1
≥35.14 (no.)	2,781	11	865	64	167	194	2,939	137	754	176	120	222
%	50.8	20.4	62.3	16.2	66.3	14.2	62.4	52.9	78.5	36.5	72.3	16.9
Ethanol intake (g/day)§												
Low (no.)	2,494	27	617	195	92	782	3,455	192	743	399	124	1,114
%	45.5	50.0	44.4	49.4	36.5	57.1	73.4	74.1	77.3	82.8	74.7	84.8
Medium (no.)	2,490	22	634	176	123	533	1,140	62	202	78	38	190
%	45.5	40.7	45.6	44.6	48.8	38.9	24.2	23.9	21.0	16.2	22.9	14.5
High (no.)	494	5	138	24	37	55	112	5	16	5	4	10
%	9.0	9.3	9.9	6.1	14.7	4.0	2.4	1.9	1.7	1.0	2.4	0.8
Total no.	5,478	54	1,389	395	252	1,370	4,707	259	961	482	166	1,314

* Without a previous diagnosis of stroke, cancer, coronary heart disease, or diabetes mellitus.

† Weight (kg)/height (m)^2.

‡ MET, metabolic equivalent task.

§ Low: <5 g/day for women, <10 g/day for men; medium: 5–25 g/day for women, 10–50 g/day for men; high: >25 g/day for women, >50 g/day for men.

retirement status is an important predictor of this cause-specific mortality.

DISCUSSION

In a general-population, prospective study of men and women who were apparently healthy at enrollment, we found evidence that early retirement is associated with increased mortality. The evidence was consistent in comparisons of persons who, at enrollment, were retirees versus still employed and in comparisons among retirees of variable ages at retirement. With respect to the most common causes of death (circulatory, cancer, injuries), the excess mortality was larger and statistically significant regarding diseases of the circulatory system, whereas the excess mortality from cancer was smaller and statistically not significant. With respect to injuries, there was no evidence of excess mortality being associated with early retirement. Finally, for the more rare causes of death due to diseases with a prolonged natural history, such as liver diseases, renal failure, and respiratory failure, there was a large, significant excess of mortality among those already retired at enrollment. This pattern likely reflects reverse causation, the chronic disease being the cause of early retirement rather than the opposite. In contrast, we infer that the excess mortality from diseases of the circulatory system, and to a certain extent from cancer, may be attributable to early retirement. Persons with cardiovascular diseases, diabetes mellitus, or cancer at enrollment were excluded from the analyses, whereas the same was not true with respect to persons who may have suffered from liver diseases or from renal or respiratory failure.

We adjusted for several potentially confounding variables, but the effect was limited, reducing the scope for a major impact of residual confounding. We had no information as to whether retirement was mandatory or voluntary, but we found no evidence for effect modification when retirement was considered early (assumed voluntary) or normal/late (assumed mandatory), using as cutoffs the age of 60 or 65 years at retirement. Thus, our findings are generally applicable and not likely to have been generated by selection

TABLE 2. Mean (standard deviation) age at retirement and duration of retirement for 3,874 retired healthy* subjects by gender and age at enrollment, the Greek European Prospective Investigation into Cancer and Nutrition cohort study, 1994–2006

Age at enrollment (years)	Men			Women		
	No.	Age at retirement (years)	Duration of retirement (years)†	No.	Age at retirement (years)	Duration of retirement (years)†
<55	54	42.22 (8.50)	6.17 (7.36)	259	42.15 (5.80)	6.76 (5.15)
55–64	395	55.29 (6.41)	5.94 (6.09)	482	52.45 (7.68)	8.01 (7.07)
≥65	1,370	61.22 (6.69)	8.89 (7.12)	1,314	61.27 (7.27)	8.50 (7.43)
All	1,819	59.37 (7.73)	8.17 (7.03)	2,055	56.79 (9.81)	8.17 (7.12)

* Without a previous diagnosis of stroke, cancer, coronary heart disease, or diabetes mellitus.
† Time (in years) from retirement to enrollment.

bias, particularly because retirees and employed people have the same access to health care in Greece.

Exclusion of the first 2 years of follow-up had little influence; the excess mortality among those who had retired at enrollment versus those still working was reduced from 51 percent to 46 percent. We cannot exclude the possibility that some early retirees who died from diseases of the circulatory system or cancer during follow-up may have suffered from the disease that caused their death prior to their retirement. This possibility would have biased the estimated

TABLE 3. Distribution of 12,953 employed and 3,874 retired healthy* subjects by age, gender, and cause of death, the Greek European Prospective Investigation into Cancer and Nutrition cohort study, 1994–2006

	Age at enrollment (years)											
	Men						Women					
	<55		55–64		≥65		<55		55–64		≥65	
	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired	Employed	Retired
Vital status												
Alive (no.)	5,400	49	1,321	371	221	1,110	4,687	257	949	470	160	1,213
%	98.6	90.7	95.1	93.9	87.7	81.0	99.6	99.2	98.8	97.5	96.4	92.3
Death from any cause (no.)	78	5	68	24	31	260	20	2	12	12	6	101
%	1.4	9.3	4.9	6.1	12.3	19.0	0.4	0.8	1.2	2.5	3.6	7.7
Cause of death												
Diseases of the circulatory system (no.)	21	2	24	8	6	107	4	0	6	3	3	48
%	0.4	3.7	1.7	2.0	2.4	7.8	0.1	0.0	0.6	0.6	1.8	3.7
Cancer (no.)	31	2	33	12	17	90	8	2	3	6	2	28
%	0.6	3.7	2.4	3.0	6.8	6.6	0.2	0.8	0.3	1.2	1.2	2.1
Injuries and external causes (no.)	13	0	6	0	5	10	4	0	0	2	0	5
%	0.2	0.0	0.4	0.0	2.0	0.7	0.1	0.0	0.0	0.4	0.0	0.4
Renal or respiratory failure or liver disease (no.)	3	1	2	3	0	22	0	0	1	0	0	6
%	0.1	1.9	0.1	0.8	0.0	1.6	0.0	0.0	0.1	0.0	0.0	0.5
Other or missing underlying cause (no.)	10	0	3	1	3	31	4	0	2	1	1	14
%	0.2	0.0	0.2	0.3	1.2	2.3	0.1	0.0	0.2	0.2	0.6	1.1
Total no.	5,478	54	1,389	395	252	1,370	4,707	259	961	482	166	1,314

* Without a previous diagnosis of stroke, cancer, coronary heart disease, or diabetes mellitus.

TABLE 4. Hazard ratios of death associated with retirement among healthy* subjects, the Greek European Prospective Investigation into Cancer and Nutrition cohort study, 1994–2006

Death by cause and retirement aspects	Age adjusted†		Age and education adjusted†		Fully adjusted†‡	
	Hazard ratio	95% confidence interval	Hazard ratio	95% confidence interval	Hazard ratio	95% confidence interval
Any cause						
Retired vs. employed at enrollment	1.63	1.29, 2.07	1.65	1.29, 2.10	1.51	1.16, 1.98
Among retirees, mortality ratio for a 5-year increase in age at retirement	0.91	0.85, 0.97	0.90	0.85, 0.96	0.90	0.85, 0.96
Diseases of the circulatory system						
Retired vs. employed at enrollment	1.96	1.31, 2.93	1.99	1.33, 2.99	1.73	1.10, 2.73
Among retirees, mortality ratio for a 5-year increase in age at retirement	0.91	0.83, 1.00	0.91	0.82, 1.00	0.91	0.82, 1.00
Cancer						
Retired vs. employed at enrollment	1.40	0.96, 2.04	1.43	0.98, 2.09	1.40	0.92, 2.13
Among retirees, mortality ratio for a 5-year increase in age at retirement	0.88	0.79, 0.97	0.87	0.79, 0.96	0.88	0.79, 0.97
Accidents and external causes§						
Retired vs. employed at enrollment	0.61	0.25, 1.46	0.59	0.25, 1.43	0.60	0.23, 1.57
Among retirees, mortality ratio for a 5-year increase in age at retirement	0.90	0.67, 1.23	0.90	0.66, 1.22	0.88	0.65, 1.20
Liver disease, renal failure, respiratory failure§						
Retired vs. employed at enrollment	7.35	2.04, 26.48	7.61	2.09, 27.67	6.43	1.55, 26.66
Among retirees, mortality ratio for a 5-year increase in age at retirement	0.92	0.73, 1.17	0.91	0.72, 1.15	0.92	0.73, 1.18
All other causes						
Retired vs. employed at enrollment	1.52	0.72, 3.20	1.49	0.71, 3.13	1.34	0.60, 3.04
Among retirees, mortality ratio for a 5-year increase in age at retirement	1.00	0.80, 1.26	1.00	0.80, 1.25	1.00	0.80, 1.26

* Without a previous diagnosis of stroke, cancer, coronary heart disease, or diabetes mellitus.

† All models were stratified for gender; that is, they do not assume a similar baseline hazard of death for men and women but the same proportional effects of the exposure and confounding variables across genders.

‡ Adjusted for age at enrollment (<45, 45–54, 55–64, ≥65 years; categorically except when assessing age at retirement, where continuously), education (none/elementary school degree, secondary school or technical school degree, university degree or higher; categorically), smoking status (never, former, and 1–10 cigarettes per day, 11–20 cigarettes per day, 21–30 cigarettes per day, 31–40 cigarettes per day, ≥41 cigarettes per day; ordered), waist-to-hip ratio (quintiles; ordered), physical activity in metabolic equivalent task–hours per day (quintiles; ordered), body mass index (quintiles; ordered), total energy intake (quintiles; ordered) and ethanol intake (<10 g/day for men and <5 g/day for women, 10–50 g/day for men and 5–25 g/day for women, >50 g/day for men and >25 g/day for women; categorically).

§ There were relatively few deaths in this category.

results if retirement was accelerated on account of this condition *and* the condition was not declared at enrollment, but it is rather implausible given the voluntary participation and the confidentiality guarantees built into the study. It is unlikely, however, that such confounding would be strong enough to explain any more than a small fraction of the excess mortality observed in this study. It is also possible that some subjects may have retired apparently healthy, but, by enrollment, they may have developed one of the above-indicated conditions and thus be excluded. Inclusion of these retirees, however, would result in strengthening the results of our study because the risk of mortality for these participants would have been relatively high. There is also the possibility that, during the follow-up period, some employed persons became ill and were forced to retire. Incorporating such information would have required a different analytic strategy (e.g., treating the exposure variable(s) as changing with time), but we could not address this issue in the current study.

Previous studies examining the health effects of early retirement have also pointed to excess mortality among early retirees, but the present investigation is better suited to address the major concern: whether morbidity causes early retirement or early retirement is associated with excess morbidity and subsequent mortality. The reason is that we were able to identify a large number of retired subjects, to exclude subjects who had been diagnosed with medical conditions that would possibly lead to a decision to retire early, and to adjust for a number of potential confounders.

In an early study of occupational cohorts in 1978, Haynes et al. (4) argued that preretirement health was the significant predictor of survival after early retirement, and the same conclusion was drawn by Baker et al. in 1982 (5). Importantly, in a study published in 1994 focusing on unemployment and mortality, Morris et al. (6) reported that men who retired early for reasons other than illness had a statistically significant 87 percent increased mortality compared with men who were continuously employed. In a study in Denmark, Quaade et al. (7) in 2002 showed an increased standardized mortality ratio for persons claiming early retirement benefits and disability benefits compared with employed persons. In a cross-sectional analysis in 2005, Hammerman-Rozenberg et al. (8) reported that working in comparison to nonworking at age 70 years correlated with better health, self-sufficiency, and longevity. Finally, in a recent, large study of an occupational cohort in 2005, Tsai et al. (3) reported that subjects who retired early, at age 55 years, had significantly higher mortality than those who retired at the usual age of 65 years. No information about health status at baseline or cause of death was given, however.

For many, retirement may be associated with an improvement in quality of life, but we could not address this issue in our study. Moreover, age at retirement is, in most instances, a contractual arrangement in which several issues beyond health are involved. Nevertheless, the results of our study suggest that working may impart health advantages, as the more extensive literature on unemployment and compromised health also suggests (6, 20–22). The mechanisms are not clear at this stage, but retirement may involve deterioration of economic status (23, 24), abandonment of healthy habits or taking up of unhealthy ones (25, 26), as well as psychosocial consequences (27–29). The message that appears to be generated by the results of this study is that early retirement may be a risk factor for all-cause mortality and particularly mortality from diseases of the circulatory system for apparently healthy persons. Further studies are needed to determine the association of mortality from diseases with a frequently prolonged clinical course with early retirement.

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