Association of retirement age with mortality: a population-based longitudinal study among older adults in the USA

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ABSTRACT

Background Retirement is an important transitional process in later life. Despite a large body of research examining the impacts of health on retirement, questions still remain regarding the association of retirement age with survival. We aimed to examine the association between retirement age and mortality among healthy and unhealthy retirees and to investigate whether sociodemographic factors modified this association.

Methods On the basis of the Health and Retirement Study, 2956 participants who were working at baseline (1992) and completely retired during the follow-up period from 1992 to 2010 were included. Healthy retirees (n=1934) were defined as individuals who self-reported health was not an important reason to retire. The association of retirement age with all-cause mortality was analysed using the Cox model. Sociodemographic effect modifiers of the relation were examined.

Results Over the study period, 234 healthy and 262 unhealthy retirees died. Among healthy retirees, a 1-year older age at retirement was associated with an 11% lower risk of all-cause mortality (95% CI 8% to 15%), independent of a wide range of sociodemographic, lifestyle and health confounders. Similarly, unhealthy retirees (n=1022) had a lower all-cause mortality risk when retiring later (HR 0.91, 95% CI 0.88 to 0.94). None of the sociodemographic factors were found to modify the association of retirement age with all-cause mortality.

Conclusions Early retirement may be a risk factor for mortality and prolonged working life may provide survival benefits among US adults.

INTRODUCTION

Retirement is one of most important transitional processes in later life. It has huge impacts on individuals' financial resources, daily activities, family relations and social network.[1] Over the past several decades and until recently, workers have retired at younger ages in the USA as well as in many other developed countries.[2 3] This trend towards early retirement along with several other ongoing demographic trends, including declining fertility rates, prolonged life expectancy and delayed workforce entry by young adults, has contributed to a shrinking working population that may not be able to fiscally support a rapidly growing retired population.[4 5] To alleviate fiscal pressure on the US Social Security, the age eligibility for claiming full retirement benefits has been gradually increased from 65 to 67 years, and benefits available at age 62 years have been reduced.[6] Most recently,

research has pointed to a trend towards increased retirement age.[7 8] Therefore, it is timely and critical to develop a better understanding of whether and how retirement age impacts retirees' health and longevity. Understanding the association of retirement age with longevity has important implications for postretirement survival and may elucidate criteria for evaluating the current policies that aim to encourage older workers to retire later and to remain in the workforce.

There is a developing body of literature on the relation between retirement age and longevity, although the findings are mixed. Several studies reported higher mortality among early retirees than those who retired around the institutionally normative age,[9–14] whereas others found no differences in longevity between early and on-time retirees[15–18] or even a lower mortality among individuals retiring early.[19] In sum, no consensus has been reached on the existence, direction and magnitude of the association between retirement age and longevity.

One major methodological challenge in studying retirement age and mortality is how to account for the healthy worker bias.[20] Poor health is an important reason for early retirement[21 22] and is also a well-established risk factor for mortality.[23 24] Therefore, the adverse effects of early retirement on longevity may be, at least partially, attributable to workers' pre-retirement health status. Knowledge of the association of retirement age with longevity is also limited by the use of non-representative samples such as German firefighters,[13] US petrochemical workers[18] and Austrian blue-collar workers.[11]

This study aimed to investigate the association of retirement age with mortality among US adults to determine whether there is an optimal retirement timing to preserve longevity. This study also explored whether sociodemographic factors modified this relation. We addressed these issues using data from the Health and Retirement Study (HRS), a large, nationally representative prospective study of US adults aged ≥51 years. To rigorously address the healthy worker bias, we restricted the primary analysis to participants who reported health had no impact on their decision to retire.

METHODS
Participants

We used data from the HRS collected between 1992 and 2010. The HRS is a co-operative agreement between the National Institute on Aging and the University of Michigan (U01 AG009740) and aims to describe changes in life patterns through

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the retirement transition among US adults by collecting information about their health conditions, family network, social relations, financial situation and employment status.[25] Ethical approval was obtained from the University of Michigan Institutional Review Board. Further details about the recruitment strategies, design and sampling approaches of the HRS have been documented elsewhere.[26] There are currently six cohorts enrolled in the HRS. This study focused on the initial HRS cohort because it has the most waves of data for tracking the occurrence of retirement and death events, and other study cohorts comprised individuals who are either too young or too old, providing limited information on retirement.

The sample was first limited to 8756 participants who were primary interview respondents (ie, not from a proxy respondent) and had ≥2 valid assessments. The sample was further restricted to 4092 participants who self-reported being working at baseline and had retired by the end of the 2010 wave of data

collection. Moreover, because occupation and preretirement health status were important confounders, 524 individuals whose occupation information was unavailable and 454 individuals who did not report whether health was an important reason to retire were excluded. Last, 158 individuals who were lost to follow-up in the year when they reported being completely retired were also excluded. These selection criteria resulted in a sample of 2956 eligible participants. The flow of participants through each stage of selection based on inclusion criteria is shown in figure 1.

To account for the healthy worker bias, the sample was stratified into two subgroups, healthy and unhealthy retirees, based on the question, 'Was poor health very important, moderately important, somewhat important, or not important at all for retirement?'. Individuals who answered 'not important at all' were classified as healthy retirees, whereas individuals who chose one of the other three answers were considered unhealthy

Figure 1 Flow chart of participants excluded from the present study, Health and Retirement Study, 1992–2010.
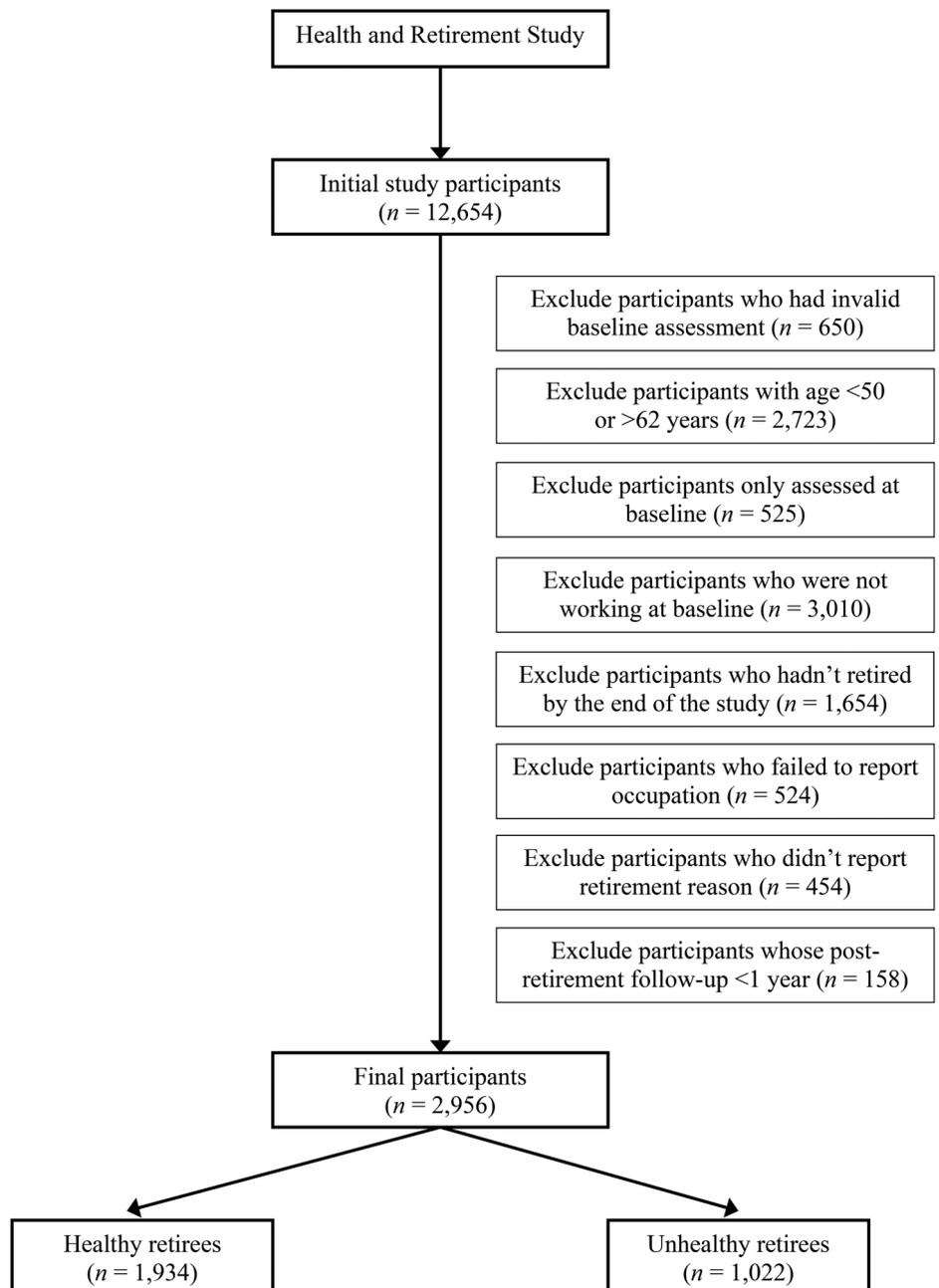
retirees. Consequently, the analytic sample consisted of 1934 healthy retirees (from 1782 households) and 1022 unhealthy retirees (from 922 households).

Measures

Outcomes: The outcome was all-cause mortality. Participants were censored when lost to follow-up or the end of the analytic period (2010 survey wave). Mortality was ascertained on the basis of a variable recording participants' year and month of death taken from an exit interview or a spouse/partner's core interview. Information on mortality was available through 2011.

Predictors: Retirement status was ascertained according to a question asking respondents in each wave: 'At this time do you consider yourself partly retired, completely retired or not retired at all?' An individual was defined as retired if they responded, 'completely retired'. Retirement age was defined as the age when an individual, for the first time, reported being completely retired.

Covariates: To account for potential confounders, sociodemographic (birth cohort, gender, race dichotomised as white/non-white, marital status dichotomised into married/non-married, education categorised as <high school, high school and >high school, non-housing wealth and preretirement occupation categorised into blue-collar, white-collar and service), lifestyle information (smoking status, alcohol use and physical activity) and health-related variables (body mass index, self-rated health, disability measured by difficulties performing activities in daily livings including walking across a room, bathing, eating, dressing and getting into and out of bed, and medical history including hypertension, diabetes, cancer, lung disease, heart problem, stroke, arthritis and psychiatric problems) were included in the multivariable analyses. All covariates were measured at baseline.

Statistical analysis

We first compared the mean values of baseline characteristics between healthy and unhealthy retirees, using a t test for continuous variables and a χ^2 test for categorical variables. We then evaluated the distribution of retirement age for healthy and unhealthy retirees separately.

We investigated the unadjusted association of retirement age with mortality among healthy retirees in a Cox model. Retirement age and its squared term were the primary predictors. The purpose of including this quadratic term was to test for a potential curvilinear relationship between retirement age and mortality. The quadratic term was included in subsequent models if it was associated with mortality at a significance level of $p < 0.05$. Subsequently, we included all of the aforementioned sociodemographic, lifestyles and health-related variables as confounders in the model to estimate the adjusted HRs for the mortality risk per 1-year increase in retirement age. Additionally, we examined the association of retirement age with mortality, modelling the continuously measured retirement age in categories to allow non-linear association. We first classified healthy retirees as early, on-time and late retirees using the first and the third quartiles of retirement age as cut-offs. Alternatively, we used mean±1SD as cut-offs to classify healthy retirees into three categories.

We evaluated effect modification by including interaction terms between retirement age (continuous) and sociodemographic (birth cohort, gender, race, education, wealth, occupation and marital status) factors in the model and testing for statistical significance. Interaction terms that did not reach statistical significance ($p \geq 0.05$) were excluded from the final model.

Table 1 Demographic, behavioural and health characteristics of participants (healthy retirees vs unhealthy retirees), Health and Retirement Study, 1992–2010

	Healthy retirees (n=1934)	Unhealthy retirees (n=1022)	
	Mean±SD or count (%)		p Value[a]
Male	967 (50.0)	457 (44.7)	**
White (vs non-White)	1628 (84.2)	775 (75.8)	***
Age	55.5±3.0	55.1±3.1	***
Education			***
<High school	307 (15.9)	285 (27.9)	
High school	1092 (56.4)	562 (55.0)	
>High school	535 (27.7)	175 (17.1)	
Married (vs others)	1487 (76.9)	666 (65.2)	***
Non-housing wealth			***
Min—1st quartile	405 (20.9)	351 (34.3)	
1st quartile—median	472 (24.4)	262 (25.6)	
Median—3rd quartile	498 (25.8)	251 (24.6)	
3rd quartile—max	559 (28.9)	158 (15.5)	
Occupation			***
White-collar	680 (35.2)	231 (22.6)	
Service	756 (39.1)	446 (43.6)	
Blue-collar	498 (25.8)	345 (33.8)	
Smoking			***
Never-smoker	754 (39.0)	337 (33.0)	
Former	756 (39.1)	373 (36.5)	
Current	424 (21.9)	312 (30.5)	
Alcohol use (yes)	1307 (67.6)	622 (60.9)	***
Frequent exercise	1041 (53.8)	498 (48.7)	**
Body mass index			***
Underweight/normal	728 (37.6)	282 (27.6)	
Overweight	843 (43.6)	422 (41.3)	
Obese	363 (18.8)	318 (31.1)	
Self-rated health	3.9±0.9	3.3±1.1	***
Limitation in ≥1 ADL	42 (2.2)	81 (7.9)	***
Chronic conditions	0.9±0.9	1.5±1.2	***
Death	234 (12.1)	262 (25.6)	***

*p<0.05. **p<0.01. ***p<0.001.
[a]Two-sample t test for continuous variables and χ^2 test for categorical variables.
ADL, activities of daily living.

We used Schoenfeld residuals to assess the proportional hazards assumption of Cox models.

As secondary analyses, Cox models were repeated for unhealthy retirees. Additionally, pooled models including healthy and unhealthy retirees were fitted to test whether the association of retirement age with mortality differed across two subgroups. Furthermore, to assess the sensitivity of study results to classification of healthy retirees, we repeated the analyses using two more broad definitions of healthy retirees. Initially, we categorised participants who reported health was 'somewhat important' to retiring as healthy retirees (n=2143). Alternatively, we categorised participants as healthy retirees (n=2342) if they reported health was 'not at all', 'somewhat' or 'moderately important' for retirement. We used inverse-probability-of-attrition weights (IPAW) to account for potential selective attrition that may have arisen during follow-up.

We centred retirement age at 65 years to reduce collinearity between linear and quadratic terms and to improve

interpretation of the statistical results. We used robust SEs to account for nested data structure of the HRS (ie, participants nested within households). All statistical tests were two sided. All analyses were conducted using Stata V.13.1.

RESULTS

A total of 2632 excluded participants were generally comparable to the included participants, except they were more often males and more likely to be white-collar workers (see online supplementary table S1).

Among 2956 participants included, 1934 (65.4%) and 1022 (34.6%) were classified as healthy and unhealthy retirees, respectively. Over an average follow-up period of 16.9 years, 234 (12.1%) healthy and 262 (25.6%) unhealthy retirees died. Compared with unhealthy retirees, healthy retirees were more often men and white, more highly educated and more likely married (table 1). They were also more likely to be white-collar workers and had more wealth than unhealthy retirees. In addition, healthy retirees were more physically active, less likely to smoke, less likely to have a limitation in one or more activities of daily living, had a lower body mass index, fewer chronic conditions and better self-reported health than unhealthy retirees. Overall, healthy retirees had relatively advantaged socioeconomic, behavioural and health profiles.

The distribution of retirement age was similar among healthy and unhealthy retirees, with a majority of people retiring around the age of 65 years (figure 2). The average retirement age (SD) was 64.9 (3.8) and 64.3 (4.1) years and the range was 53.3–78.0 and 54.7–79.4 years for healthy and unhealthy retirees, respectively.

Among healthy retirees, older retirement age was significantly associated with lower mortality in the unadjusted model (table 2).

The addition of a quadratic term for retirement age did not add significantly to the model or alter the HR associated with the linear term for retirement age. The association of retirement age with mortality for healthy retirees remained nearly identical, after adjusting for sociodemographic, lifestyle and health-related covariates; retiring 1 year later was associated with an 11%

(95% CI 8% to 15%) lower mortality risk. Based on the χ^2 tests, there was no strong evidence suggesting that the proportional hazards assumption was violated for any of the covariates in the adjusted model (p >0.01; p=0.38 for global test). Results of interaction analysis showed that none of the sociodemographic factors significantly modified the association of retirement age and mortality.

When retirement age was modelled categorically, 466 and 483 healthy retirees were classified as early (<62.4 years) and late (>67.0 years) retirees using the first and the third quartiles as cut-offs, respectively. Alternatively, 252 and 297 healthy retirees were considered early (<61.1 years) and late (>68.7 years) retirees using mean±1SD as cut-offs, respectively. The findings obtained using two categorisation approaches consistently showed that early and late retirees had significantly higher and lower mortality risk, respectively, compared with on-time retirees (figure 3).

In the pooled analysis, unhealthy retirees had an 84% (95% CI 51% to 126%) higher mortality risk than healthy retirees (table 2). However, the association of retirement age with mortality did not differ between these subgroups (p=0.83). When unhealthy retirees were analysed separately, retiring 1 year later was associated with a 9% (95% CI 6% to 12%) lower mortality risk. The estimates for the association of retirement with mortality in healthy retirees remained almost unchanged when categorising healthy retirees differently (see online supplementary table S2). Results were virtually unchanged when we applied IPAW to deal with potential selective attrition due to non-response (data not shown).

DISCUSSION

In a population-based longitudinal study of US adults, we found early retirement was associated with increased mortality risk, and prolonged working life may be related to survival benefits among healthy and unhealthy retirees, independent of a wide range of sociodemographic, lifestyle and health-related confounds. By using a cohort of US adults who do not face mandatory retirement and have a flexible retirement arrangement, we

Figure 2 Distribution of retirement age for healthy and unhealthy retirees, Health and Retirement Study, 1992–2010.
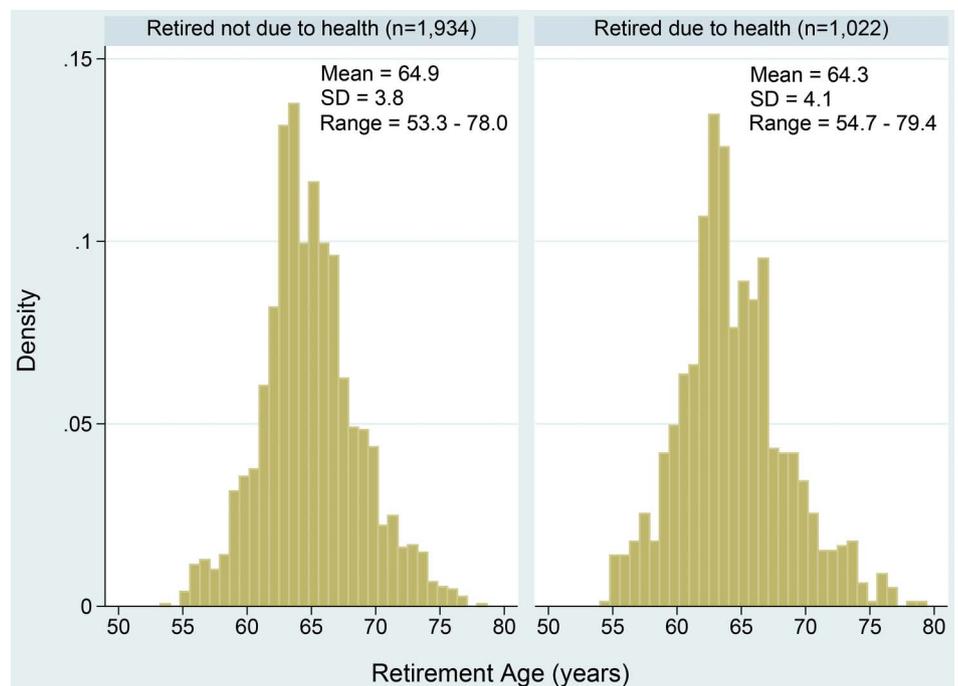
Table 2 Association of retirement age with mortality, stratified by healthy versus unhealthy retirees, Health and Retirement Study, 1992–2010

	Healthy retirees (n=1934)		Unhealthy retirees (n=1022)		Pooled analysis* (n=2956)	
			HR	95% CI		
Unadjusted						
Retirement age (centred at 65)	0.89	0.86 to 0.92	0.90	0.87 to 0.92	0.89	0.87 to 0.91
Adjusted†						
Retirement age (centred at 65)	0.89	0.85 to 0.92	0.91	0.88 to 0.94	0.90	0.88 to 0.92
Retired due to health (yes)	–	–	–	–	1.84	1.51 to 2.26
Male	1.66	1.21 to 2.27	1.79	1.33 to 2.43	1.75	1.41 to 2.17
White (vs non-white)	1.11	0.75 to 1.66	1.03	0.76 to 1.40	1.04	0.82 to 1.33
Birth cohort (centred at 1931)	1.02	0.96 to 1.09	1.01	0.96 to 1.07	1.02	0.98 to 1.06
Education (ref. <high school)						
High school	0.67	0.47 to 0.96	0.85	0.63 to 1.15	0.79	0.62 to 0.99
>High school	0.66	0.40 to 1.07	1.21	0.73 to 2.00	0.90	0.63 to 1.28
Married (vs others)	0.81	0.59 to 1.13	0.98	0.73 to 1.33	0.90	0.72 to 1.13
Wealth (ref. <1st quartile)						
1st quartile—median	1.21	0.83 to 1.76	0.96	0.69 to 1.35	1.09	0.85 to 1.39
Median—3rd quartile	0.97	0.64 to 1.47	0.90	0.63 to 1.30	0.93	0.71 to 1.22
3rd quartile—max	0.97	0.63 to 1.49	0.90	0.57 to 1.42	0.91	0.67 to 1.23
Occupation (ref. white-collar)						
Service	0.93	0.64 to 1.35	1.30	0.84 to 2.01	1.11	0.84 to 1.48
Blue-collar	0.97	0.64 to 1.46	1.19	0.77 to 1.83	1.09	0.81 to 1.46
Smoking (ref. never-smokers)						
Former smokers	1.25	0.88 to 1.77	1.37	0.96 to 1.93	1.33	1.04 to 1.71
Current smokers	2.66	1.88 to 3.77	2.55	1.82 to 3.57	2.59	2.03 to 3.31
Drinking (yes)	0.94	0.70 to 1.27	0.85	0.65 to 1.12	0.90	0.73 to 1.10
Frequent exercise (yes)	1.04	0.80 to 1.34	0.74	0.57 to 0.95	0.87	0.72 to 1.04
BMI (ref. normal/low)						
Overweight	0.89	0.66 to 1.19	1.07	0.78 to 1.47	0.97	0.78 to 1.20
Obese	1.24	0.86 to 1.77	1.09	0.76 to 1.55	1.13	0.88 to 1.46
Self-rated health	0.90	0.77 to 1.05	0.91	0.80 to 1.05	0.91	0.82 to 1.01
Chronic conditions	1.22	1.05 to 1.40	1.12	1.00 to 1.26	1.16	1.06 to 1.27
Limitation in any ADL	2.32	1.18 to 4.56	0.97	0.64 to 1.48	1.14	0.79 to 1.66

*Both healthy and unhealthy retirees were included. p Value for interaction, retirement age×retired due to health (yes or no)=0.834.
†Estimates adjusted for sociodemographic (birth cohort, gender, marital status, education, wealth), lifestyle (smoking status, alcohol use, body mass index) and health-related (self-rated health, medical history and activities of daily living) measures.
ADL, activities of daily living; BMI, body mass index.

were able to extend previous research by showing late retirement was independently related to a reduced risk of mortality.

Our findings were consistent with previous investigations of Austrian, German, Greek, Swedish and US populations showing an increased mortality risk associated with early retirement.[9–14] Bamia *et al*[9] found early exit from the workforce was a risk factor for mortality in Greek retirees who were free of chronic conditions prior to retirement. In a more recent investigation of Swedish residents who were healthy and employed at age 60 years, Carlsson *et al*[10] showed early retirement was associated with an increased likelihood of death over the follow-up period.

The mechanisms behind the association of retirement age with mortality are generally not well understood. One possible explanation is employment is a key component of individuals' identity that provides them with substantial financial, psychosocial and cognitive resources. Additionally, retirement could be a stressful life event associated with cognitive decline, difficulties in daily activities, morbidities, anxiety and depression.[20 27–31] Delayed transition into retirement and continued participation in volunteer activities and paid work in old age after retirement could delay the declines in physical, cognitive and mental functioning and reduce the risk of morbidities,[32–36] which leads to better survival. This may be particularly true for individuals in work-oriented countries, where work is highly valued and

considered a necessary part of life.[37] Work characteristics (eg, more physically demanding or stressful jobs) may prompt earlier retirement that may have longer term effects on health and mortality even if workers do not retire due to health reasons.[8] Moreover, from the life course perspective, the decision about when to retire is shaped by many factors, including cultural and institutional norms; delayed transition into retirement may become more socially and culturally desirable.[7 38]

There was no evidence that the effects of retirement age on mortality were modified by sociodemographic characteristics, suggesting that the beneficial effect of retiring late may be universal across different sociodemographic profiles. Our findings are consistent with previous studies reporting an increased risk of mortality associated with retiring early in homogeneous populations.[11 13 14] Wagner *et al*[13] found early retirement was a mortality risk among German firefighters. Kuhn *et al*[11] reported a higher probability of dying before age 67 years among male blue-collar workers who had access to early retirement than those who were ineligible.

Pooled analyses including healthy and unhealthy retirees showed unhealthy retirees had relatively high mortality. These findings were in line with previous studies showing individuals who retired due to health-related reasons had relatively high mortality risk.[13]
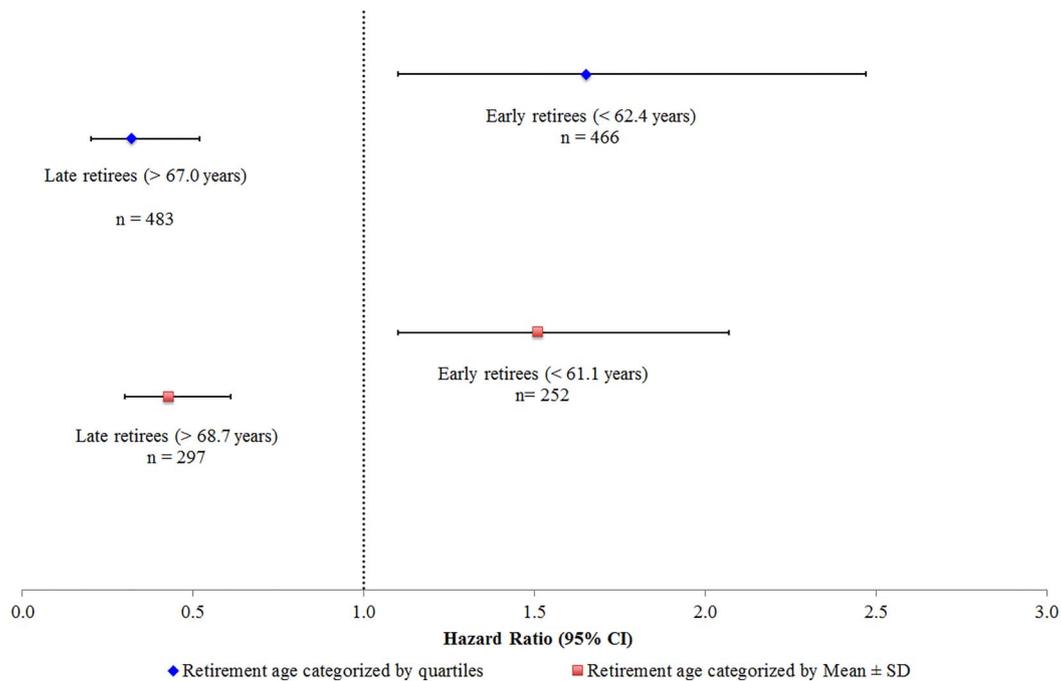
Figure 3 Association of categorised retirement age with mortality in healthy retirees, Health and Retirement Study, 1992–2010. *Note*: On-time retirees were considered reference group.

This study had several distinct substantive and methodological strengths. First, we used a large sample from a nationally representative study with rich sociodemographic, lifestyle and health information. Second, we rigorously accounted for the confounding effects of preretirement health status by restricting the primary analysis to retirees who self-reported health was not important for retirement. Using self-reported information to define healthy retirees appeared valid, as evidenced by the fact that healthy retirees had relatively advantaged socioeconomic, behavioural and health profiles. Additionally, self-reported health is arguably better than objectively measured health since subjective evaluations of health may have the largest impact on an individual's choice to retire.[39 40] Third, unlike most previous studies, we examined the health effect of both early and late retirement. Fourth, in addition to examining the main effect of retirement age on mortality, we investigated whether this relation differed across sociodemographic subgroups. Finally, this study had a long follow-up period, which allows the investigation of long-term survival and provides sufficient death events to achieve statistical power.

We acknowledge several limitations in this study. First, this study focused exclusively on retirement age and mortality. Future research should investigate the mechanisms by which retirement age impacts longevity to have a better understanding of the relationship between retirement age and trajectories of health and quality of life before and after retirement. Second, the question used in this study to define healthy retirees does not necessarily identify whether their health was the dominant reason for them to retire. The decision about when to retire is multifactorial and complex;[8] it is possible that individuals who considered health was important for retirement indeed left the workforce owing to a variety of reasons related to, but not directly indicative of, poor health, although we argue this definition was the most conservative approach to control for confounding by poor health status. Third, as with any observational study, residual confounding may persist if important confounders were omitted.

In general, this study adds to the retirement literature by studying a representative US cohort and using a rigorous definition of healthy retirees. The study findings may have important implications for policies concerning the labour market, retirement and later life health. In the context of rising longevity, changes in retirement ages across cohorts and young adults delaying entry into the workforce, policymakers have pressed for policy changes encouraging late retirement to alleviate the old-age dependency ratio. In addition to the economic and social impacts of delaying retirement age, it is also important to consider the health consequences of retirement for policy evaluation. This study suggests late retirement has a beneficial effect on longevity and early retirement is associated with higher mortality. In this sense, reducing early retirement benefits, providing social and economic incentives to prolong working life and enacting policies that aim to postpone retirement may be beneficial for individuals' health.

What is already known on this subject

► Previous studies reported conflicting results regarding the health effects of retirement age.
► Prior research has not sufficiently accounted for the healthy worker bias.
► The health effects of late retirement have been rarely examined.

What this study adds

► Early retirement may be a risk factor for mortality and prolonged working life may provide survival benefits.
► The relation between retirement age and mortality did not vary across sociodemographic subgroups.

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