American Journal of Epidemiology

Vol. 185, No. 1
DOI: 10.1093/aje/kww182
Advance Access publication:
December 7, 2016

Original Contribution

Optimism and Cause-Specific Mortality: A Prospective Cohort Study

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Initially submitted May 19, 2016; accepted for publication October 28, 2016.

Growing evidence has linked positive psychological attributes like optimism to a lower risk of poor health outcomes, especially cardiovascular disease. It has been demonstrated in randomized trials that optimism can be learned. If associations between optimism and broader health outcomes are established, it may lead to novel interventions that improve public health and longevity. In the present study, we evaluated the association between optimism and cause-specific mortality in women after considering the role of potential confounding (sociodemographic characteristics, depression) and intermediary (health behaviors, health conditions) variables. We used prospective data from the Nurses' Health Study (n = 70,021). Dispositional optimism was measured in 2004; all-cause and cause-specific mortality rates were assessed from 2006 to 2012. Using Cox proportional hazard models, we found that a higher degree of optimism was associated with a lower mortality risk. After adjustment for sociodemographic confounders, compared with women in the lowest quartile of optimism, women in the highest quartile had a hazard ratio of 0.71 (95% confidence interval: 0.66, 0.76) for all-cause mortality. Adding health behaviors, health conditions, and depression attenuated but did not eliminate the associations (hazard ratio = 0.91, 95% confidence interval: 0.85, 0.97). Associations were maintained for various causes of death, including cancer, heart disease, stroke, respiratory disease, and infection. Given that optimism was associated with numerous causes of mortality, it may provide a valuable target for new research on strategies to improve health.

health psychology; optimism; psychological well-being; resilience

Abbreviations: CI, confidence interval; HR, hazard ratio; MET, metabolic equivalent of task.

Although most biomedical and public health efforts to improve health have been focused on reducing harmful lifestyle risk factors, increasing attention has been paid to the identification of positive health assets (1, 2). An emerging body of research has suggested that various facets of positive psychological well-being are associated with better health outcomes (3). In particular, dispositional optimism—the generalized expectation that good things will happen—has been linked with reduced risks of chronic health conditions, especially vascular factors and disease (3–10). Importantly, although optimism is approximately 25% heritable (11), initial (albeit short-term) randomized trials have suggested that it can be modified using fairly accessible tools (12–16). Thus, optimism may be a novel and promising target for new research on prevention and intervention strategies aimed at improving health (17).

However, research on optimism and long-term health to date is limited, with the most rigorous work primarily evaluating associations with cardiovascular morbidity and mortality (3–10). A key question is whether optimism may be related to broader health outcomes. If so, this may provide some insight into key pathways via which optimism may influence health beyond those primarily linked with cardiovascular disease. Moreover, although most studies on this topic have included adjustment for sociodemographic factors, fewer have been able to account for a broad range of variables that may either confound or lie on the pathway linking optimism to disease outcomes (3). Prior work has suggested that optimism is significantly associated with indicators of socioeconomic status, with higher optimism being evident among individual with more education or more income (18). Furthermore, other work has suggested

that higher optimism may lead to healthier diet or other behaviors (19), but it may also be that there is bidirectionality in these relationships (20). Prior research has also indicated that optimism may be associated with a reduced likelihood of a variety of health-related conditions, such as an unhealthy lipid profile or type 2 diabetes mellitus (21, 22), and that optimism is not inevitably altered by alterations in disease status (23). We used data from the Nurses' Health Study (NHS), a long-term observational study of women, to examine optimism and the risk of mortality, with careful assessment of confounding (including depression) (24), and the role of other factors to evaluate the association of optimism with a lower risk of mortality.

METHODS

Study population

The Nurses' Health Study began in 1976, when 121,700 female registered nurses who were 30–55 years of age completed a mailed questionnaire about their health and health behaviors. Since then, questionnaires have been mailed to participants every 2 years to obtain updated information. The follow-up rate remains approximately 90%. In 2004, a measure of optimism was included in the questionnaire, and we therefore considered 2004 as the baseline for the present study. Mortality and cause-specific mortality have been assessed throughout follow-up (data are available through 2014).

Women were excluded from the analyses if they died before study baseline in 2004 (n = 19,586), did not answer the baseline questionnaire in 2004 (n = 8,691), did not answer optimism questions in 2004 (n = 4,122), or replied to a shorter version of the questionnaire sent to persistent nonresponders that did not assess optimism (n = 17,880). To reduce concerns about reverse causality, we further excluded women who died within 2 years of study baseline in 2004 to take into account the possible concern that they may have had recent changes in optimism due to underlying illness (n = 1,400). Therefore, no person-time before 2006 was included in the analyses. The final analytic sample included 70,021 women. Women who were included in the analysis were very similar to those who were excluded: The mean ages were 70.0 years and 70.8 years, respectively; 10.3% of those included had a master or doctoral degree versus 8.4% of those who were excluded; and the mean body mass indices (calculated as weight in kilograms divided by height in meters squared) at baseline were 23.3 and 23.6, respectively. The study was approved by the Institutional Review Board at the Brigham and Women's Hospital.

Measures

Optimism. Optimism was assessed in 2004 and again in 2008 using the Life Orientation Test-Revised. The measure has good discriminant and convergent validity, as well as good reliability (25). Using a 5-point Likert scale, respondents were asked the degree to which they agreed with 6 statements, such as, "In uncertain times, I usually expect the best." Negatively worded item were reverse coded, and then all items were summed to create a composite score that ranged from 0 to 24, with higher scores indicating higher levels of optimism. To reduce respondent burden, 4 filler items were omitted from the Life Orientation Test-Revised by the Nurses' Health Study investigators. Because optimism may best be characterized by both endorsing positively worded items and rejecting negatively worded items (26), we followed recommendations to use the 6-item composite rather than 3-item subscales sometimes used in prior research (27). Internal consistency reliability was high in the present sample in 2004 (Cronbach $\alpha = 0.78$). The intraclass correlation was also high from 2004 to 2008, with a value of 0.64. To assess the possibility of discontinuous or threshold effects, we created quartiles of optimism based on the score distribution in the sample. Median optimism scores by quartile were 13, 19, 22, and 24.

Assessment of mortality and cause of mortality. Information about mortality was collected from systematic searches of state vital records and the National Death Index; this was supplemented by reports from family members and postal authorities. Using these methods, we ascertained more than 98% of deaths in the cohort (28). Cause of death was evaluated by study physicians (unaware of this study's hypotheses) who reviewed death certificates and medical records when available.

Assessment of potential confounder or other relevant variables. Potential confounders included sociodemographic factors and depression. Sociodemographic variables were obtained from the 2006 questionnaire and included age (continuous), race (white, black, Asian, or other), marital status (married, divorced/separated/single, or widowed), educational level (registered nurse/associate degree, bachelor degree, or master/doctorate degree), husband's educational level (less than high school, some high school, high school graduate, college graduate, or graduate school), and father's occupation when the nurse was 16 years old (none (including retired and deceased), craftsman/laborer/farmer, clerical/sales/service, or professional/managerial). Depression status (yes vs. no) was defined according to self-report of physician diagnosis of clinical depression, regular antidepressant use, or depressive symptoms measured using the Center for Epidemiologic Study Depression Scale–Revised in 2006 or the Geriatric Depression Scale in all follow-up cycles (depression defined as Center for Epidemiologic Studies Depression Scale score $\geq$10 or Geriatric Depression Scale score $\geq$5) (29, 30). Depression status was updated at each follow-up cycle.

Additional variables that may also be relevant, especially as possible explanations of the relationship of optimism with mortality, included health conditions (assessed in 2006 and updated every 2 years) and health behaviors (assessed in 2006 and updated every 2–4 years). We identified and updated information on these variables at each follow-up cycle. Health conditions were self-reported (yes vs. no) and included high cholesterol, hypertension, type 2 diabetes mellitus, myocardial infarction, stroke, cancer, and body mass index, which was calculated from self-reported weight and height (31).

Health behaviors included diet, physical activity level, cigarette smoking, alcohol consumption, and undergoing annual physical examinations. Diet was assessed with the Willett food frequency questionnaire (32), which comprises questions about consumption of a range of foods over the past year; overall diet quality was quantified using the Alternative Healthy Eating Index-2010 (continuous variable from 0 to 110). The Alternative Healthy Eating Index includes 11 different diet components that have been shown to be related to chronic disease risk (33). Physical activity level was assessed across 6 different types of exercise, and this assessment has previously been validated in this cohort (34). Activity was summarized as weekly expenditure of metabolic equivalent of tasks (METs) per week (<3.0 METs/week, 3.0–8.9 METs/week, 9.0–17.9 METs/week, 18.0–26.9 METs/week, or ≥27.0 METs/week). Moderate alcohol intake from wine, beer, and liquor was assessed; values were combined and reported as grams per day of alcohol (0.0 g/day, 0.1–14.9 g/day, or ≥15.0 g/day). Participants were characterized as never, former, or current smokers, with those in the latter group being further categorized by the number of cigarettes smoked per day (1–14 cigarettes/day, 15–24 cigarettes/day, or ≥25 cigarettes/day). Information on participants' annual physical examinations for screening purposes (yes vs. no) was also assessed on the 2006 questionnaire and updated every 2 years thereafter.

Statistical analysis

Cox proportional hazards models were used to evaluate associations between baseline quartiles of optimism score in 2004 and mortality. In total, 5 models were evaluated for analyses. The first 2 models focused on known potential confounding covariates; model 1 (considered the core model) was adjusted for sociodemographic confounders, and model 2 was adjusted for sociodemographic variables and depression. In 2 subsequent models, we added sets of potential intermediate variables to the core model and examined their impact on the optimism-mortality association. Specifically, model 3 included time-updated health conditions, and model 4 incorporated time-updated health behaviors into model 1 (core model). Finally, model 5 included all variables from model 2 plus health conditions and behaviors. *P* values for trend were calculated by modeling the median of each quartile of optimism score as a continuous variable. The same set of models was used to investigate the relationship between optimism as a continuous variable and all-cause mortality. The core model was used to assess the relationship between optimism and cause-specific mortality. Causes included heart disease, stroke, respiratory disease, infection, total cancer, lung cancer, breast cancer, colorectal cancer, and ovarian cancer. Other than the women who died within 2 years of study baseline, no additional women were excluded in this primary set of cause-specific mortality models.

We conducted 3 additional secondary analyses. First, to further address concerns about possible bias due to preexisting disease in the all-cause mortality analyses, we excluded participants with prior cardiovascular disease or cancer diagnoses as of the 2004 baseline. Second, to further address this possible bias in the cause-specific mortality analyses, we excluded participants who had the disease in question at baseline. Thus, in analyses in which we examined heart disease as the cause of death, we excluded participants who reported heart disease at baseline and repeated this same procedure for stroke and cancer. Because we did not have information on prevalent infection or respiratory diseases at baseline, we could not run these models for those causes of death. Third, to facilitate comparisons of effect size across studies, we analyzed optimism as a continuous variable (standardized). Fourth, we updated optimism scores in 2008 (lagging mortality by 2 years after the updated optimism measurement). All analyses were conducted in SAS, version 9.3 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

At baseline, the average age of respondents was 70.1 (standard deviation, 6.9) years. Most women were married (69.2%). With regard to educational level, 69.0% had registered nurse or associate degrees, 20.7% had bachelor of arts/science degrees, and 10.3% had master or doctorate degrees. The majority were white (97.6%); 1.3% were black, 0.8% were Asian, and 0.3% reported being another race/ethnicity. Generally, the distributions of most sociodemographic characteristics, health behaviors, and health conditions were similar across optimism quartiles in 2004 (Table 1). However, there were some notable differences; for example, more optimistic women tended to have more education and to report more physical activity. They also reported a lower prevalence of hypertension, high cholesterol, and type 2 diabetes mellitus and a substantially lower prevalence of depression.

Optimism and risk of all-cause mortality

We observed strong associations between higher optimism levels and lower risks of mortality (Table 2; all *P* for trend < 0.001). For example, in the core model, when comparing the most optimistic women (top quartile) with least optimistic (bottom quartile), the hazard ratio was 0.71 (95% confidence interval (CI): 0.66, 0.76) for all-cause mortality. After we further controlled for depression, the results were not meaningfully different.

We also explored several groups of variables that may help to explain the relationship of optimism with mortality (Table 2). There was a modest attenuation of the primary association when health conditions were included (hazard ratio (HR) = 0.73, 95% CI: 0.68, 0.78) (35, 36). Adding health behaviors to the core model yielded a larger attenuation (HR = 0.86, 95% CI: 0.81, 0.92). When we included all groups of variables in the model (health behaviors, health conditions, and depression), the results were further attenuated (HR = 0.91, 95% CI: 0.85, 0.97) but remained statistically significant (*P* for trend < 0.001), indicating that these factors explain part but not all of the observed relationship between optimism and mortality.

Table 1. Age-Standardized Characteristics of Participants at Baseline, by Categories of Optimism Score[a], Nurses' Health Study, 2004

Characteristic	Optimism Score Quartile			
	1 (n = 20,823), %[b]	2 (n = 19,698), %[b]	3 (n = 17,228), %[b]	4 (n = 12,272), %[b]
Demographic factors				
Race				
White	97.8	97.4	97.7	97.7
Black	0.9	1.3	1.4	1.6
Asian	1.0	0.9	0.7	0.3
Other	0.3	0.4	0.3	0.4
Marital status				
Married	66.8	69.6	70.6	70.7
Divorced/single	8.4	7.8	7.0	7.2
Widowed	24.8	22.6	22.3	22.1
Educational level				
Registered nurse	75.3	69.6	65.0	63.4
Bachelor degree	17.9	20.6	22.6	23.0
Master/doctoral degree	6.9	9.8	12.4	13.7
Husband's educational level				
Less than high school	2.2	1.9	1.3	1.7
Some high school	4.5	3.9	3.1	3.3
High school graduate	42.5	38.8	38.0	36.2
College graduate	28.5	30.0	29.9	31.1
Graduate school	22.3	25.4	27.7	27.7
Father's occupation				
None (including retired and deceased)	9.7	9.3	9.1	8.9
Craftsman, laborer, or farmer	27.9	26.4	24.7	24.2
Clerical, sales, or service	38.9	38.7	38.5	38.0
Professional or managerial	23.6	25.6	27.7	28.9
Health behaviors				
Smoking status				
Never smoker	42.9	44.9	45.5	48.3
Former smoker	48.6	48.3	48.2	46.0
Current smoker, 1–14 cigarettes/day	4.2	3.7	3.4	3.1
Current smoker, 15–24 cigarettes/day	3.2	2.5	2.3	2.1
Current smoker, ≥25 cigarettes/day	1.1	0.6	0.6	0.6
Physical activity level, METs/week				
<3.0	25.9	18.8	16.3	15.7
3.0–8.9	22.0	20.4	19.0	18.4
9.0–17.9	19.6	21.1	20.9	20.1
18.0–26.9	12.0	13.5	14.5	14.6
≥27.0	20.5	26.3	29.3	31.2
Alcohol consumption, g/day				
0.0	47.4	42.5	40.6	42.8
0.1–14.9	40.6	44.2	44.9	43.2
≥15.0	12.0	13.3	14.6	14.1

Table continues

Table 1. Continued

Characteristic	Optimism Score Quartile			
	1 (n = 20,823), %[b]	2 (n = 19,698), %[b]	3 (n = 17,228), %[b]	4 (n = 12,272), %[b]
Health conditions				
Physical examination for screening	84.3	86.9	88.7	88.8
High cholesterol	72.4	69.0	66.8	64.6
Hypertension	63.1	59.2	57.3	54.3
Type 2 diabetes mellitus	13.8	10.8	9.2	8.9
Myocardial infarction	3.3	2.8	2.4	2.4
Stroke	3.1	2.7	2.6	2.2
Cancer	10.3	9.8	9.4	9.3
Depression	20.5	12.6	10.4	7.7
Age, years[c,d]	70.8 (7.1)	70.3 (6.9)	69.2 (6.7)	69.0 (6.7)
Diet (AHEI)[c]	54.5 (15.3)	56.9 (14.6)	58.4 (14.5)	59.0 (14.8)
Body mass index[c,e]	26.9 (5.7)	26.6 (5.3)	26.3 (5.1)	26.3 (5.1)

Abbreviations: AHEI, Alternative Healthy Eating Index; MET, metabolic equivalent of task.
[a] Optimism was measured using the Life Orientation Test-Revised.
[b] Values of polytomous variables may not sum to 100% because of rounding.
[c] Values are expressed as mean (standard deviation).
[d] Value is not adjusted for age.
[e] Weight (kg)/height (m)^2.

Table 2. Hazard Ratios for the Associations of Optimism With All-Cause Mortality[a], Nurses' Health Study, 2004–2012

Type of Variables and Model	Optimism Score Quartile								*P* for Trend
	1 (n = 3,538 cases; n = 147,454 person-years)		2 (n = 2,585 cases; n = 143,153 person-years)		3 (n = 1,728 cases; n = 127,589 person-years)		4 (n = 1,252 cases; n = 91,293 person-years)		
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	
Confounding variables									
Demographic model (core model)[b]	1.00	Referent	0.84	0.80, 0.89	0.74	0.70, 0.79	0.71	0.66, 0.76	<0.001
Depression model[c]	1.00	Referent	0.86	0.82, 0.91	0.77	0.72, 0.81	0.74	0.69, 0.80	<0.001
Intermediate variables									
Health conditions model[d]	1.00	Referent	0.85	0.81, 0.90	0.77	0.72, 0.81	0.73	0.68, 0.78	<0.001
Health behaviors model[e]	1.00	Referent	0.93	0.89, 0.98	0.87	0.82, 0.93	0.86	0.81, 0.92	<0.001
All potential confounding and intermediate variables	1.00	Referent	0.96	0.91, 1.01	0.91	0.86, 0.97	0.91	0.85, 0.97	<0.001

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Women who died within 2 years of baseline in 2004 (initial assessment of optimism) were excluded from the sample.
[b] Demographic factors included age, race, marital status, educational level, husband's educational level, and father's occupation when the participant was 16 years of age.
[c] The depression model included demographic factors and depression.
[d] The health conditions model included demographic factors and high cholesterol, hypertension, type 2 diabetes mellitus, myocardial infarction, stroke, cancer, and body mass index.
[e] The health behaviors model included demographic factors and smoking status, physical activity level, alcohol consumption, physical examination for screening purposes, and diet (Alternative Healthy Eating Index).

Optimism and risk of cause-specific mortality

As demonstrated in Table 3, in the core models, higher optimism was associated with a lower risk of mortality from many major causes of death, including cancer, heart disease, and stroke (for all, P for trend < 0.05). For example, when comparing the most optimistic individuals with the least, the most optimistic had a 16% lower hazard ratio for all cancers (95% CI: 0.74, 0.96); the hazard ratio was 0.62 (95% CI: 0.50, 0.76) for heart disease mortality and 0.61 (95% CI: 0.43, 0.85) for stroke mortality. Optimism was also associated with reduced hazard ratio for mortality from respiratory disease (HR = 0.63, 95% CI: 0.48, 0.82) and infection (HR = 0.48, 95% CI: 0.29, 0.80). Although the magnitude of the relative risk estimates for the specific causes of cancer mortality were consistent (HRs ranging from 0.82–0.88), none reached statistical significance, likely because of the limited number of deaths from each type of cancer.

Secondary analyses

After we excluded women with diagnoses of cardiovascular disease or cancer at baseline, the association between optimism and all-cause mortality was not meaningfully different (see Web Table 1, available at http://aje.oxfordjournals.org/). In analyses of cause-specific mortality (i.e., heart disease, stroke, and cancers), when we excluded participants who had the specific disease at baseline, the results were largely similar (see Web Table 2). When we considered optimism as a continuous variable in the core model, each standard-deviation increase in optimism was associated with a multivariate-adjusted hazard ratio of 0.86 (95% CI: 0.84, 0.88) for all-cause mortality. Finally, in analyses in which we used updated data on optimism score from 2008, results were similar to those from the main analyses but slightly stronger. For example, when comparing the most optimistic women to the least optimistic in the core model, the most optimistic women had a 36% lower hazard ratio for all-cause mortality (95% CI: 0.60, 0.69).

DISCUSSION

We found strong and statistically significant associations of increasing levels of optimism with decreasing risks of mortality, including mortality due each major cause of death, such as cancer, heart disease, stroke, respiratory disease, and infection. Importantly, findings were maintained after close control for potential confounding factors, including sociodemographic characteristics and depression (both diagnosed depression and depressive symptoms) and were still evident, although attenuated, even after inclusion of health conditions or health behaviors in the models.

To our knowledge, this is one of the first studies in which significant, broad-based associations between optimism and health, including cancer mortality, have been demonstrated in a general population sample. However, the association between optimism and cancer mortality was weaker than those observed for the other primary causes of death; some cancers (e.g., breast cancer) appear to be somewhat intractable to many feasible modifications, which might explain this weaker association. The observed association when all cancers were combined was stronger than that observed when considering specific types of cancer mortality. For any given type of cancer, the number of cases was often small (ranging from 153 to 579 cases), and the magnitudes of the hazard ratios were also small. If the true effect of optimism on cancer is somewhat small, it may be difficult to detect significant associations without substantially more cases; this may explain why prior work has reported null associations (our sample included 2,335 cancer deaths, compared with 317 in the only other large study in which this question was examined) (10). In the present study, however, the consistency of risk estimates across the different cancer types was striking.

Table 3. Hazard Ratios for the Associations of Optimism With Cause-Specific Mortality[a,b], Nurses' Health Study, 2004–2012

Cause of Death	No. of Deaths	Optimism Score Quartile								P for Trend
		1		2		3		4		
		HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	
Heart disease	986	1.00	Referent	0.77	0.66, 0.90	0.67	0.56, 0.80	0.62	0.50, 0.76	<0.001
Stroke	411	1.00	Referent	0.88	0.69, 1.11	0.88	0.67, 1.14	0.61	0.43, 0.85	0.014
Respiratory disease	659	1.00	Referent	0.85	0.70, 1.02	0.70	0.56, 0.87	0.63	0.48, 0.82	<0.001
Infection	185	1.00	Referent	0.71	0.50, 1.01	0.61	0.41, 0.92	0.48	0.29, 0.80	0.001
Total cancer	2,325	1.00	Referent	0.97	0.87, 1.07	0.85	0.76, 0.95	0.84	0.74, 0.96	0.002
Lung cancer	577	1.00	Referent	1.04	0.85, 1.27	0.86	0.68, 1.08	0.86	0.66, 1.12	0.179
Breast cancer	294	1.00	Referent	1.14	0.86, 1.54	1.04	0.76, 1.43	0.84	0.57, 1.22	0.698
Colorectal cancer	153	1.00	Referent	0.80	0.53, 1.18	0.63	0.39, 1.00	0.88	0.55, 1.40	0.140
Ovarian cancer	189	1.00	Referent	1.14	0.79, 1.64	1.09	0.74, 1.61	0.82	0.51, 1.33	0.828

Abbreviations: CI, confidence interval; HR, hazard ratio.

[a] Women who died within 2 years of baseline (initial assessment of optimism) were excluded from the sample.

[b] Adjusted for age, race, marital status, educational level, husband's educational level, and father's occupation when the participant was 16 years of age.

This is also one of the first studies in which the associations of optimism with death from infection and respiratory disease have been reported. The association with infection that we found is consistent with results from previous research that indicated the effects of optimism on immune function; studies have demonstrated that individuals with higher optimism levels have better immune responsiveness after vaccination and that changes in optimism levels predict alterations in immune functioning over time (37, 38). Further, the association with respiratory disease is consistent with previous research in which researchers demonstrated an association between higher levels of baseline optimism and healthier levels of objectively measured pulmonary function over the course of follow-up (39). However, the association of optimism with death from infection and respiratory disease should be interpreted cautiously because of the novelty of the findings and should be investigated further in future research.

Optimists appear to differ on numerous processes that are critically important to a broad spectrum of health outcomes. It has been shown in several studies that optimism is associated with a healthier lipid profile, lower levels of inflammatory markers, higher levels of serum antioxidants, and as noted above, better immune responsiveness (21, 37, 38, 40–42). Other investigations have suggested a slower rate of telomere shortening over time, healthier autonomic function, and higher levels of heart rate variability (43–45). Indeed, results from these reports of associations between optimism and a wide array of health factors are consistent with our finding that optimism is associated with multiple causes of death. Our results also suggest that we should consider healthier behaviors (e.g., eating a healthier diet, engaging in more physical activity, etc.)—which are associated with many disease outcomes—not simply as potential confounders, especially in light of past research that showed that optimism is associated with increased physical activity, higher-quality sleep, abstention from cigarette smoking, and consumption of healthier diets (19, 42, 46–49). In the present study, given that assessments of optimism preceded assessments of behavior and that primary associations were somewhat attenuated after inclusion of behavior in the model, our findings might suggest that these behaviors partly serve as a mechanism underlying the observed associations between optimism and mortality (35, 36) (although we recognize that it may be difficult to distinguish well between confounding and intermediate variables and that health behaviors may be both confounding and intermediate variables). Although the present study was not designed to test such mediational hypotheses, its results do suggest that studies that can explicitly test potential mediating pathways may be fruitful.

To our knowledge, there have been only 3 studies in which investigators have examined the association between dispositional optimism and mortality in a general population sample, and in those, only 2 specific causes of death were considered: cardiovascular disease and cancer (8–10). In a study conducted among 999 older Dutch men and women, higher levels of optimism were associated with 45%–77% lower risks of cardiovascular mortality and all-cause mortality (although that study did not control for depression) (8). In a second study conducted in a different sample of 545 older Dutch men, researchers similarly found that a higher level of optimism was associated with a substantially lower risk of cardiovascular mortality (9). In a third study, conducted among 97,253 US women, investigators also found that a higher optimism level was associated with lower risks of CHD-related and all-cause mortality, but findings for the cancer-mortality association were mixed (10). Thus, the few existing studies generally support our findings.

Limitations of the present study should be considered. Reverse causation is possible if underlying health conditions influence optimism. However, we conducted multiple analyses to minimize this issue. In the primary analyses, we measured optimism in 2004 and only considered deaths that occurred from 2006 to 2012 (the large majority of which occurred in the later years). In the secondary analyses, we excluded anyone with a major chronic disease at study baseline for the all-cause mortality analyses and anyone who had cancer, heart disease, or stroke at baseline for those cause-specific analyses. Our findings remained stable, indicating that reverse causality is unlikely to fully explain the observed associations. Residual confounding or confounding by unmeasured variables is always a limitation in observational research. In most studies on this topic, analyses were only adjusted for sociodemographic factors. However, we modeled a broad range of variables that may confound or possibly lie on the pathway linking optimism to disease outcomes, including sociodemographic factors, health conditions, health behaviors, depression, and depressive symptoms. The relation of optimism to mortality remained statistically significant across all analyses. Finally, our sample included mainly white women, and therefore our results might not be generalizable to minorities or men; however, there is no clear basis for believing that the effects of optimism on health differ by sex or race.

This study also has considerable strengths. The large and richly characterized cohort permitted adjustment for a large number of potential confounders, consideration of numerous additional variables, including factors known to contribute to optimism, and examination of more causes of death than has previously been possible.

In summary, optimism was broadly and robustly associated with a lower risk of mortality. Most importantly, in terms of public health, randomized trials have demonstrated that optimism can be altered with relatively uncomplicated interventions (12–16). Tested interventions range from structured classroom-style instruction and activities to brief paper-and-pencil exercises in which people are asked to write about a best possible version of themselves. Most of the interventions developed to date were evaluated in younger samples, and their durability has not been examined with longer follow-up times or with major chronic disease outcomes. Findings from the present study suggest the potential value of evaluating these interventions and their effectiveness among older individuals in the general population. Our finding that optimism is associated with a wide range of causes of mortality adds to a growing evidence base that optimism plays an important role in health and longevity, further supporting the possibility that optimism

could be a novel target for future research on prevention and intervention strategies aimed at improving public health.

ACKNOWLEDGMENTS

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The first 2 authors contributed equally to this work.

This work was supported by grants from the National Institutes of Health (P01 CA87969, UM1 CA186107, and T32 HL 098048).

We thank the staff of the Nurses' Health Study for their valuable contributions, as well as the cancer registries from the following states for their help: Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Minnesota, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Washington, and Wyoming. We also thank our funders for making this work possible.

The authors assume full responsibility for analyses and interpretation of these data.

Conflict of interest: E.S.K. worked as a consultant with AARP/Life Reimagined. The other authors report no conflicts.

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