Original Investigation

Association of Religious Service Attendance With Mortality Among Women

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IMPORTANCE Studies on the association between attendance at religious services and mortality often have been limited by inadequate methods for reverse causation, inability to assess effects over time, and limited information on mediators and cause-specific mortality.

OBJECTIVE To evaluate associations between attendance at religious services and subsequent mortality in women.

DESIGN, SETTING, AND PARTICIPANTS Attendance at religious services was assessed from the first questionnaire in 1992 through June 2012, by a self-reported question asked of 74 534 women in the Nurses' Health Study who were free of cardiovascular disease and cancer at baseline. Data analysis was conducted from return of the 1996 questionnaire through June 2012.

MAIN OUTCOMES AND MEASURES Cox proportional hazards regression model and marginal structural models with time-varying covariates were used to examine the association of attendance at religious services with all-cause and cause-specific mortality. We adjusted for a wide range of demographic covariates, lifestyle factors, and medical history measured repeatedly during the follow-up, and performed sensitivity analyses to examine the influence of potential unmeasured and residual confounding.

RESULTS Among the 74 534 women participants, there were 13 537 deaths, including 2721 owing to cardiovascular deaths and 4479 owing to cancer deaths. After multivariable adjustment for major lifestyle factors, risk factors, and attendance at religious services in 1992, attending a religious service more than once per week was associated with 33% lower all-cause mortality compared with women who had never attended religious services (hazard ratio, 0.67; 95% CI, 0.62-0.71; $P < .001$ for trend). Comparing women who attended religious services more than once per week with those who never attend, the hazard ratio for cardiovascular mortality was 0.73 (95% CI, 0.62-0.85; $P < .001$ for trend) and for cancer mortality was 0.79 (95% CI, 0.70-0.89; $P < .001$ for trend). Results were robust in sensitivity analysis. Depressive symptoms, smoking, social support, and optimism were potentially important mediators, although the overall proportion of the association between attendance at religious services and mortality was moderate (eg, social support explained 23% of the effect [$P = .003$], depressive symptoms explained 11% [$P < .001$], smoking explained 22% [$P < .001$], and optimism explained 9% [$P < .001$]).

CONCLUSIONS AND RELEVANCE Frequent attendance at religious services was associated with significantly lower risk of all-cause, cardiovascular, and cancer mortality among women. Religion and spirituality may be an underappreciated resource that physicians could explore with their patients, as appropriate.

Invited Commentary

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The World Health Organization defines health as "a state of complete physical, mental and social well-being."[1] Certain religious groups and others likewise view health holistically and emphasize the unity of body, mind, and spirit.[2-4] Health is often viewed as an inseparable component of spiritual well-being within some religious understandings.[5,6] Religious participation and beliefs can affect individual behavior, shift cognition and emotion, promote compassion, shape communities and public life, and may otherwise promote well-being, health, and wholeness, but religion can also promote guilt, anxiety, violence, and intolerance. A priori, the effects of religious practice on health are not thus immediately clear. Religious practice is common in the United States: approximately 65% of Americans consider religion to be an important part of life, 83% report praying to God in the last week, and 43% report having attended a religious service in the past week.[7,8]

A meta-analysis of studies on the connection between attendance at religious services and mortality between 1994 and 2009 concluded that religious service attendance helped reduce mortality by 18% in healthy populations.[9] Research on religion and health has led to some controversy.[9-12] Sloan et al[13,14] questioned the validity of these studies and argued that the evidence is often weak and unconvincing, with poor methods and study design. Denberg criticized this kind of research as "simply reporting an association and then calling for more future research," arguing that it was "trivial and unworthy of publication."[15(p430)] Koenig et al[16] responded that the review by Sloan et al was highly selective and biased with a misunderstanding of the epidemiologic method.

Much of the debate concerned major limitations to the methods in previous studies[10,17]: that it was difficult to infer causality and that the observed association could be owing to reverse causation if only healthy participants were able to attend services. Some stronger longitudinal studies on this subject have been published.[18-20] However, to our knowledge, no previous study has used methods for repeated measures and time-dependent confounding that handle potential reverse causation between service attendance and health and evaluate incident (ie, current, conditional on the past) rather than prevalent (ie, already present) attendance at religious services and its association with mortality. We address these issues using the Nurses' Health Study, a large prospective cohort study among US women with repeated measurements of attendance at religious services, including detailed information on diet and lifestyle, medical history, and long-term follow-up. In addition, we assess interactions with race, time-varying effects, and cause-specific mortality.

Key Points

Question Is frequent attendance at religious services associated with lower mortality among women?

Findings In a large prospective long-term cohort study of US women, the Nurses' Health Study, there was a consistent inverse association between frequent attendance at religious services and all-cause mortality, cardiovascular mortality, and cancer mortality. Compared with women who never attended religious services, women who attended more than once per week had 33% lower mortality during 16 years of follow-up, with depressive symptoms, smoking, social support, and optimism as potential mediators.

Meaning For those who already hold religious beliefs, religion and spirituality may be an underappreciated resource that physicians could explore with their patients, as appropriate.

Methods

Study Design

The Nurses' Health Study began in 1976 and included 121 700 nurses aged 30 to 55 years from across the United States.[21] Information on lifestyle and medical history was collected using a self-administered questionnaire at baseline and every 2 years thereafter. Attendance at religious services was first self-reported in 1992, and every 4 years subsequently, in response to the question, "How often do you go to religious meetings or services?" Response categories included more than once a week, once a week, 1 to 3 times per month, less than once per month, never (or almost never). We defined baseline for this analysis as attendance at religious services as assessed in the 1996 questionnaire; we used attendance in 1992 as an additional covariate. Follow-up for mortality continued through June 2012. Participants who did not reply to the 1996 questionnaire or who died before the baseline of 1996 (n = 27 101), who had missing data for attendance at religious services in 1996 (n = 7246), or who had a diagnosis of cardiovascular disease (n = 4362) or cancer (n = 8457, except nonmelanoma skin cancer) before 1996 were excluded. Participants were followed up from the return of the 1996 questionnaire until death, loss to follow-up, or the end of follow-up in June 2012, whichever came first. Our study included 74 534 participants with 1 104 175 person-years. There were 13 537 total deaths, including 2721 cardiovascular deaths and 4479 cancer deaths, during follow up. The study protocol was approved by the Brigham and Women's Hospital and Harvard T. H. Chan School of Public Health Institutional Review Boards.

Outcome

All-cause and cause-specific mortality was assessed between the return of the 1996 questionnaire and the end of follow-up (June 2012). Deaths were identified through reports from next of kin and the National Death Index. We identified causes of death based on family reports, death certificates, and medical records. We searched the National Death Index for names of nonresponders; this has been shown to have good sensitivity and specificity.[22] We used *International Classification of Diseases, 8th revision* (*ICD-8*) codes to define cancer-related deaths (codes 140-207) and cardiovascular disease–related deaths (codes 390-459 and 795). We used the following *ICD-8* codes to identify detailed subcategories of cardiovascular disease and cancer: ischemic heart disease (codes 410-414), cerebrovascular disease (codes 430-438), and any other cardiovascular disease (codes 390-459 and 795, excluding 410-414 and 430-438), and cancers of the lung (code 162), breast (code 174), ovaries (code 183), pancreas (code 157), colon or rectum (codes 153

and 154), and non-Hodgkin lymphoma (codes 200, 202, 204) and cancer of other sites.

Covariates

We adjusted the analyses for the following known predictors of mortality in this cohort: age (as a continuous variable in years), alcohol consumption (none, 0.1-4.9, 5.0-14.9, or ≥15.0 g/d), physical exercise (metabolic equivalent hours per week; quintiles), multivitamin use (yes or no), hypertension (yes or no), hypercholesterolemia (yes or no), type 2 diabetes mellitus (yes or no), menopausal status (premenopausal or postmenopausal), postmenopausal hormone use (never, past, and current), physical examination in the past 2 years (no, yes for symptoms, and yes for screenings), Alternate Healthy Eating Index-2010 score (quintiles),[23] smoking status (never, former, or current), pack-years (<10, 10-19, 20-39, or ≥40 pack-years for former smokers; <25, 25-44, 45-64,or ≥65 pack-years for current smokers), body mass index (calculated as weight in kilograms divided by height in meters squared; <21.0, 21.0-22.9, 23.0-24.9, 25.0-27.4, 27.5-29.9, 30.0-34.9, or ≥35.0), husband's educational level (less than high school, some high school, high school graduate, college, or graduate school), good physical function (defined as absence of limitations in moderate activities or moderate limitations in demanding activities; yes or no[24,25]), social integration score (derived from the following 6 components: marital status, other group participation, number of close friends, number of close relatives, number of close friends seen at least once per month, number of close relatives seen at least once per month[26]; quartiles), living alone (yes or no), median family income (dollars per year; quintiles), geographic region (North, South, Midwest, or other), depression in 1992 (yes or no), and attendance at religious services in 1992 (never, <1 time per week, or ≥1 time per week). Indicator variables were used for any missing covariate information for categorical variables and median imputation was used for missing continuous covariates.

For mediation analysis, covariate measurements before the religious attendance exposure were taken as potential confounders and those subsequent to religious attendance exposures were taken as potential mediators. For mediators, we considered the first measure available subsequent to 1996, which included, in 2000, depressive symptoms measured using the Center for Epidemiologic Studies Depression 10 scale[27]; in 1998, smoking, alcohol consumption, and diet quality; in 2000, number of close friends and having someone close to talk to; and in 2004, optimism and phobic anxiety measured using the Crown-Crisp Experiential Index.[28]

Statistical Analysis

Data analysis was conducted from return of the 1996 questionnaire through June 2012. We examined the association of attendance at religious services with all-cause and cause-specific mortality using various analytic strategies including Cox proportional hazards regression models and marginal structural models with weights accounting for missing data and censoring. The marginal structural models account for reverse causation and time-varying confounding by weighting and are described at length elsewhere,[29,30] and in eAppendix 1 in the Supplement. Person-time was accrued from baseline (return of the 1996 questionnaire) until the date of death, loss to follow-up, or June 2012, whichever came first. We calculated hazard ratios (HRs) and their 95% CIs, comparing frequency of attendance at religious services (more than once per week, once per week, or less than once per week) vs never attend, for all-cause mortality and cause-specific mortality. For cause-specific mortality, we also further adjusted for cause-specific risk factors. Linear trends across categories of attendance at religious services were tested by modeling attendance frequency as a continuous variable. Confounders were adjusted for in 1992 in the Cox proportional hazards regression models; confounders were updated over time in the marginal structural model. We examined the joint effect of attendance at religious services in 1996 and 2000 with all-cause mortality from 2000 to 2012. We further stratified the analysis by race/ethnicity (among white and African American participants only), and religious group (among Catholic and Protestant participants only). Likelihood ratio tests were used to assess the significance of the interaction. The relative excess risk due to interaction and its 95% CI were calculated.[31,32]

We applied mediation analysis methods[33,34] to examine proportions of the association between attendance at religious services in 1996 and mortality in 2012 that was mediated by the following factors: current smoking, alcohol intake, and diet quality in 1998; social support and depressive symptoms in 2000; components of social integration in 2000 (including currently married, number of close friends, number of close relatives, seen close friends at least once per month, seen close relatives at least once per month, and hours of social group participation); and phobic anxiety and optimism in 2004. For the mediation analysis, we further excluded participants who had mediator information missing or who died between baseline and the mediator measurement. These mediators were selected a priori based on subject knowledge and assessed using multivariable logistic regression and linear regression models of the outcome and of the potential mediator, the results of which were then combined to estimate direct and indirect effects.[33,34] Methods for mediation assume baseline covariates suffice to control for exposure-outcome, mediator-outcome, and exposure-mediator confounding. Proportion mediated on a risk difference scale was calculated as the indirect effect divided by the total effect and tests were conducted for evidence of mediation. We further examined the change in attendance at religious services over time and calculated years of life saved.[35]

We conducted several sensitivity analyses to test the robustness of our results. To minimize the influence of reverse causation, we additionally performed subgroup analyses among participants who were not living in a nursing home, never smokers, with no physical or functional limitations, and no major medical comorbidities (such as depression), and excluded death events in the first 4 years of follow-up. We compared effects sizes of attendance at religious services with other components of social integration and with other covariates. We also updated covariates, modeled attendance at religious services as time-varying exposure, compared HRs over different specific time frames of follow-up, and with different analytic

strategies as sensitivity analyses. We further assessed how substantial residual unmeasured confounding would need to be to explain away the observed associations.[17,36]

Results

Among 74 534 women at 1996 baseline with reported religious service attendance, 14 158 attended more than once per week, 30 401 attended once per week, 12 103 attended less than once per week, and 17 872 never attended (**Table 1**). Most of our study participants were Catholic or Protestant. Women who attended religious services more frequently tended to have fewer depressive symptoms, were less likely to be current smokers, and were more likely to be married (Table 1). During follow up, most participants maintained their levels of attendance at religious services, but there was also considerable movement across all categories (eTable 1 in the Supplement).

Using a Cox proportional hazards regression model, compared with women who never attended religious services, women who attended regularly had lower mortality on follow-up (**Figure**), with a multivariable-adjusted HR of 0.67 (95% CI, 0.62-0.71) for those attending more than once per week in 1996, HR of 0.74 (95% CI, 0.70-0.78) for those attending weekly, and HR of 0.87 (95% CI, 0.81-0.92) for those attending less than weekly ($P < .001$ for trend). Those who attended religious services regularly in both 2000 and 1996 had even lower mortality rates, with a multivariable-adjusted HR of 0.55 (95% CI, 0.52-0.59 [**Table 2**]). When using marginal structural models to better address potential feedback and reverse causation, the effect sizes were similar (Table 2). Results were also similar in analyses among participants who were not living in a nursing home, never smokers, with no physical or functional limitations, and no major medical comorbidities (such as depression), and with exclusion of death events in the first 4 years of follow up (eTable 2 and eTable 3 in the Supplement). Effect size of attendance at religious services was comparable with those of various health behaviors (eTable 4 in the Supplement). The inverse association between attendance at religious services and mortality were consistent over time (eTable 5 in the Supplement). Attendance at religious services once per week or more was associated with 0.43 (95% CI, -0.09 to -1.54) years' longer survival for the 16 years of the study (eAppendix 2 in the Supplement).

In the Cox model, for an unmeasured confounder to explain the HR estimate of 0.67, the unmeasured confounder would have to both increase the likelihood of attendance at religious services and decrease the likelihood of mortality by 2.35-fold above and beyond the measured confounders. For an unmeasured confounder to bring the upper confidence limit of 0.71 for this estimate above 1.0, the unmeasured confounder would still have to both increase the likelihood of attendance at religious services and decrease the likelihood of mortality by 2.16-fold. Similar substantial confounding would be needed to explain the other estimates.

For cause-specific mortality, frequent attendance at religious services was also inversely associated with cardiovascular mortality and cancer mortality, with an HR of 0.73 (95% CI, 0.62-0.85; $P < .001$ for trend) and an HR of 0.79 (95% CI, 0.70-0.89; $P < .001$ for trend), respectively (**Table 3**). Attendance at religious services was associated with lower mortality from cerebrovascular disease and other cardiovascular diseases, but not from ischemic heart disease (eTable 6 in the Supplement). For site-specific cancer mortality, frequent attendance at religious services is associated with significantly lower risk of breast cancer mortality and colorectal cancer mortality, but not for other sites of cancer (eTable 7 in the Supplement). Although attendance at religious services was associated with lower cardiovascular mortality and cancer mortality, attendance was not significantly associated with incidence of breast cancer (eTable 8 in the Supplement) or cardiovascular disease (eTable 9 in the Supplement).

The HR comparing those attending religious services more than once per week with those not attending was 0.88 (95% CI, 0.85-0.92) for white participants and 0.64 (95% CI, 0.46-0.90) for African American participants (eTable 10 in the Supplement; $P = .08$ for heterogeneity). The HRs for service attendance were comparable for Protestants and Catholics; for each level of service attendance, Catholics had slightly lower mortality than did Protestants (eTable 11 in the Supplement). We further compared the magnitude of the association of attendance at religious services with other aspects of social integration and found that the inverse association with mortality was strongest for attendance at religious services (eTable 12 in the Supplement).

We used mediation analysis to estimate the proportion of the association that was mediated through each mediator. Depressive symptoms, smoking, social support, and optimism were potentially important mediators, although the overall proportion of the association that was mediated through each mediator was moderate (eg, smoking explained 22% of the effect, social support explained 23%) (**Table 4**).[26]

Discussion

In this large prospective cohort of US nurses, we found a consistent inverse association between frequent attendance at religious services and all-cause mortality, cardiovascular mortality, and cancer mortality. Compared with women who never attended religious services, women who attended services more than once per week had a 33% lower mortality risk; results were robust across different race/ethnicity groups, different analytic strategies, and in sensitivity analyses.

In examining the potential pathways from religious service to all-cause mortality, we found that depressive symptoms, smoking, social support, and optimism were potentially important mediators. No single mediator explained more than about 25% of the effect. There may be many pathways from attendance at religious services to health. However, the proportion of effects mediated may be underestimated, as mediators were considered only at a single time point and are measured imperfectly. Moreover, some individuals died before the mediators occurred and were excluded further, which may affect our results. Future studies implementing causal mediation analysis with time-varying attendance at religious ser-

Table 1. Age-Adjusted Baseline Characteristics and Subsequent Mediators of Study Participants by Frequency of Attendance at Religious Services in 1996

Characteristic[a]	Attendance at Religious Service in 1996[b]			
	Never (n = 17 872)	Less Than Once per Week (n = 12 103)	Once per Week (n = 30 401)	More Than Once per Week (n = 14 158)
Age at 1996, mean (SD), y[c]	61.1 (7.1)	60.8 (7.2)	62.1 (7.1)	63.2 (6.9)
Attendance at religious services in 1992				
Never	14 047 (78.6)	2312 (19.1)	912 (3.0)	156 (1.1)
Less than once per week	3288 (18.4)	8157 (67.4)	4803 (15.8)	637 (4.5)
Once or more than once per week	536 (3.0)	1634 (13.5)	24 686 (81.2)	13 365 (94.4)
White participants	17515 (98.0)	11 740 (97.0)	29 793 (98.0)	13 733 (97.0)
Religious group				
Catholic	5183 (29.0)	3389 (28.0)	16 417 (54.0)	5805 (41.0)
Protestant	11 081 (62.0)	7504 (62.0)	13 072 (43.0)	7362 (52.0)
Other Christian	357 (2.0)	242 (2.0)	608 (2.0)	849 (6.0)
Ashkenazi Jewish	715 (4.0)	726 (6.0)	304 (1.0)	0
Sephardic Jewish	0	0	0	0
Eastern (eg, Buddhist, Hindu)	0	0	0	0
Muslim	0	0	0	0
Other religious heritage	357 (2.0)	121 (1.0)	304 (1.0)	142 (1.0)
Did not answer the question	179 (1.0)	121 (1.0)	0	0
College and graduate school	10 008 (56.0)	6899 (57.0)	16 417 (54.0)	7645 (54.0)
Diabetes	1072 (6.0)	847 (7.0)	1824 (6.0)	849 (6.0)
Hypertension	7149 (40.0)	4962 (41.0)	11 856 (39.0)	5380 (38.0)
Hypercholesterolemia	9293 (52.0)	6415 (53.0)	16 113 (53.0)	7504 (53.0)
Physical examination in past 2 y	15 549 (87.0)	10 893 (90.0)	27 665 (91.0)	12 884 (91.0)
Current hormone use	8757 (49.0)	6173 (51.0)	14 592 (48.0)	7079 (50.0)
Geographic region				
North	6613 (37.0)	4478 (37.0)	10 944 (36.0)	4672 (33.0)
West	2323 (13.0)	1331 (11.0)	2736 (9.0)	1841 (13.0)
Midwest	7149 (40.0)	5083 (42.0)	13 680 (45.0)	6230 (44.0)
Other	1787 (10.0)	1210 (10.0)	3040 (10.0)	1416 (10.0)
BMI, mean (SD)	26.5 (5.5)	26.6 (5.3)	26.5 (5.1)	26.5 (5.1)
Physical activity, mean (SD), MET-h/wk	17.7 (22.9)	18.2 (21.6)	17.7 (22.0)	17.8 (20.5)
Current smokers	3574 (20.0)	1694 (14.0)	3040 (10.0)	708 (5.0)
Age at first birth, mean (SD), y	24.7 (3.9)	24.8 (3.8)	24.8 (3.7)	24.8 (3.9)
Parity, mean (SD), No.	2.9 (1.6)	2.9 (1.6)	2.9 (1.6)	2.9 (1.6)
No physical function limitation	8579 (48.0)	5930 (49.0)	15 809 (52.0)	7221 (51.0)
Depression in 1996	1430 (8.0)	847 (7.0)	1824 (6.0)	708 (5.0)
Multivitamin use	9115 (51.0)	6657 (55.0)	15 809 (52.0)	7928 (56.0)
Alcohol consumption, mean (SD), g/d	6.8 (11.2)	5.4 (9.0)	4.6 (8.3)	3.4 (7.2)
Live alone	3038 (17.0)	1936 (16.0)	4256 (14.0)	2124 (15.0)
Not employed in last 2 y	7149 (40.0)	4478 (37.0)	11 856 (39.0)	6088 (43.0)
Alternate Healthy Eating Index-2010 quintile 5, best diet quality	3396 (19.0)	2421 (20.0)	6080 (20.0)	2973 (21.0)
Current smoking in 1998	3038 (17.0)	1452 (12.0)	2432 (8.0)	566 (4.0)
Alcohol consumption in 1998, mean (SD), g/d	6.6 (10.9)	5.4 (9.2)	4.6 (8.4)	3.4 (7.3)
Depressive symptoms in 2000, mean (SD)[d]	79.3 (14.4)	80.1 (13.4)	80.9 (12.9)	82.3 (12.2)
Social integration score in 2000, mean (SD)	4.2 (2.6)	4.9 (2.8)	5.4 (2.7)	5.9 (2.8)
Currently married in 2000	12 510 (70.0)	8714 (72.0)	23 105 (76.0)	10 902 (77.0)
Close relatives seen monthly in 2000, mean (SD), No.	1.9 (1.1)	2.2 (1.2)	2.3 (1.2)	2.4 (1.3)
Close friends seen monthly in 2000, mean (SD), No.	2.7 (1.1)	2.9 (1.1)	2.9 (1.1)	3.2 (1.1)
Relatives you feel close to in 2000, mean (SD), No.	3.0 (1.5)	3.2 (1.5)	3.4 (1.5)	3.5 (1.5)

(continued)

Table 1. Age-Adjusted Baseline Characteristics and Subsequent Mediators of Study Participants by Frequency of Attendance at Religious Services in 1996 (continued)

Characteristic[a]	Attendance at Religious Service in 1996[b]			
	Never (n = 17 872)	Less Than Once per Week (n = 12 103)	Once per Week (n = 30 401)	More Than Once per Week (n = 14 158)
Close friends in 2000, mean (SD), No.	3.2 (1.2)	3.4 (1.1)	3.5 (1.2)	3.6 (1.2)
Hours per week in social groups in 2000, mean (SD)	1.9 (1.4)	2.0 (1.4)	2.3 (1.3)	2.9 (1.3)
Optimism score in 2004, mean (SD)	24.1 (4.9)	24.4 (4.8)	24.5 (4.8)	25.2 (4.4)
Phobic anxiety score in 2004, mean (SD)	2.9 (2.4)	2.9 (2.4)	3.0 (2.5)	2.8 (2.4)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); MET, metabolic equivalent.

[a] Covariates were taken from the 1996 questionnaire.

[b] Data are presented as number (percentage) of patients unless otherwise indicated. Values are standardized to the age distribution of the study population.

[c] Value is not age adjusted.

[d] Score from 0 to 100.

vices, time-varying mediators, and confounders are warranted. Other mechanisms that have been proposed that were not assessed here include increasing psychosocial resilience, religious coping mechanisms, purpose in life, and self-discipline.[37]

Our findings were consistent with the results of previous studies and the effect sizes were similar or somewhat larger, especially when examining associations with a consistent pattern of attendance at religious services. The literature supports the notion that attendance at religious services is associated with better health and reduced mortality.[14,38-43] In our study, we were able to account for time-dependent confounding and examined the association between repeated measures of attendance at religious services with long-term all-cause and cause-specific mortality. Although our study was not targeted to a particular religious group, the study consists mainly of white Christians. Our results might not be generalizable to the general population, other countries, or areas with limited religious freedom. Moreover, our study population consists of US nurses with similar socioeconomic status who tend to be more health conscious. Our analysis is also restricted to the specific period under consideration, and the effects of attendance at religious services may vary over time as the nature of attendance itself changes. Although frequency of attendance at religious services did not substantially change in our study, it is possible that the content of the services themselves changed. Further research could examine other religious practices, mindfulness practices, other aspects of spirituality and religiosity, other race/ethnicity and demographic groups, and could further investigate the potential underlying mechanisms of causal pathways.[44,45] Our results do not imply that health care professionals should prescribe attendance at religious services, but for those who already hold religious beliefs, attendance at services could be encouraged as a form of meaningful social participation.

One limitation of our study is that we have only 1 domain measure of religiosity or spirituality, namely, attendance at religious services. This domain captures only 1 aspect of religiosity and may be subject to measurement error and overreporting,[46-48] although with overreporting the relative ordering of frequency might still be preserved. There is no reason to think that individual overreporting would be related to mortality, and such nondifferential misclassification in fact tends to yield conservative effect estimates.[49] Our finding of substantially lower breast cancer mortality in frequent attenders, despite no association with breast cancer incidence, lends support to an effect of social participation and enhances the plausibility of our results. Attendance at religious services may be highly correlated with other measures of social engagement, such as number of close friends and having someone close to talk to, which are significant predictors for lower mortality and thus may serve as important mechanisms. However, some studies of the health effects of religious attendance[4,50] have examined the role of other measures of

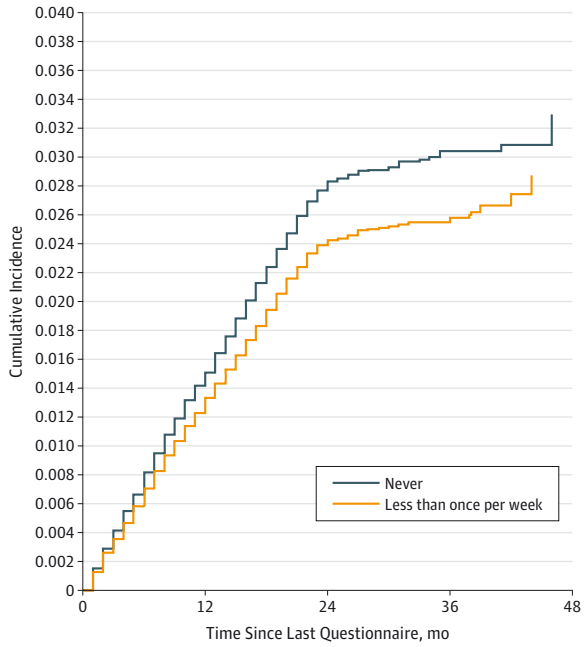
Table 2. Joint Effects of Attendance at Religious Services in 1996 and 2000 With All-Cause Mortality in the Nurses' Health Study, 2000-2012

Attendance at Religious Services			Multivariable HR (95% CI)[a]	
1996	2000	Deaths, No./Person-years	All-Cause Mortality, Cox Model	All-Cause Mortality, MSM
Less than once per week	Never	5897/322 052	1 [Reference]	1 [Reference]
Less than once per week	Less than once per week	1140/132 130	0.71 (0.66-0.76)	0.45 (0.40-0.50)
Less than once per week	Once per week	425/40 790	0.76 (0.68-0.84)	0.48 (0.41-0.58)
Less than once per week	More than once per week	73/6535	0.85 (0.67-1.07)	0.54 (0.35-0.83)
At least once per week	Never	157/7828	0.90 (0.77-1.07)	1.13 (0.93-1.36)
At least once per week	Less than once per week	526/53 736	0.71 (0.65-0.78)	0.46 (0.40-0.54)
At least once per week	Once per week	3517/348 329	0.61 (0.58-0.64)	0.52 (0.48-0.56)
At least once per week	More than once per week	1802/192 776	0.55 (0.52-0.59)	0.50 (0.46-0.54)

Abbreviations: HR, hazard ratio; MSM, marginal structural model.

[a] For the predictors the multivariable model adjusted for, see the Covariates subsection of the Methods section.

Figure. Cumulative Incidence of All-Cause Mortality and Attendance at Religious Services in the Nurses' Health Study, 1996-2012



For the predictors the multivariable model adjusted for, see the Covariates subsection of the Methods section. Hazard ratio, 0.67 (95% CI, 0.62-0.71; *P* < .001 for trend for Cox model).

social engagement and find that religious attendance has robust effects even after the inclusion of these measures. In our study, this was also the case, and we moreover found that the inverse association between social support and mortality was driven substantially by attendance at religious services. Future research could assess associations with other forms of social participation.

A randomized trial of attendance at religious services is neither ethical nor feasible. Our study is an observational study. Although we adjusted for major confounders for the association between attendance at religious services and mortality, the results may still be subject to unmeasured confounders and residual confounding. Personal, social, psychological, and socioeconomic characteristics may confound attendance at religious services and explain the association; for example, data on optimism were not available at baseline. However, we performed sensitivity analysis techniques to assess how strong unmeasured confounding would need to be to explain the observed association. For an unmeasured confounder to explain the association of attendance at religious services and lower mortality, it would have to both increase the likelihood of attendance at services and decrease the likelihood of mortality by 2.35-fold above and beyond the measured covariates. Such substantial confounding by unmeasured factors seems unlikely, given adjustment for an extensive set of covariates. We also performed subgroup analyses among participants who were not living in a nursing home, never smokers, had no physical or functional limitations, and had no major medical comorbidities (such as depression), and we excluded death events in the first 4 years of follow-up, and estimates were similar.

Table 4. Mediation Analysis Between Attendance at Religious Services in 1996 and All-Cause Mortality in 2012

Mediator	Proportion Mediated, %	*P* Value for Indirect Effect
Depressive symptoms[a]	11	<.001
Current smoking[b]	22	<.001
Alcohol[c]	0.2	.76
Diet quality[d]	−0.03	.94
Phobic anxiety[e]	−1	.65
Optimism[f]	9	<.001
Social integration score derived without religious service attendance	23	.003

[a] Depressive symptoms: continuous score in 2000; measured using the Center for Epidemiologic Studies Depression-10 scale.

[b] Smoking: current smoking vs past or never smoking in 1998.

[c] Alcohol: defined as a binary variable, heavy drinker (>50 g/d) vs moderate (≤50 g/d) or never drinker in 1998.

[d] Diet quality: continuous score, defined as Alternate Healthy Eating Index–2010 score, measured in 1998.

[e] Phobic anxiety: continuous score measured in 2004 using the Crown-Crisp Index.

[f] Optimism: continuous score, measured in 2004.

Table 3. Multivariable Adjusted Hazard Ratios Between Attendance at Religious Services and Cardiovascular Disease and Cancer Mortality in the Nurses' Health Study, 1996-2012[a]

	Attendance at Religious Services				
Mortality	Never	Less Than Once per Week	Once per Week	More Than Once per Week	*P* Value for Trend
All cardiovascular disease (n = 2721)					
Cases, No.	670	378	1116	557	
Age-adjusted HR (95% CI)	1 [Reference]	0.86 (0.74-0.99)	0.74 (0.66-0.82)	0.62 (0.54-0.71)	<.001
Multivariable HR (95% CI)	1 [Reference]	0.92 (0.79-1.06)	0.80 (0.70-0.91)	0.73 (0.62-0.85)	<.001
All cancer (n = 4479)					
Cases, No.	1255	692	1752	780	
Age-adjusted HR (95% CI)	1 [Reference]	0.78 (0.70-0.87)	0.71 (0.66-0.77)	0.59 (0.54-0.66)	<.001
Multivariable HR (95% CI)	1 [Reference]	0.91 (0.81-1.01)	0.86 (0.78-0.95)	0.79 (0.70-0.89)	<.001

Abbreviation: HR, hazard ratio.

[a] For the predictors the multivariable model adjusted for, see the Covariates subsection of the Methods section.

Strengths of our study include a large sample size, long duration of follow-up, prospective cohort study design, and repeated measures of attendance at religious services, analytic methods for feedback and reverse causation, and extensive control of confounding. We have clear temporality of the exposure, covariates, and outcome, and have been able to adjust for baseline attendance at religious services and baseline confounders, and account for time-dependent confounding. Our results were robust across statistical methods of analysis, exclusions to address reverse causation, and in sensitivity analysis for unmeasured confounding.

Conclusions

In this large prospective long-term cohort study of US women, frequent attendance at religious services, particularly recent attendance, was associated with lower risk of all-cause mortality, cardiovascular mortality, and cancer mortality.

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