Association of Religious Service Attendance With Mortality Among Women

Shanshan Li, ScD; Meir J. Stampfer, MD, DrPH; David R. Williams, PhD; Tyler J. VanderWeele, PhD

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.
The World Health Organization defines health as “a state of complete physical, mental and social well-being.” Certain religious groups and others likewise view health holistically and emphasize the unity of body, mind, and spirit. Health is often viewed as an inseparable component of spiritual well-being within some religious understandings. 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 whole-ness, 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.

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. Research on religion and health has led to some controversy. Sloan et al 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 methods and study design. Denberg criticized this kind of research as “simply reporting an association and then calling methods and study design. Denberg criticized this kind of research as “simply reporting an association and then calling methods and study design. Denberg criticized this kind of research as “simply reporting an association and then calling methods and study design. 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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 no24,25), 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 month26; 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 Scale; 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 methods33,34 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
Table 1. Age-Adjusted Baseline Characteristics and Subsequent Mediators of Study Participants by Frequency of Attendance at Religious Services in 1996

| Characteristic                                      | Attendance at Religious Service in 1996<sup>a</sup> | Age at 1996, mean (SD), y<sup>c</sup> | Religions group<sup>b</sup> | College and graduate school | Geographic region<sup>b</sup> | BMI, mean (SD) | Physical activity, mean (SD), MET-h/wk | Current smokers | Age at first birth, mean (SD), y | Parity, mean (SD), No. | No physical function limitation | Depression in 1996 | Multivitamin use | Alcohol consumption, mean (SD), g/d | Live alone | Not employed in last 2 y | Alternate Healthy Eating Index-2010 quintile 5, best diet quality | Current smoking in 1998 | Alcohol consumption in 1998, mean (SD), g/d | Depressive symptoms in 2000, mean (SD)<sup>d</sup> | Social integration score in 2000, mean (SD) | Currently married in 2000<sup>b</sup> | Close relatives seen monthly in 2000, mean (SD)<sup>d</sup>, No. | Close friends seen monthly in 2000, mean (SD)<sup>d</sup>, No. | Relatives you feel close to in 2000, mean (SD), No. | Phobic anxiety score in 2004, mean (SD) |
|----------------------------------------------------|--------------------------------------------------|-------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------|-------------------------------------|-----------------|-----------------------------------|----------------------|---------------------------------------|-------------------|------------------------|---------------------------------------|-------------------|-----------------------------------|-----------------------------------------------|------------------|-----------------------------------|------------------------------------------|-------------------|---------------------------------------------|----------------------|-------------------|
| Age at 1996, mean (SD), y                           | Never (n = 17872)                                 | 61.1 (7.1)                          | 5183 (29.0)                  | 10 008 (56.0)               | North                       | 6.8 (11.2)     | 19.7 (22.9)                         | 22.6 (5.5)      | 24.7 (3.9)                         | 2.9 (1.6)            | 8579 (48.0)                     | 1430 (8.0)         | 9115 (51.0)                     | 6.6 (10.9)                  | 739.3 (13.4)               | 4.2 (2.6)                          | 12510 (70.0)                     | 79.3 (14.4)                  | 3.0 (1.5)                              | 2.9 (2.4)                          | 2.8 (2.4)                          |
|                                                   | Less Than Once per week (n = 12103)               | 60.8 (7.2)                          | 3389 (28.0)                  | 6899 (57.0)                 | West                        | 5.4 (9.0)      | 18.2 (21.6)                         | 26.6 (5.3)      | 24.8 (3.8)                         | 2.9 (1.6)            | 5930 (49.0)                     | 847 (7.0)          | 6657 (55.0)                     | 5.4 (9.2)                  | 80.1 (13.4)               | 4.9 (2.8)                          | 38714 (72.0)                      | 80.1 (13.4)                  | 3.2 (1.5)                              | 2.9 (2.4)                          | 2.8 (2.4)                          |
|                                                   | Once per Week (n = 30401)                         | 62.1 (7.1)                          | 16 417 (54.0)               | 10 944 (54.0)               | Midwest                     | 4.6 (8.3)      | 17.7 (22.0)                         | 26.5 (5.1)      | 24.8 (3.7)                         | 2.9 (1.6)            | 15 809 (52.0)                    | 1824 (7.0)         | 15 809 (52.0)                    | 4.6 (8.4)                  | 80.9 (12.9)               | 5.4 (2.7)                          | 23105 (76.0)                      | 80.9 (12.9)                  | 3.4 (1.5)                              | 5.9 (2.8)                          | 2.9 (2.4)                          |
|                                                   | More Than Once per Week (n = 14158)               | 63.2 (6.9)                          | 5805 (41.0)                  | 7645 (54.0)                 | Other                       | 3.4 (7.2)      | 17.8 (20.5)                         | 26.5 (5.1)      | 24.8 (3.9)                         | 2.9 (1.6)            | 7221 (51.0)                     | 6088 (4.0)         | 7928 (56.0)                     | 3.4 (7.3)                  | 82.3 (12.2)               | 5.9 (2.8)                          | 10 902 (77.0)                     | 82.3 (12.2)                  | 3.5 (1.5)                              | 5.9 (2.8)                          | 2.8 (2.4)                          |

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

<sup>a</sup>Covariates were taken from the 1996 questionnaire.

<sup>b</sup>Data are presented as number (percentage) of patients unless otherwise indicated. Values are standardized to the age distribution of the study population.

<sup>c</sup>Value is not age adjusted.

<sup>d</sup>Score from 0 to 100.
strategies as sensitivity analyses. We further assessed how substantial residual unmeasured confounding would need to be to explain away the observed associations.\textsuperscript{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 1996 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 2.35-fold above and beyond the measured confounders.

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

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

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

* For the predictors the multivariable model adjusted for, see the Covariates subsection of the Methods section.
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, 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

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).

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

<table>
<thead>
<tr>
<th>Mortality</th>
<th>Attendance at Religious Services</th>
<th>P Value for Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cardiovascular disease (n = 2721)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases, No.</td>
<td>670</td>
<td>378</td>
</tr>
<tr>
<td>Age-adjusted HR (95% CI)</td>
<td>1 (Reference)</td>
<td>0.86 (0.74-0.99)</td>
</tr>
<tr>
<td>Multivariable HR (95% CI)</td>
<td>1 (Reference)</td>
<td>0.92 (0.79-1.06)</td>
</tr>
<tr>
<td>All cancer (n = 4479)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases, No.</td>
<td>1255</td>
<td>692</td>
</tr>
<tr>
<td>Age-adjusted HR (95% CI)</td>
<td>1 (Reference)</td>
<td>0.78 (0.70-0.87)</td>
</tr>
<tr>
<td>Multivariable HR (95% CI)</td>
<td>1 (Reference)</td>
<td>0.91 (0.81-1.01)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Mediator</th>
<th>Proportion Mediated, %</th>
<th>P Value for Indirect Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depressive symptoms*</td>
<td>11</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Current smokingb</td>
<td>22</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Alcoholc</td>
<td>0.2</td>
<td>.76</td>
</tr>
<tr>
<td>Diet qualityd</td>
<td>−0.03</td>
<td>.94</td>
</tr>
<tr>
<td>Phobic anxietye</td>
<td>−1</td>
<td>.65</td>
</tr>
<tr>
<td>Optimismf</td>
<td>9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Social integration score derived without religious service attendance</td>
<td>23</td>
<td>.003</td>
</tr>
</tbody>
</table>

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

b 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.

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).
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. 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.

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, 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. 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 have examined the role of other measures of 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.

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.
Research

Original Investigation

Religious Service Attendance and Mortality Among Women

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Author Contributions: Drs Li and VanderWeele had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Li, VanderWeele.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Li, VanderWeele.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Li, VanderWeele.

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Administrative, technical, or material support: Stamper, Williams, VanderWeele.

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Empirical Studies About Attendance at Religious Services and Health

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In this issue of JAMA Internal Medicine, Li et al1 report a clear and moderately strong association between attendance at religious services and decreased mortality during a 16-year follow-up of a subgroup from the Nurses’ Health Study. The study by Li et al1 includes baseline and follow-up data from 74,534 participants and documented 13,537 deaths. The inverse association of attendance at religious services and adverse health outcomes has been studied extensively, with most results in concert with the study by Li et al, so the results are primarily confirmatory. However, this study is a major contribution to the literature.2

A particular strength of the study, in addition to the large sample size and excellent participation over time by the enrolled women, is the ability to test the temporal association between the independent variable and the outcome variable at multiple time points as well as the use of time-varying covariates to control for confounding, especially by social support and functional status. A favorable distribution of participants across the different categories of attendance at religious services, from almost never to more than once per week, provides ample numbers for comparison. Even so, the study exhibits limitations in terms of generalizability, many of which are acknowledged by the authors yet should be highlighted. Before addressing these limitations, however, we may ask, “What is the rationale for publishing studies about religion in a medical journal focused on documenting empirical evidence related to health and health care?”

First, readers and investigators must, as do these authors, focus on the data, no more and no less, and not attempt to generalize beyond the evidence. The study by Li et al does not address philosophical or theological questions such as, “Does God (or any higher being) exist?” The data do not validate claims made about some of the positive benefits of specific religious experiences, claims made even by medical professionals.3 Nor do the data address a biological mechanism by which the religion or spirituality variable enhances health, as do Miller et al4 in their study of the importance of spiritual experience in protecting against the onset of depression, with cortical thickening being associated with spirituality in certain regions of the brain, suggesting a possible mechanism. Finally, the data do not suggest that medical professionals should recommend attendance at religious services. In other words, the data cannot be taken even as proof of concept for intervention. For such an intervention to be validated, a randomized clinical trial would be required, which is almost certainly unethical, as emphasized by the authors.1

Second, readers must recognize that studies of religion and spirituality have proliferated dramatically for the past 20 to 30 years.3 Investigators have answered this question positively, given the significant increase in publications exploring the association of religion or spirituality and health that have entered the mainstream of scientific reports. Therefore, such studies should be evaluated using the same criteria with which any published empirical study is evaluated. Despite the obvious strengths of the study by Li et al, there are clear limitations, which are basically embedded in the nature of the sample itself and faced by all investigators who perform secondary data analysis. These limitations, in my view, primarily constrict our ability to generalize from the data presented to the population in general. What are these limitations?

The study addresses only one aspect of religion and spirituality, namely, attendance at religious services. Reasons for attendance at religious services may vary appreciably across individuals, such as religious devotion, lifelong habits, social pressures, and perhaps simple loneliness causing individuals to search for a support group with which to connect. One of the strengths of the study is that the investigators explore extensively the role of social supports as a confounding variable in their longitudinal analyses and the explanatory power of attendance at religious services remains robust in these controlled analyses. However, we have no assurance that attendance at religious services is a marker of the strength of one’s religion or spirituality and no description of the extent of private practices of spirituality, such as prayer, or perceptions of spiritual well-being among the participants.

In addition, the sample is derived from female nurses who volunteered to participate in the study. These women are therefore better educated than the general population, more willing to participate in activities that are of value to the larger community given their volunteer status, and informed about health and health care in general. The mean baseline age of the participants is 60 years or older and therefore the study cannot be