



## Miscellaneous

# Religious-service attendance and subsequent health and well-being throughout adulthood: evidence from three prospective cohorts

Ying Chen,<sup>1,2</sup> Eric S Kim<sup>3</sup> and Tyler J VanderWeele<sup>1,2\*</sup>

<sup>1</sup>Human Flourishing Program, Harvard Institute for Quantitative Social Science, Cambridge, MA, USA,

<sup>2</sup>Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, MA, USA and

<sup>3</sup>Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, MA, USA

\*Corresponding author. Department of Epidemiology, Harvard T. H. Chan School of Public Health, Kresge Building, 677 Huntington Avenue, Boston, MA 02115, USA. E-mail: tvanderw@hsph.harvard.edu

Editorial decision 15 March 2020; Accepted 19 June 2020

## Abstract

**Background:** Religious-service attendance has been linked with a lower risk of all-cause mortality, suicide and depression. Yet, its associations with other health and well-being outcomes remain less clear.

**Methods:** Using longitudinal data from three large prospective cohorts in the USA, this study examined the association between religious-service attendance and a wide range of subsequent physical health, health behaviour, psychological distress and psychological well-being outcomes in separate cohorts of young, middle-aged and older adults. All analyses adjusted for socio-demographic characteristics, prior health status and prior values of the outcome variables whenever data were available. Bonferroni correction was used to correct for multiple testing.

**Results:** Estimates combining data across cohorts suggest that, compared with those who never attended religious services, individuals who attended services at least once per week had a lower risk of all-cause mortality by 26% [95% confidence interval (CI): 0.65 to 0.84], heavy drinking by 34% (95% CI: 0.59 to 0.73) and current smoking by 29% (95% CI: 0.63 to 0.80). Service attendance was also inversely associated with a number of psychological-distress outcomes (i.e. depression, anxiety, hopelessness, loneliness) and was positively associated with psychosocial well-being outcomes (i.e. positive affect, life satisfaction, social integration, purpose in life), but was generally not associated with subsequent disease, such as hypertension, stroke, and heart disease.

**Conclusions:** Decisions on religious participation are generally not shaped principally by health. Nevertheless, for individuals who already hold religious beliefs, religious-service attendance may be a meaningful form of social integration that potentially relates to greater longevity, healthier behaviours, better mental health and greater psychosocial well-being.

**Key words:** Religious-service attendance, health, well-being, adulthood lifecourse, outcome-wide epidemiology, longitudinal study

### Key Messages

- This study provides evidence throughout adulthood from three longitudinal cohorts for associations of religious-service attendance with subsequent mortality, health behaviours and psychosocial well-being, but not with subsequent physical diseases.
- This study examined a wide range of health and well-being outcomes simultaneously, which provides a broad picture of the complex religion–health dynamics.
- This study provides the first longitudinal evidence for a number of health and well-being outcomes in relation to religious-service attendance, with rigorous control for potential confounding and reverse causation.

## Introduction

Public health and religion both emphasize a holistic view of health and both share the mission of promoting health and well-being broadly.<sup>1,2</sup> Religious involvement is common in the USA. In 2018, 76% of Americans reported a religious affiliation, 50% considered religion very important in their life and 32% reported attending religious services over the past week.<sup>3</sup>

Religious participation may promote health by enhancing social integration, regulating health behaviours, fostering a sense of purpose and strengthening character; however, religion may also degrade health by generating anxiety, guilt and even violence.<sup>1</sup> Thus, the associations between religion and health may not be immediately clear. Whereas there is a large body of empirical research on religion and health, the strongest longitudinal evidence comes from only a few more rigorous studies. These studies suggest that the communal aspects of religious practices, specifically religious-service attendance, is associated with a lower risk of all-cause mortality, suicide, depression and substance use, and with better survival in cancer and cardiovascular patients.<sup>1,4–15</sup>

Past research on religion and health has contributed substantially to the literature, yet several methodological limitations remain. First, other than for mortality and depression, many prior studies on religion and health remain cross-sectional from which causality cannot be inferred.<sup>1,16</sup> For instance, the limited longitudinal evidence on service attendance in relation to incident physical illness and anxiety often found weaker associations in contrast to prior cross-sectional work.<sup>17–19</sup> Moreover, almost all prior evidence on religion and subjective well-being outcomes remains cross-sectional.<sup>16,20</sup> Second, prior prospective

studies on religion and mental health or psychosocial well-being did not always adequately account for baseline health to reduce the possibility of reverse causation.<sup>21</sup> Specifically, healthier individuals may be more likely to attend services, and thus the association between service attendance and better health may be spurious if such ‘reverse causation’ is not addressed.<sup>22</sup> Third, whereas health has been defined broadly as ‘a state of complete physical, mental and social well-being’,<sup>23</sup> rigorous evidence on religion and health remains restricted to a limited set of outcomes. There has been growing interest in examining multiple categories of outcomes within the same study, which can potentially reduce publication bias and provide a broader picture of the complex religion–health dynamics.<sup>24,25</sup> Finally, religious involvement is often characterized by a cyclic structure across a lifetime, often with a return to religious community in later life. Prior work has, however, seldom compared the religion–health associations across life stages.<sup>26</sup> To address these issues, this study examined longitudinal data from three large cohorts of young, middle-aged and older adults, with repeated measurements of religious-service attendance and multiple health and well-being outcomes.

## Methods

### Study population

We used longitudinal data from three cohorts of young, middle-aged and older adults including (i) the Growing Up Today Study (GUTS, mean baseline age = 23.0 years),<sup>27</sup> (ii) the Nurses’ Health Study II (NHSII, mean age = 46.8 years)<sup>28</sup> and (iii) the Health and Retirement Study (HRS,

mean age = 69.3 years).<sup>29</sup> Of note, GUTS participants are the children of a subset of NHSII participants and some GUTS participants are siblings. See detailed description for each cohort in [Supplementary Appendix Text 1](#), available as [Supplementary data](#) at *IJE* online.

Data on the exposure variable of religious-service attendance were taken from the GUTS 2007 questionnaire, the NHSII 2001 Trauma Exposure and Post-traumatic Stress Supplementary Survey and the HRS 2008/2010 questionnaires (a randomly selected 50% of HRS participants were visited for an enhanced face-to-face interview, whereas the remaining 50% were assessed 2 years later); these years were considered as the baseline years for this study. Data on the outcome variables were taken from the most recent questionnaire waves wherein the relevant outcomes were assessed (i.e. the GUTS 2010 or 2013 wave, NHSII 2008, 2009 or 2013 wave and HRS 2014/2016 wave). The total sample sizes for this study were 9862 participants in GUTS, 68 376 in NHSII and 13 770 in HRS. Further details regarding the selection of baseline years and the outcome years, and the derivation of sample sizes in each cohort are provided in [Supplementary Appendix Text 2](#), available as [Supplementary data](#) at *IJE* online. This study was approved by the institutional review board at Brigham and Women's Hospital and the Harvard T.H. Chan School of Public Health.

### Assessment of religious-service attendance

The frequency of religious-service attendance was reported in response to the questions 'How often do you go to religious meetings or services?' in GUTS and NHSII and 'About how often have you attended religious services during the past year?' in HRS. In all three cohorts, responses were grouped into the following categories: never, <once per week and  $\geq$ once per week.<sup>30</sup>

### Assessment of health and well-being outcomes

We examined a wide range of health and well-being outcomes<sup>31</sup> that were available in at least two of the three cohorts. These outcomes included physical health (all-cause mortality, number of the following physical-health problems: diabetes, hypertension, stroke, heart diseases, cancer and overweight/obesity), health behaviours (heavy drinking, current smoking status, short sleep duration, frequent physical activity and preventive-healthcare use), psychological distress (depression diagnosis, depressive symptoms, anxiety symptoms, hopelessness and loneliness) and psychosocial well-being (positive affect, life satisfaction, social integration and purpose in life). Details regarding the measurement of each outcome are provided in

[Supplementary Appendix Text 3](#), available as [Supplementary data](#) at *IJE* online.

### Assessment of covariates

A wide range of socio-demographic covariates were adjusted for whenever data were available including age, gender, race/ethnicity, marital status, geographic region, employment status, night-shift work schedule, socioeconomic status, health-insurance status, childhood maternal attachment and childhood-abuse victimization. Covariate data were taken from the questionnaire wave prior to the exposure assessment; if no such data were available, we used covariate data that were assessed in the same wave as the exposure.

We also adjusted for previous religious-service attendance, assessed in the questionnaire wave prior to the exposure assessment, to evaluate *current* (i.e. conditional on past) rather than prevalent (i.e. already present) service attendance. Specifically, conditioning on past attendance helps to reduce the 'cumulative effects' that past attendance may have exerted on health, thus allowing the health associations of *current* service attendance to be evaluated and moreover helps further control for reverse causation and unmeasured confounding.<sup>21</sup> Data on prior attendance were available in GUTS and the HRS, but not in NHSII ([Supplementary Appendix Text 2](#), available as [Supplementary data](#) at *IJE* online).

To reduce the possibility of reverse causation, we also controlled simultaneously for prior values of all outcome (and other health-related) variables in all models, whenever data were available.<sup>21</sup> Specifically, adjustments were made for prior physical-health conditions (i.e. prior number of physical-health problems), prior health and behaviours (i.e. prior binge eating, smoking, heavy drinking, use of marijuana and other illicit drugs, sexually transmitted infections, preventive-healthcare use, dietary quality, physical activity and sleep duration), prior social factors (i.e. prior volunteering and voting-registration status), prior psychological distress (prior depressive symptoms, hopelessness, loneliness and negative affect) and prior psychosocial well-being (prior positive affect, purpose in life, life satisfaction, optimism, perceived mastery and social integration). Further details regarding the measurement of all covariates are provided in [Supplementary Appendix Text 4](#), available as [Supplementary data](#) at *IJE* online.

### Statistical analysis

Statistical analyses of the data from NHSII and GUTS were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC). Statistical analyses of the HRS data were

conducted in Stata, version 14.1 (StataCorp). All *P*-values were calculated based on two-sided tests. Chi-square tests and analysis of variance tests were used to examine participant characteristics across levels of religious-service attendance at baseline in all three cohorts.

In NHSII and the HRS, separate regression models were used to regress each outcome on service attendance, adjusting for covariates. In GUTS, generalized estimating equations models were used to account for clustering by sibling status. In all cohorts, beta coefficients were estimated for continuous outcomes, risk ratios (RRs) were estimated for non-rare binary outcomes (defined as prevalence  $\geq 10\%$ ) and odds ratios (ORs) were estimated for rare binary outcomes [defined as prevalence  $< 10\%$ ; for rare outcomes, ORs would approximate risk ratios (RRs)].<sup>32,33</sup> All continuous outcomes were standardized (mean = 0, standard deviation = 1), so that the effect estimates were reported in terms of standard deviations of the outcome variables. In the Online Supplement, available as [Supplementary data at IJE online](#), we also present analyses using the unstandardized scores. To combine the effect estimates across cohorts, we calculated sample-size-weighted meta-analytic estimates.<sup>34</sup> To account for multiple testing, Bonferroni correction was applied.

We performed multiple imputation by chained equations to impute missing data on all variables with five imputed data sets.<sup>35–37</sup> As a sensitivity analysis, we also reanalysed the models using complete-case analyses. Furthermore, to evaluate the robustness of our results to unmeasured confounding,<sup>38</sup> we calculated E-values,<sup>39</sup> which assess the minimum strength of association on an RR scale that an unmeasured confounder would need to have with both the exposure and the outcome, above and beyond the measured covariates, to fully explain away the observed exposure–outcome association.

## Results

### Characteristics of the study participants

Across all cohorts, healthier participants were more likely to attend religious services. Participant characteristics that were assessed in all three cohorts are shown across levels of service attendance in [Table 1](#). A full list of participant characteristics by service attendance is available in [Supplementary Table 1A–C](#) in the Appendix, available as [Supplementary data at IJE online](#). Further, descriptive statistics of the full analytic samples are provided in [Supplementary Tables 2A–C](#) in the Appendix, available as [Supplementary data at IJE online](#).

### Religious-service attendance and physical health

Compared with those never attending religious services, participants who attended services  $\geq 1$ /week had a lower risk of all-cause mortality by 26% (RR = 0.74, 95% confidence interval [CI]: 0.63 to 0.86) in NHSII, by 28% (RR: 0.72, 95% CI: 0.63 to 0.83) in HRS and by 26% (RR: 0.74, 95% CI: 0.65 to 0.84) for the combined estimate. Further,  $\geq 1$ /week attenders (vs never-attenders) possibly had slightly fewer physical-health problems (e.g. combined  $\beta = -0.03$ , 95% CI:  $-0.05$  to  $-0.01$ ), an association which was somewhat stronger in middle adulthood. There was, however, little association with specific physical-disease outcomes except for cancer in young adults ([Table 2](#)).

### Religious-service attendance and health behaviours

At least weekly (vs never) service attendance was associated with a substantially lower risk of heavy drinking (combined RR: 0.66, 95% CI: 0.59 to 0.73) and current smoking (combined RR: 0.71, 95% CI: 0.63 to 0.80). There was, however, little association of service attendance with other health-behaviour outcomes ([Table 2](#)).

### Religious-service attendance and psychological distress

Service attendance was inversely associated with psychological-distress outcomes ([Table 2](#)). Specifically,  $\geq 1$ /week attenders (vs never-attenders) had fewer depressive symptoms (combined  $\beta = -0.11$ , 95% CI:  $-0.13$  to  $-0.09$ ) and this association was evident across all stages of adulthood, although particularly strong in young adults. Service attendance was also inversely associated with physician-diagnosed depression (combined RR: 0.84, 95% CI: 0.80 to 0.89). Furthermore,  $\geq 1$ /week attenders (vs never-attenders) also had lower levels of anxiety, hopelessness and loneliness, though the effect sizes were smaller (e.g. for anxiety symptoms, the combined  $\beta = -0.05$ ,  $-0.07$  to  $-0.03$ ).

### Religious-service attendance and psychosocial well-being

Religious-service attendance was positively associated with psychosocial well-being outcomes ([Table 2](#)). Specifically,  $\geq 1$ /week attenders vs never-attenders had greater positive affect (combined  $\beta = 0.10$ ; 95% CI: 0.08 to 0.12), life satisfaction (combined  $\beta = 0.12$ , 95% CI: 0.06 to 0.18), social integration (combined  $\beta = 0.26$ , 95% CI: 0.24 to 0.28) and purpose in life (combined  $\beta = 0.25$ , 95% CI: 0.23 to 0.26).

**Table 1** Participant characteristics according to frequency of religious-service attendance at study baseline [the Growing Up Today Study (GUTS) 2007 questionnaire wave, N = 9229; the Nurses' Health Study II (NHSII) 2001 supplementary survey, N = 69300; the Health and Retirement Study (HRS) 2008 and 2010 questionnaire waves, N = 12 549]<sup>a</sup>

	GUTS			NHSII			HRS		
	Never	Less than once/week	At least once/week	Never	Less than once/week	At least once/week	Never	Less than once/week	At least once/week
Baseline characteristics	n = 3106	n = 4272	n = 1851	n = 16 868	n = 21 376	n = 30 056	n = 3194	n = 3909	n = 5446
Age, mean (SD), years	23.0 (1.7)	23.0 (1.7)	22.9 (1.8)	47.6 (4.5)	46.6 (4.7)	46.5 (4.7)	69.3 (10.0)	68.0 (9.3)	70.3 (8.9)
Female (%)	1846 (59.4)	2734 (64.0)	1257 (67.9)	16 868 (100.0)	21 376 (100.0)	30 056 (100.0)	1647 (51.6)	2257 (57.7)	3489 (64.1)
Race/ethnicity (%)									
Non-Hispanic White	2853 (92.1)	4020 (94.3)	1713 (92.9)	16 094 (95.4)	20 279 (94.9)	28 716 (95.5)	2725 (85.3)	3013 (77.1)	3997 (73.4)
African-American	21 (0.7)	27 (0.6)	17 (0.9)	113 (0.7)	299 (1.4)	432 (1.4)	200 (6.3)	504 (12.9)	888 (16.3)
Hispanic	65 (2.1)	50 (1.2)	27 (1.5)	269 (1.6)	406 (1.9)	414 (1.4)	193 (6.0)	313 (8.0)	457 (8.4)
Other	158 (5.1)	164 (3.9)	87 (4.7)	392 (2.3)	392 (1.8)	493 (1.6)	75 (2.4)	79 (2.0)	104 (1.9)
Married (%)	279 (11.0)	296 (8.2)	177 (11.1)	11 519 (70.7)	16 202 (79.0)	24 618 (85.2)	1847 (57.8)	2444 (62.5)	3633 (66.7)
Geographic region (%)									
West	727 (23.4)	544 (12.7)	272 (14.7)	4106 (24.4)	3164 (14.8)	3381 (11.3)	816 (25.6)	718 (18.4)	828 (15.2)
Midwest	864 (27.9)	1540 (36.1)	731 (39.5)	4487 (26.7)	6772 (31.7)	11 201 (37.3)	723 (22.7)	1063 (27.3)	1522 (28.0)
South	445 (14.4)	686 (16.1)	365 (19.7)	2786 (16.6)	3802 (17.8)	5928 (19.8)	1127 (35.3)	1495 (38.3)	2351 (43.2)
Northeast	1065 (34.3)	1500 (35.1)	481 (26.0)	5447 (32.4)	7603 (35.6)	9498 (31.7)	523 (16.4)	625 (16.0)	736 (13.5)
Household income (%) <sup>b</sup>									
<\$50 000	307 (11.8)	415 (11.8)	203 (14.0)	2395 (16.6)	2581 (14.6)	4062 (17.0)	1946 (60.9)	2220 (56.8)	3366 (61.8)
\$50 000–\$74 999	564 (21.6)	813 (23.0)	388 (27.0)	4029 (27.9)	4643 (26.3)	6813 (28.5)	509 (15.9)	613 (15.7)	842 (15.5)
\$75 000–\$99 999	555 (21.2)	815 (23.1)	325 (22.4)	2892 (20.0)	3780 (21.4)	5258 (22.0)	275 (8.6)	358 (9.2)	459 (8.4)
≥\$100 000	1187 (45.4)	1487 (42.1)	538 (37.0)	5103 (35.4)	6634 (37.6)	7747 (32.4)	464 (14.5)	718 (18.4)	779 (14.3)
Depression (%)	426 (13.8)	478 (11.3)	140 (7.6)	2123 (13.0)	2218 (10.8)	2293 (8.0)	537 (17.1)	543 (14.1)	578 (10.7)
Overweight/obesity (%)	790 (29.4)	1152 (30.3)	439 (26.5)	7966 (49.3)	10 036 (49.0)	13 689 (47.5)	2165 (68.8)	2792 (72.2)	3792 (70.4)
Cigarette smoking (%)	806 (30.0)	887 (23.5)	159 (9.6)	2439 (14.5)	2141 (10.0)	1364 (4.5)	653 (20.6)	551 (14.2)	329 (6.1)
Heavy drinking (%) <sup>c</sup>	877 (32.6)	1165 (30.7)	145 (8.7)	482 (3.0)	335 (1.7)	245 (0.9)	455 (17.4)	506 (16.2)	281 (6.2)

<sup>a</sup>This table shows participant characteristics that were assessed in all three cohorts by religious-service attendance. Full lists of other participant characteristics by service attendance in each cohort are provided in [Supplementary Table 1A–C](#) in the Appendix, available as [Supplementary data](#) at [IJE](#) online. <sup>b</sup>In GUTS, household income was reported by the mothers (i.e. the NHSII participants who had their children enrolled in GUTS) in an earlier questionnaire wave and was used to measure GUTS participants' family socio-economic status in earlier life. <sup>c</sup>Heavy drinking was defined as at least 12 episodes of binge drinking over the past year in GUTS, as >5 drinks in a single day in NHSII and as ever having ≥4 drinks on a single occasion over the past 3 months in HRS.

**Table 2** Religious-service attendance (at least once/week vs never) and subsequent health and well-being across adulthood [the Growing Up Today Study (GUTS) from 2007 to 2010 or 2013 questionnaire wave, N = 9862; the Nurses' Health Study II (NHSII) from 2001 to 2008, 2009 or 2013 questionnaire wave, N = 68376; the Health and Retirement Study (HRS) from 2008 to 2014 or from 2010 to 2016 questionnaire wave, N = 13770].<sup>a</sup>

	Never(Ref.) <sup>b</sup>	GUTS		NHSII		HRS		Sample-size weighted Meta-Analytic Combined Estimate		p-value <sup>c</sup>
		At least once/week	RR/β (95% CI)	At least once/week	RR/β (95% CI) <sup>c,d</sup>	At least once/week	RR/β (95% CI) <sup>c,d</sup>	RR <sup>c</sup>	β <sup>d</sup>	
<b>Physical health</b>										
All-cause mortality	1.00	—	—	0.74 (0.63, 0.86)	0.72 (0.63, 0.83)	0.74	0.74	0.65, 0.84	<0.002***	
No. of physical-health problems	0.00	-0.02 (-0.10, 0.06)	-0.04 (-0.05, -0.02)	-0.04 (-0.05, -0.02)	-0.02 (-0.09, 0.05)	-0.03	-0.03	-0.05, -0.01	<0.002***	
Diabetes	1.00	0.67 (0.25, 1.75)	0.92 (0.85, 1.01)	0.92 (0.85, 1.01)	1.09 (0.97, 1.24)	0.91	0.91	0.81, 1.03	0.141	
Hypertension	1.00	0.85 (0.55, 1.32)	—	—	1.04 (0.96, 1.12)	0.95	0.95	0.79, 1.15	0.354	
Stroke	1.00	—	1.01 (0.86, 1.18)	1.01 (0.86, 1.18)	0.95 (0.80, 1.12)	1.00	1.00	0.87, 1.14	0.398	
Heart Disease	1.00	—	0.93 (0.78, 1.10)	0.93 (0.78, 1.10)	0.93 (0.81, 1.07)	0.93	0.93	0.80, 1.07	0.235	
Cancer	1.00	0.37 (0.15, 0.94)	0.96 (0.91, 1.01)	0.96 (0.91, 1.01)	0.97 (0.84, 1.12)	0.87	0.87	0.78, 0.97	0.015*	
Overweight/obesity	1.00	1.02 (0.90, 1.16)	0.97 (0.95, 1.00)	0.97 (0.95, 1.00)	1.05 (0.94, 1.18)	0.99	0.99	0.96, 1.02	0.343	
<b>Health behaviours</b>										
Heavy drinking	1.00	0.66 (0.54, 0.81)	0.57 (0.50, 0.64)	0.57 (0.50, 0.64)	1.31 (0.92, 1.86)	0.66	0.66	0.59, 0.73	<0.002***	
Current cigarette smoking	1.00	0.83 (0.70, 0.98)	0.70 (0.62, 0.79)	0.70 (0.62, 0.79)	0.67 (0.40, 1.14)	0.71	0.71	0.63, 0.80	<0.002***	
Short sleep duration	1.00	0.96 (0.80, 1.15)	0.98 (0.93, 1.02)	0.98 (0.93, 1.02)	—	0.97	0.97	0.93, 1.02	0.207	
Frequent physical activity	1.00	—	1.01 (0.98, 1.03)	1.01 (0.98, 1.03)	1.10 (0.86, 1.42)	1.02	1.02	0.98, 1.07	0.245	
Preventive-healthcare use	1.00	0.98 (0.90, 1.06)	1.02 (1.00, 1.05)	1.02 (1.00, 1.05)	—	1.02	1.02	1.00, 1.04	0.103	
<b>Psychological distress</b>										
Depression diagnosis	1.00	0.69 (0.57, 0.84)	0.86 (0.82, 0.91)	0.86 (0.82, 0.91)	0.85 (0.69, 1.04)	0.84	0.84	0.80, 0.89	<0.002***	
Depressive symptoms	0.00	-0.18 (-0.29, -0.07)	-0.10 (-0.11, -0.08)	-0.10 (-0.11, -0.08)	-0.13 (-0.20, -0.06)	-0.11	-0.11	-0.13, -0.09	<0.002***	
Anxiety symptoms	0.00	-0.04 (-0.12, 0.05)	-0.06 (-0.08, -0.03)	-0.06 (-0.08, -0.03)	—	-0.05	-0.05	-0.07, -0.03	<0.002***	
Hopelessness	0.00	-0.09 (-0.22, 0.04)	-0.08 (-0.10, -0.05)	-0.08 (-0.10, -0.05)	-0.05 (-0.11, 0.02)	-0.07	-0.07	-0.10, -0.05	<0.002***	
Loneliness	0.00	-0.19 (-0.29, -0.10)	-0.03 (-0.05, -0.01)	-0.03 (-0.05, -0.01)	-0.11 (-0.20, -0.02)	-0.06	-0.06	-0.08, -0.04	<0.002***	

(Continued)

Table 2 Continued

	Never(Ref.) <sup>b</sup>		GUTS		NHSII		HRS		Sample-size weighted			
	At least once/week		At least once/week		At least once/week		At least once/week		Meta-Analytic Combined Estimate			
	RR/β	(95% CI)	RR/β	(95% CI) <sup>c,d</sup>	RR/β	(95% CI) <sup>c,d</sup>	RR/β	(95% CI) <sup>c,d</sup>	RR <sup>c</sup>	β <sup>d</sup>	95% CI	p-value <sup>e</sup>
<b>Psychosocial well-being</b>												
Positive affect	0.00	0.14 (0.06, 0.22)	0.09 (0.07, 0.11)	—	0.10 (0.01, 0.20)	0.10 (0.01, 0.20)	0.10	0.08, 0.12		0.10	0.08, 0.12	<0.002***
Life satisfaction	0.00	0.13 (0.04, 0.22)	—	—	0.11 (0.03, 0.20)	0.11 (0.03, 0.20)	0.12	0.06, 0.18		0.12	0.06, 0.18	<0.002***
Social integration	0.00	—	0.27 (0.25, 0.29)	—	0.22 (0.13, 0.28)	0.22 (0.13, 0.28)	0.26	0.24, 0.28		0.26	0.24, 0.28	<0.002***
Purpose in life	0.00	—	0.29 (0.27, 0.30)	—	0.05 (-0.02, 0.11)	0.05 (-0.02, 0.11)	0.25	0.23, 0.26		0.25	0.23, 0.26	<0.002***

RR, risk ratio; CI, confidence interval.

<sup>a</sup>The notation '—' indicates the particular outcome was not measured in that cohort (note: in NHSII, only self-reported information on hypertension was available, whereas data on other physical-health outcomes were verified against medical records. Therefore, this study did not examine hypertension in NHSII). The analytic sample in each cohort was restricted to those who responded to the baseline questionnaire wave in which religious-service attendance was measured. Multiple imputation was performed to impute missing data on all variables.

<sup>b</sup>A set of generalized estimating equations or regression models were used to regress each outcome on religious-service attendance separately, to estimate the OR for rare binary outcomes (with binomial distribution), the OR would approximate the RR for rare outcomes, rare outcome defined as the prevalence <10%, the RR for non-rare binary outcomes (Poisson distribution, non-rare outcome defined as prevalence ≥10%) or β (where the outcome follows a normal distribution). If the reference value is '1', the effect estimate is OR or RR; if the reference value is '0', the effect estimate is β.

<sup>c</sup>GUTS: All models controlled for participants' age, sex, race/ethnicity, marital status, geographic region, maternal attachment, childhood-abuse victimization, their mother's report of socio-economic status (SES) (i.e. subjective SES, household income, census tract college education rate and census tract median income), participants' prior religious-service attendance, prior health status or prior health behaviours (i.e. prior depressive symptoms, hopelessness, loneliness, binge eating, overweight/obesity, smoking, heavy drinking, marijuana use, use of other illicit drugs, prescription-drug misuse, history of sexually transmitted infections, preventive-healthcare use, frequency of volunteering and voting-registration status). NHSII: All models controlled for participants' age, race/ethnicity, marital status, geographic region, employment status, night-shift schedule, perceived stress, subjective SES, pre-tax household income, census tract college education rate, census tract median income, childhood-abuse victimization and prior health status or prior health behaviours (i.e. prior positive affect, hopelessness, community engagement, number of close friends, depressive symptoms, preventive-healthcare use, dietary quality, heavy drinking, current smoking, frequent physical activity, number of physical-health problems: overweight/obesity, type 2 diabetes, stroke, heart disease, cancer). HRS: All models controlled for participants' age, sex, race/ethnicity, marital status, geographic region, income, level of education, wealth, employment status, health insurance, childhood abuse, prior religious-service attendance and prior health status or prior health behaviours (i.e. prior positive affect, purpose in life, life satisfaction, optimism, perceived mastery, depressive symptoms, loneliness, hopelessness, negative affect, social integration, heavy drinking, current smoking, exercise and number of physical-health problems: overweight/obesity, type 2 diabetes, stroke, heart disease, hypertension, cancer).

<sup>d</sup>The effect estimates for the outcomes of current smoking (NHSII, HRS), heavy drinking (NHSII, HRS), all-cause mortality (NHSII, HRS), diabetes (GUTS, NHSII), hypertension (GUTS), stroke (NHSII), heart disease (NHSII), short sleep duration (NHSII) and cancer (GUTS) were OR. These outcomes were rare (prevalence <10%), so the OR would approximate the RR. Effect estimates for other dichotomized outcomes were RR.

<sup>e</sup>All continuous outcomes were standardized (mean = 0, standard deviation = 1) and β was the standardized effect size.

\*\*\*p < 0.05 before Bonferroni correction; \*\*p < 0.01 before Bonferroni correction; \*p < 0.05 after Bonferroni correction (the p-value cut-off for Bonferroni correction is 0.05/22 outcomes = 0.002).

## Additional analyses

Across all outcomes, results comparing  $<1$ /week vs never-attendance are available in [Supplementary Table 3A–C](#) in the Appendix, available as [Supplementary data](#) at *IJE* online. The unstandardized effect estimates for all continuous outcomes are provided in [Supplementary Table S4](#), available as [Supplementary data](#) at *IJE* online. The sensitivity analysis using complete cases yielded similar results to the primary analyses ([Supplementary Appendix Table 5](#), available as [Supplementary data](#) at *IJE* online).

## Sensitivity analysis for unmeasured confounding

We calculated E-values<sup>39</sup> to assess the robustness of the observed associations to unmeasured confounding (e.g. by personality factors such as conscientiousness or agreeableness). Results suggest that the associations with all-cause mortality, heavy alcohol consumption, smoking, depression diagnosis, social integration and purpose in life were moderately robust to unmeasured confounding ([Table 3](#)). For example, an unmeasured confounder would need to be associated with both service attendance and cigarette smoking by RRs of 2.17 each, above and beyond the measured covariates, to fully explain away the association between service attendance and smoking, and by 1.81-fold each to shift the CI to include the null value. Similar unmeasured confounding associations sufficient to explain away each observed association are reported in [Table 3](#).

## Discussion

Based on data from three prospective cohorts, this study suggests that religious-service attendance is positively associated with multiple aspects of subsequent health and well-being throughout adulthood. Estimates combining data across cohorts suggest that, compared with those who never attend religious services, individuals who attend services  $\geq 1$ /week have a lower risk of all-cause mortality by 26%, heavy drinking by 34%, smoking by 29% and depression by 16%, and greater psychosocial well-being (e.g. greater purpose in life by 0.25 standard deviations).

Results of this study are largely consistent with prior longitudinal evidence, especially with regard to mortality, depression, alcohol drinking and smoking,<sup>1,4,5</sup> but extends the literature with more rigorous confounding control, and allowing the effect sizes across outcomes and across adulthood life stages to be compared. It is also one of the first studies to provide longitudinal evidence regarding some subjective well-being outcomes. In contrast to some prior cross-sectional evidence,<sup>1</sup> however, we found little association of service attendance with physical-disease outcomes.

Whereas service attendance was related to a substantially lower risk of some strong risk factors (e.g. smoking, heavy drinking) for these physical-disease outcomes, it remains unclear why service attendance was not associated with the risk of physical diseases in the same sample. It is possible that service attendance may be related to an elevated level of other risk factors (e.g. stress, guilt) simultaneously, which may have offset its benefits. Further work to understand the associations with specific physical-disease outcomes is warranted. Similarly, although some prior cross-sectional studies have suggested associations between religious involvement and anxiety,<sup>1,40,41</sup> this study suggests that the effect size may be small: only one-twentieth of a standard deviation. We hypothesize that religion may provide peace and relief for some, but generate fear and anxiety for others,<sup>16</sup> resulting in a weak overall association.

This work also adds to the evidence that the religion and health dynamics may be bidirectional.<sup>4</sup> For instance, as observed in some prior studies as well,<sup>22</sup> whereas service attendance was associated with fewer depressive symptoms subsequently, depression itself was also related to a lower likelihood of service attendance across all cohorts in this study. A similar pattern was also observed with cigarette smoking and heavy drinking in these cohorts. It is thus important to continue considering the reciprocal religion–health dynamics in future work.<sup>16,21</sup>

As compared with other forms of community involvement, religious-service attendance often has stronger associations with health.<sup>42,43</sup> Whereas service attendance enhances social integration, religious groups also share a set of beliefs, purposes and values, often including respect for the body and leading a healthy lifestyle.<sup>44</sup> It is perhaps the coming-together of shared values and enhanced social integration that provides the health benefits.<sup>1,16,45</sup> This may also help to explain why the associations of service attendance with many outcomes in this study remained robust, even after adjusting for other major aspects of social integration.

This study is subject to several limitations. First, whereas we adjusted for a wide range of baseline covariates, we cannot fully rule out the possibility of reverse causation. For instance, in GUTS, we were not able to adjust for baseline physical health or certain aspects of psychological well-being, due to lack of data. However, we accounted for a wide range of other baseline health-related characteristics and depression. Further, potential reverse causation by baseline health may be less of a concern in GUTS because it is composed of relatively healthy young adults. Second, data on past service attendance were not available in NHSII, so the analyses may thus evaluate the health associations of prevalent service attendance rather than current attendance; however, in many cases, results



**Table 3** Robustness to unmeasured confounding (E-values<sup>a</sup>) for the associations between religious-service attendance (at least once/week vs never) and subsequent health and well-being [the Growing Up Today Study (GUTS) from 2007 to 2010 or 2013 questionnaire wave, *N*=9862; the Nurses' Health Study II (NHSII) from 2001 to 2008, 2009 or 2013 questionnaire wave, *N*= 68 376; the Health and Retirement Study (HRS) from 2008 to 2014 or from 2010 to 2016 questionnaire wave, *N*= 13 770].

	GUTS		NHSII		HRS		Combined estimate	
	Effect estimate <sup>b</sup>	CI limit <sup>c</sup>	Effect estimate <sup>b</sup>	CI limit <sup>c</sup>	Effect estimate <sup>b</sup>	CI limit <sup>c</sup>	Effect estimate <sup>b</sup>	CI limit <sup>c</sup>
All-cause mortality	—	—	2.04	1.60	2.12	1.70	2.04	1.67
No. of physical problems	1.16	1.00	1.23	1.17	1.16	1.00	1.20	1.12
Diabetes	2.35	1.00	1.39	1.00	1.40	1.00	1.43	1.00
Hypertension	1.63	1.00	—	—	1.24	1.00	1.29	1.00
Stroke	—	—	1.11	1.00	1.29	1.00	1.00	1.00
Heart disease	—	—	1.36	1.00	1.36	1.00	1.36	1.00
Cancer	4.85	1.32	1.25	1.00	1.21	—	1.56	1.21
Overweight/obesity	1.16	1.00	1.21	1.00	1.28	1.00	1.11	1.00
Heavy drinking	2.40	1.77	2.90	2.50	1.95	1.00	2.40	2.08
Current cigarette smoking	1.70	1.16	2.21	1.85	2.35	1.00	2.17	1.81
Short sleep duration	1.25	1.00	1.16	1.00	—	—	1.21	1.00
Frequent physical activity	—	—	1.11	1.00	1.43	1.00	1.16	1.00
Preventive-healthcare use	1.16	1.00	1.16	1.00	—	—	1.15	1.00
Depression diagnosis	2.26	1.67	1.60	1.43	1.63	1.00	1.67	1.50
Depressive symptoms	1.64	1.36	1.42	1.36	1.50	1.30	1.43	1.37
Anxiety symptoms	1.23	1.00	1.30	1.23	—	—	1.27	1.19
Hopelessness	1.39	1.00	1.36	1.29	1.27	1.00	1.33	1.26
Loneliness	1.66	1.41	1.20	1.11	1.46	1.21	1.31	1.24
Positive affect	1.53	1.30	1.39	1.33	1.42	1.13	1.41	1.34
Life satisfaction	1.50	1.25	—	—	1.45	1.19	1.47	1.30
Social integration	—	—	1.88	1.83	1.69	1.51	1.86	1.81
Purpose in life	—	—	1.93	1.89	1.27	1.00	1.81	1.77

<sup>a</sup>See VanderWeele and Ding (ref no.<sup>39</sup>) for the formula for calculating E-values.

<sup>b</sup>The E-values for effect estimates are the minimum strength of the association on the risk ratio (RR) scale that an unmeasured confounder would need to have with both the exposure and the outcome to fully explain away the observed association between the exposure and outcome, conditional on the measured covariates. For example, in the NHSII cohort, an unmeasured confounder would need to be associated with both religious-service attendance and mortality by RRs of 2.04 each, above and beyond the measured covariates, to fully explain away the observed association between service attendance (at least once/week vs never) and mortality.

<sup>c</sup>The E-values for the limit of the 95% confidence interval (CI) closest to the null denote the minimum strength of association on the RR scale that an unmeasured confounder would need to have with both the exposure and the outcome to shift the confidence interval to include the null value, conditional on the measured covariates. For example, in the NHSII cohort, an unmeasured confounder would need to be associated with both religious-service attendance and mortality by 1.60-fold each, above and beyond the measured covariates, to shift the upper limit of the CI to include the null value for the association between service attendance (at least once/week vs never) and mortality.

with and without adjustment for past attendance have been similar,<sup>4,5,16</sup> though this is not guaranteed. Third, this study assessed only one aspect of religious participation, namely service attendance. Among various domains of religious involvement, service attendance often shows the strongest health associations in community samples.<sup>16</sup> However, other aspects of religious participation certainly merit further investigation, especially for religious traditions that do not convene congregational meetings regularly. Next, both service attendance and the majority of outcomes other than mortality were self-reported, so common methods bias may be a concern. However, physical-health outcomes were obtained from medical records in NHSII and the results were similar to those of

the other two cohorts in which physical health was self-reported; the prospective-study design also helps to reduce concerns about self-report bias as does control for baseline outcomes. Next, whereas the meta-analytic estimates provide additional evidence for the averaged associations across cohorts, these did not take into account differential lengths of follow-up across cohorts; however, many of our outcomes were continuous or binary rather than time-to-event. Finally, NHSII participants were predominantly White female nurses and all GUTS participants had a mother working in the nursing field. Although data on religious affiliation were not available, because of the US sample and demographics, many of the participants were likely Christian.<sup>5,46</sup> The results may

thus not be generalizable to other populations or religious groups. However, results in these two cohorts were in many cases similar to those in HRS, which had a more diverse national sample. These limitations are, however, balanced by important strengths of this study including confounding control, study design, sample size, three distinct age cohorts, and numerous outcomes. We believe this is the most comprehensive empirical study to date on the role of religious-community participation in shaping health and well-being throughout adulthood.

Decisions on religious participation are often not principally shaped by health. Rather, such decisions are made based on values, experiences, systems of meaning, truth claims and relationships. However, for those who already positively self-identify with a religious tradition, service attendance may be a meaningful form of social integration that may in turn positively relate to longevity, health behaviours, mental health and psychosocial well-being. For individuals without religious beliefs, other forms of community participation may likewise be pursued. Although effect sizes on health may sometimes not be as substantial, other forms of community life certainly also contribute to health.<sup>5,16,43</sup> In a clinical context, although ethical and logistical challenges remain, some attention to spiritual issues is often desired by patients and such needs are often unmet.<sup>47</sup> Further reflection on whether and how to address such issues would be worthwhile.

Religious-service attendance is potentially a powerful social determinant of health.<sup>26</sup> While regression analyses with observational data generally cannot definitively establish causality, they can provide evidence and, for many of the outcomes examined here, the evidence is now quite strong.<sup>48</sup>

## Supplementary data

Supplementary data are available at *IJE* online.

## Author contributions

T.J.V. developed the study concept. Y.C. and E.S.K. had full access to the data in the study and take responsibility for the integrity of the data and accuracy of the data analysis. Y.C. drafted the manuscript. Y.C., E.S.K. and T.J.V. provided critical revisions and approved the final submitted version of the manuscript.

## Funding

This study was supported by the Templeton Foundation (grant #52125 and #61075) and the National Institutes of Health (grant CA222147). The National Institutes of Health supported the Nurses' Health Study II (grant U01 CA176726 and R01 CA67262), the Growing Up Today Study (grant U01 HL145386, R01

HD057368) and the Health and Retirement Study (grant U01 AG09740). Funding agencies had no role in the data collection, analysis or interpretation; nor were they involved in the writing or submission of this publication.

## Acknowledgements

We thank the Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School and the Institute for Social Research at the University of Michigan for their support in conducting this study.

## Conflict of interest

None declared.

## References

1. Koenig H, King DE, Benner V. *Handbook of Religion and Health*, 2nd edn. New York, NY: Oxford University Press, 2012.
2. International Health Conference. Constitution of the World Health Organization. *Bull World Health Organ* 1946 2002; 80:983–84.
3. Gallup. *Religion*. 2019. <https://news.gallup.com/poll/1690/religion.aspx> (20 October 2019, date last accessed).
4. Li S, Okereke OI, Chang S-C, Kawachi I, VanderWeele TJ. Religious service attendance and lower depression among women—a prospective cohort study. *Ann Behav Med* 2016;50: 876–84.
5. Li S, Stampfer MJ, Williams DR, VanderWeele TJ. Association of religious service attendance with mortality among women. *JAMA Intern Med* 2016;176:777–85.
6. Lim C, Putnam RD. Religion, social networks, and life satisfaction. *Am Soc Rev* 2010;75:914–33.
7. VanderWeele TJ, Yu J, Cozier YC *et al*. Attendance at religious services, prayer, religious coping, and religious/spiritual identity as predictors of all-cause mortality in the Black Women's Health Study. *Am J Epidemiol* 2017;185:515–22.
8. Idler E, Blevins J, Kiser M, Hogue C. Religion, a social determinant of mortality? A 10-year follow-up of the Health and Retirement Study. *PLoS One* 2017;12:e0189134.
9. Hummer RA, Rogers RG, Nam CB, Ellison CG. Religious involvement and U.S. adult mortality. *Demography* 1999;36: 273–85.
10. Schnall E, Wassertheil-Smoller S, Swencionis C *et al*. The relationship between religion and cardiovascular outcomes and all-cause mortality in the Women's Health Initiative Observational Study. *Psychol Health* 2010;25:249–63.
11. Musick MA, House JS, Williams DR. Attendance at religious services and mortality in a national sample. *J Health Soc Behav* 2004;45:198–213.
12. la Cour P, Avlund K, Schultz-Larsen K. Religion and survival in a secular region: a twenty year follow-up of 734 Danish adults born in 1914. *Soc Sci Med* 2006;62:157–64.
13. Isoaho R, Kivelä S-L, Vahlberg T, Teinonen T. Religious attendance and 12-year survival in older persons. *Age Ageing* 2005; 34:406–09.

14. Litwin H. What really matters in the social network-mortality association? A multivariate examination among older Jewish-Israelis. *Eur J Ageing* 2007;4:71–82.
15. Yeager DM, Gleib DA, Au M, Lin HS, Sloan RP, Weinstein M. Religious involvement and health outcomes among older persons in Taiwan. *Soc Sci Med* 2006;63:2228–41.
16. VanderWeele TJ. Religion and health: a synthesis. In: Petzet JR, Balboni MJ (eds). *Spirituality and Religion within the Culture of Medicine: From Evidence to Practice*. New York, NY: Oxford University Press, 2017, pp. 357–401.
17. Cozier YC, Yu J, Wise LA *et al*. Religious and spiritual coping and risk of incident hypertension in the Black Women's Health Study. *Ann Behav Med* 2018;52:989–98.
18. Peterman JS, Labelle DR, Steinberg L. Devoutly anxious: the relationship between anxiety and religiosity in adolescence. *Psychol Relig Spirituality* 2014;6:113–22.
19. Rasic D, Robinson JA, Bolton J, Bienvenu OJ, Sareen J. Longitudinal relationships of religious worship attendance and spirituality with major depression, anxiety disorders, and suicidal ideation and attempts: findings from the Baltimore epidemiologic catchment area study. *J Psychiatr Res* 2011;45:848–54.
20. Rizvi MAK, Hossain MZ. Relationship between religious belief and happiness: a systematic literature review. *J Relig Health* 2017;56:1561–82.
21. VanderWeele TJ, Jackson JW, Li S. Causal inference and longitudinal data: a case study of religion and mental health. *Soc Psychiatry Psychiatr Epidemiol* 2016;51:1457–66.
22. Maselko J, Hayward RD, Hanlon A, Buka S, Meador K. Religious service attendance and major depression: a case of reverse causality? *Am J Epidemiol* 2012;175:576–83.
23. World Health Organization. Preamble to the Constitution of the World Health Organization. *International Health Conference*. 19–22 June 1946. New York, signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.
24. VanderWeele TJ. Outcome-wide epidemiology. *Epidemiology* 2017;28:399–402.
25. VanderWeele TJ, Mathur MB, Chen Y. Outcome-wide longitudinal designs for causal inference: a new template for empirical studies. *Stat Sci*; 203–250. Available early access: <https://www.e-publications.org/ims/submission/STS/user/submissionFile/38456?confirm=800c6919> (20 October 2019, date last accessed).
26. Idler EL. *Religion as a Social Determinant of Public Health*. New York, NY: Oxford University Press, 2014.
27. Field AE, Camargo CA Jr, Taylor CB *et al*. Overweight, weight concerns, and bulimic behaviors among girls and boys. *J Am Acad Child Adolesc Psychiatry* 1999;38:754–60.
28. Colditz GA, Manson JE, Hankinson SE. The Nurses' Health Study: 20-year contribution to the understanding of health among women. *J Womens Health* 1997;6:49–62.
29. Wallace RB, Herzog AR. Overview of the health measures in the Health and Retirement Study. *J Hum Resour* 1995;30:S84–S107.
30. VanderWeele TJ, Li S, Tsai AC, Kawachi I. Association between religious service attendance and lower suicide rates among US women. *JAMA Psychiatry* 2016;73:845–51.
31. VanderWeele TJ. On the promotion of human flourishing. *P Natl Acad Sci USA* 2017;114:8148–56.
32. Spiegelman D, Hertzmark E. Easy SAS calculations for risk or prevalence ratios and differences. *Am J Epidemiol* 2005;162:199–200.
33. Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702–06.
34. Marín-Martínez F, Sánchez-Meca J. Weighting by inverse variance or by sample size in random-effects meta-analysis. *Educ Psychol Meas* 2010;70:56–73.
35. Sterne JA, White IR, Carlin JB *et al*. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ* 2009;338:b2393.
36. Moons KG, Donders RA, Stijnen T, Harrell Jr FE. Using the outcome for imputation of missing predictor values was preferred. *J Clin Epidemiol* 2006;59:1092–101.
37. Groenwold RH, Donders ART, Roes KC, Harrell FE Jr, Moons KG. Dealing with missing outcome data in randomized trials and observational studies. *Am J Epidemiol* 2012;175:210–17.
38. Ding P, VanderWeele TJ. Sensitivity analysis without assumptions. *Epidemiology* 2016;27:368–77.
39. VanderWeele TJ, Ding P. Sensitivity analysis in observational research: introducing the E-value. *Ann Intern Med* 2017;167:268–74.
40. Ellison CG, Bradshaw M, Flannelly KJ, Galek KC. Prayer, attachment to God, and symptoms of anxiety-related disorders among US adults. *Soc Relig* 2014;75:208–33.
41. Bartkowski JP, Acevedo GA, Van Loggenbergh H. Prayer, meditation, and anxiety: Durkheim revisited. *Religions* 2017;8:191.
42. Tsai AC, Lucas M, Kawachi I. Association between social integration and suicide among women in the United States. *JAMA Psychiatry* 2015;72:987–93.
43. Chang SC, Glymour M, Cornelis M *et al*. Social integration and reduced risk of coronary heart disease in women: the role of lifestyle behaviors. *Circ Res* 2017;120:1927–37.
44. Aquinas T. *Summa Theologica. Complete English Translation in Five Volumes*. Notre Dame, IN: Ave Maria Press, 1274/1948.
45. VanderWeele TJ. Religious communities and human flourishing. *Curr Dir Psychol Sci* 2017;26:476–81.
46. Pew Research Center. *Racial and Ethnic Composition among Christians*. <https://www.pewforum.org/religious-landscape-study/christians/christian/racial-and-ethnic-composition/> (20 October 2019, date last accessed).
47. VanderWeele TJ, Balboni TA, Koh HK. Health and spirituality. *Jama* 2017;318:519–20.
48. VanderWeele TJ. Can regression analyses of observational data provide causal conclusions? *JAMA Psychiatry*, in press.