Journal of Religion and Health (2022) 61:4062–4080
https://doi.org/10.1007/s10943-021-01368-6

ORIGINAL PAPER

The Association of Religion and Spirituality with Obesity and Weight Change in the USA: A Large-Scale Cohort Study

Nicholas D. Spence[1,2,3,4] · Erica T. Warner[3,4,5] · Maryam S. Farvid[6] · Tyler J. VanderWeele[6,7] · Ying Zhang[8] · Frank B. Hu[6,9,10] · Alexandra E. Shields[3,4,5]

Accepted: 21 July 2021 / Published online: 29 October 2021

Abstract

The association between religion, spirituality, and body weight is controversial, given the methodological limitations of existing studies. Using the Nurses' Health Study II cohort, follow-up occurred from 2001 to 2015, with up to 35,547 participants assessed for the religious or spiritual coping and religious service attendance analyses. Cox regression and generalized estimating equations evaluated associations with obesity and weight change, respectively. Religious or spiritual coping and religious service attendance had little evidence of an association with obesity. Compared with not using religious or spiritual coping at all, the fully adjusted hazard ratios (HRs) were minimally different across categories: a little bit (HR = 1.05, 95% CI: 0.92–1.18), a medium amount (HR = 1.09, 95% CI: 0.96–1.24), and a lot (HR = 1.10; 95% CI: 0.96–1.25) ($P_{\text{trend}} = 0.17$). Compared with participants who never or almost never attend religious meetings or services, there was little evidence of an association between those attending less than once/month (HR = 1.08, 95% CI: 0.97–1.10), 1–3 times/month (HR = 1.01, 95% CI: 0.90–1.13), once/week (HR = 0.92, 95% CI: 0.83–1.02), and more than once/week (HR = 0.94, 95% CI: 0.82–1.07) ($P_{\text{trend}} = 0.06$). Findings were similar for weight change. There was no significant association between religious or spiritual coping, religious service attendance, obesity, and weight change. While religion and spirituality are prominent in American society, they are not important psychosocial factors influencing body weight in this sample.

Keywords Obesity · Weight change · Religion · Spirituality · USA

✉ Nicholas D. Spence
nicholas.spence@utoronto.ca

Extended author information available on the last page of the article

Introduction

In the USA, there are approximately two-thirds of people living with overweight (35.2%) or obesity (31.4%) (Centers for Disease Control and Prevention, 2020). This chronic disease has multiple causes, including biological, environmental, and psychosocial (Goodarzi, 2018; Noriea et al., 2018; Williams et al., 2015). Religion and spirituality (R/S) is a potentially important psychosocial factor in understanding body weight, given its role in the organization of society, social relationships, ideology, social norms, and lifestyle behavior (Hill et al., 2000; Koenig et al., 2012; Paloutzian & Park, 2014). A key social institution in the USA, religion is remarkably high compared to other wealthy Western democracies (Pew Research Center, 2015).

The association between R/S and body weight has been widely debated, as indicated by the large body of work dedicated to this issue (Koenig, 2012; Yeary et al., 2017); indeed, over 85 quantitative articles have been written on the issue (Yeary et al., 2017), but the lack of high-quality evidence has resulted in a lack of consensus (Koenig, 2012; Yeary et al., 2017). In fact, a review found that 89% of quantitative work was cross-sectional, with only 11% incorporating some aspect of a longitudinal design (Yeary et al., 2017). Moreover, 41% of studies conducted only bivariable analysis, and a mere 8% of studies explored social mechanisms of action of the association between R/S and body weight through mediation analysis (Yeary et al., 2017), using traditional approaches with key limitations (VanderWeele, 2015).

Cross-sectionally, a disproportionate amount of research has found a positive association between R/S and body weight (Yeary et al., 2017), with a small effect size comparable to other social factors (Yeary et al., 2017). Longitudinally, there has been little evidence of an association between R/S and body weight (Cline & Ferraro, 2006); however, the limited number of studies is heterogenous (Yeary et al., 2017), with respect to the level of evidence for causality (VanderWeele, 2015). In a study of adults using the Americans' Changing Lives (ACL) national survey, 3617 participants were assessed prospectively from 1986 to 1994 (Cline & Ferraro, 2006). There was no significant association between BMI and all R/S variables, including religious service attendance, religious media practice, religious salience, religious consolation/coping, and religious affiliation. On the other hand, for women, religious service attendance was inversely associated with obesity (odds ratio [OR] = 0.87; 95% confidence interval [95% CI] = 0.77–0.97) and religious media practice was positively associated with obesity (OR = 1.14, 95% CI: 1.05–1.23). For men, religious consolation/coping was inversely associated with obesity (OR = 0.83, 95% CI: 0.71–0.99). In contrast, a retrospective cohort study from 2005–2010, among 36,965 adults in Japan, found no significant association between the degree of religiosity (i.e., "Are you religious?") and overweight/obesity (Kobayashi et al., 2015). Likewise, in the Dutch Gezondheid en Levens Omstandigheden Bevolking Eindhoven en omstreken Study ($N = 767$), among participants aged 20–49, with 6 years of follow-up, religious affiliation was not significantly associated with BMI (van Lenthe et al., 2000). Similarly,

among 3010 students from the Twin Cities Minnesota Metropolitan area in the Teens Eating for Energy and Nutrition at School Study (1997–2000), spiritual/religious beliefs were not significantly associated with BMI over 18 months (Pasch et al., 2008). Using the Coronary Artery Risk Development in Young Adults Study in the USA, over 18 years of follow-up, with 2433 Black and White participants, religious participation in R/S activities was not significantly associated with obesity (Feinstein et al., 2012). Among racially diverse adults aged 50 and over in the USA ($N = 2912$), in the Health and Retirement Study, over 4 years of follow-up, there was no significant association between religious service attendance and BMI (Suh et al., 2019). In the predominantly White Growing Up Today Study (GUTS) in the USA ($N = 7458$), there was no significant association between religious service attendance and prayer or meditation during adolescence and overweight/obesity in young adulthood from 1999–2010 (Chen & VanderWeele, 2018).

Scant attention has been paid to the social mechanisms by which R/S is proposed to be associated with body weight (Yeary et al., 2017). Proposed explanations have centered on mediators, especially lifestyle factors, including diet, physical activity, alcohol consumption, smoking, sleep, and social integration (Dodor et al., 2018; Feinstein et al., 2012; Ferguson et al., 2015; Kim et al., 2003; Koenig, 2012; Kortt & Dollery, 2014; Lycett, 2015; Nathenson & Wen, 2012; Yeary et al., 2017), which are linked to participation in R/S institutions and the regulation of behavior based on religious codes of conduct. However, existing studies are limited by methodological issues in causal inference (VanderWeele, 2015): inadequate adjustment for confounding, single point-in-time measures of exposures, assessment of mediation by adjusting for proposed mediators, and lack of temporal ordering of confounders, exposure, mediators, and outcome. Another unexplored social mechanism by which R/S may be associated with body weight is related to its relationship with psychosocial stress. The detrimental effects of psychosocial stressors on biological systems regulating stress processes are well known, with a wide range of effects on the sympathetic nervous system, immune system, and the hypothalamic–pituitary–adrenal (HPA) axis, which controls stress hormones and inflammatory processes that are associated with weight gain and obesity (Incollingo Rodriguez et al., 2015; Logan & Barksdale, 2008; McEwen & Stellar, 1993). The ability to handle psychosocial stressors is a function of many factors, particularly the availability of resilience resources, such as R/S.

Using the Nurses' Health Study (NHS) II, we assessed the association between two dimensions of R/S, participation in organized religion or public practices and religious or spiritual (R/S) coping, and both obesity and weight change. Next, we investigated the social mechanisms by which R/S might be associated with obesity and weight change: (i) by applying methodological advances in causal inference and mediation (VanderWeele, 2015), we examined the potential pathways through which R/S is associated with obesity and weight change, including lifestyle factors and social integration; (ii) effect modification to assess the potential differential association of R/S by level of stress in relation to obesity and weight change. This is the first study of its kind to prospectively examine these associations, using multiple waves of data with different dimensions of R/S, including key covariates and

temporal ordering of the exposure, covariates, and outcome, which addresses major shortcomings identified in existing work (Koenig, 2012; Yeary et al., 2017).

Methods

Sample

The NHS II is a prospective cohort study on risk factors for chronic disease that started in 1989, with 116,429 predominantly White, female, nurses in the USA, aged 25–42 at enrollment (Harvard School of Public Health, 2013). Follow-up for the NHS II occurs biennially. R/S was assessed in Supplemental Surveys (2001, 2008) and the biennial questionnaire (2013).

In the obesity analysis, the analytic sample was 26,449 for R/S coping and 24,535 for religious service attendance. Women missing a response on the exposure or with a major chronic disease, including obesity, prior to 2001 were excluded from the analyses (Figure S1). In the weight change analyses, the analytic sample was 35,547 for R/S coping and 33,204 for religious service attendance. Women missing a response on the exposure or with a major chronic disease, excluding obesity, prior to 2001 were excluded from the analyses (Figure S2).

The study protocol was approved by the Institutional Review Boards of the Brigham and Women's Hospital and Harvard T.H. Chan School of Public Health (Boston, USA), consistent with the Declaration of Helsinki. The Institutional Review Boards allowed participants' completion of questionnaires to be considered as implied consent.

Religion and Spirituality Measures

The organizational religiousness or public practices domain was assessed in 2001, 2008, and 2013 by the question, "How often do you go to religious meetings or services?" with response categories, "never or almost never, less than once/month, 1–3 times/month, once/week, more than once/week" (Fetzer Institute, 1999; Koenig, 1997).

The R/S coping domain was assessed in 2001 and 2008 as a positive coping strategy for life stress (Ano & Vasconcelles, 2005; Levin & Vanderpool, 1989; Liu et al., 2017; Pargament et al., 1998, 2000), using a single item from the COPE Inventory: "I try to find comfort in my religion or spiritual beliefs," with response categories, "not at all, a little bit, a medium amount, a lot" (Carver et al., 1989).

Body Weight and Obesity Measurement

Body weight was self-reported in the biennial surveys. Along with self-reported height in 1989, a measure of body mass index (BMI) in kg/m^2 was derived; these are validated indicators in this cohort (Rimm et al., 1990; Troy et al., 1995). Based

on the BMI, participants were classified as cases with obesity using standard classification criteria (i.e., BMI ≥ 30.0) (World Health Organization, 2018). Incident cases were identified through the first instance of obesity during follow-up.

Covariates

Based on a review of the literature (Chen & VanderWeele, 2018; Cline & Ferraro, 2006; Feinstein et al., 2012; Hruby et al., 2016; Hu et al., 2003; Kobayashi et al., 2015; Koenig, 2012; Noriea et al., 2018; Pasch et al., 2008; van Lenthe et al., 2000; VanderWeele, 2015; Williams et al., 2015; Yeary et al., 2017), there were several covariates identified for this study (see Methods S1): demographic (age, household income, country of birth, region of residence, race); stress; childhood and adolescence (abuse, parental socioeconomic status, birthweight, preterm birth, breastfed as infant, age at menarche); clinical (oral contraceptive use, parity, menopausal status and hormone replacement therapy, depression, physical exam in the last 2 years); lifestyle (physical activity, sedentary behavior, alcohol, cigarette smoking, caloric intake, DASH style diet, sleep, rotating night shift work); and social integration (social–emotional support and Berkman-Syme Social Network Index).

Statistical Analyses

The association between R/S and incident obesity was examined using Cox proportional hazards models to calculate hazard ratios (HR) and 95% CIs from 2001–2015. Person-time was accrued by study participants from the return of the 2001 questionnaire until the onset of obesity, newly pregnant status, age 65 because of loss of lean muscle mass associated with aging, death, last returned questionnaire, or the end of follow-up in June 2015, whichever came first.

The association between R/S and absolute weight change (kg/year), as well as relative weight change (percentage change/year), was examined from 2001–2015. We assessed the association between R/S and weight change within two periods (2001–2007; 2009–2015), in relation to religious coping, which was measured in 2001 and 2008, and within three periods (2001–2007; 2009–2013; 2013–2015), in relation to religious service attendance, which was measured in 2001, 2008, and 2013. These analyses were conducted using generalized estimating equations, with an unstructured covariance matrix to account for within-individual repeated measures. The coefficients from the multivariable analysis represent annual weight change (kg) (95% CI) or annual percentage weight change (95% CI). Weight changes were excluded when participants were missing body weight, became newly pregnant, reached age 65 because of loss of lean muscle mass associated with aging, or died.

Covariates were initially assessed and updated using the first available measure before religious coping in 2001 and 2008 and before religious service attendance in 2001, 2008, and 2013. We tested multiple models to examine the relationship between R/S, incident obesity, and weight change. Model 1 was minimally adjusted

for age and questionnaire cycle (obesity) or interval (weight change). Model 2 additionally adjusted for the other R/S exposure, demographic, stress, childhood and adolescence, and clinical covariates. Next, Model 3 additionally adjusted for lifestyle and social integration, though contemporaneous control of these variables cannot distinguish between mediators or confounders.

The proposed social mechanisms of action of R/S were investigated in two ways. First, the differential association of each R/S measure with obesity and weight change across levels of perceived stress was assessed by a bilinear interaction term. The results are presented along with a stratified model by tertile of perceived stress. As a sensitivity analysis, a similar approach was used to assess effect modification by BMI for the weight change analyses, including underweight/normal weight (BMI = < 25.0), overweight (BMI = 25.0–29.9), and obese (BMI ≥ 30.0).

Second, using the causal inference approach (VanderWeele, 2015), mediation analysis was conducted to investigate the role of potential mediators in the relationship between R/S and obesity and weight change. We incorporated confounders that occurred before R/S coping and religious service attendance in 2001. Mediators used were the first available measure after religious coping and religious service attendance in 2001: physical activity (2005); alcohol consumption (2003); cigarette smoking (2003); sedentary behavior, including sitting at work or away from home or while driving (2005), sitting at home while watching TV/VCR (2005), and other sitting at home, e.g., reading, meal times, at desk (2005); sleep length (2003); DASH style diet (2003); total calories (2003); Berkman-Syme Social Network Index (2008); and social–emotional support (2008). A causal interpretation of mediation analysis estimates is premised on the assumption that baseline covariates suffice to control for confounding for the exposure–outcome, mediator–outcome, and exposure–mediator relationships (VanderWeele, 2015). Mediation analyses may be of interest even when there is no total effect if the direct and mediated effects are in opposite directions. For the obesity analysis, we excluded participants who died or became obese between baseline and measurement of the mediator or who had missing mediator information. For the weight change analysis, we excluded participants who died, reached age 65, became newly pregnant, or who had missing mediator information.

R/S measures were modeled as ordinal variables for tests of trend. Missing covariate information for categorical data were handled using indicator variables. All analyses were performed using SAS version 9.3 software (SAS Institute, Inc., Cary, North Carolina).

Results

The women in our study were predominantly White with a mean age of 46.6 years (standard deviation, 4.5 years) at baseline. Approximately 43.3% of women use R/S to cope with stress a lot, and 45.6% of women attend religious meetings or services once/week or more. Baseline characteristics of study participants by categories of R/S coping and religious service attendance are presented in Tables 1, 2 for the obesity analysis and Tables S1, S2 for the weight change analyses. Overall, participants

Table 1 Baseline characteristics of study participants for the obesity analysis by categories of religious or spiritual coping, Nurses' Health Study II, 2001

Characteristic No. (%)	To cope with stress, I try to find comfort in my religion or spiritual beliefs			
	Not at all ($n=2485$)	A little bit ($n=5932$)	A medium amount ($n=6556$)	A lot ($n=11,476$)
Age (yrs.) [mean (SD)]	47.0 (4.5)	46.4 (4.5)	46.3 (4.6)	46.4 (4.6)
Household income (≥ $100 000 USD)	1032 (41.5)	2220 (37.4)	2179 (33.2)	3324 (29.0)
Geographic region of residence in the USA (Northeast)	921 (37.1)	2187 (36.9)	2240 (34.2)	3304 (28.8)
Country of birth (USA)	2226 (89.6)	5454 (91.9)	6030 (92.0)	10,539 (91.8)
race (white)	2323 (93.5)	5597 (94.4)	6214 (94.5)	10,764 (93.8)
Perceived stress score (0–16) [mean (SD)]	4.4 (3.2)	4.4 (2.9)	4.3 (2.8)	3.9 (2.7)
Child abuse (0–6), (most severe)	43 (1.7)	67 (1.1)	90 (1.4)	202 (1.8)
Parental ownership of home at birth or infancy	1274 (51.3)	3083 (52.0)	3466 (52.9)	6099 (53.2)
Paternal education at infancy (≥ 4 years of college)	630 (25.4)	1344 (22.7)	1481 (22.6)	2444 (21.3)
Maternal education at infancy (≥ 4 years of college)	287 (11.6)	586 (9.9)	671 (10.2)	1140 (9.9)
Age at menarche (≥ 15 yrs.)	222 (8.9)	494 (8.3)	555 (8.5)	912 (8.0)
Birthweight (≥ 10 lbs.)	25 (1.0)	45 (0.8)	70 (1.1)	119 (1.0)
Preterm birth (≥ 2 weeks premature)	135 (5.4)	380 (6.4)	439 (6.7)	743 (6.5)
Breastfed as infant	751 (30.2)	1610 (27.1)	1963 (29.9)	3797 (33.1)
Oral contraceptive use (current)	295 (11.9)	735 (12.4)	746 (11.4)	1026 (8.9)
Parity (nulliparous)	677 (27.2)	1196 (20.2)	1156 (17.6)	1781 (15.5)
Menopausal hormone therapy use (among postmenopausal women)	263 (10.6)	552 (9.3)	585 (8.9)	1128 (9.8)
Depression	288 (11.6)	563 (9.5)	562 (8.6)	757 (6.6)
Received a physical exam in the last 2 years	1977 (79.6)	4815 (81.2)	5464 (83.3)	9753 (85.0)
Smoking (current smoker)	248 (10.0)	556 (9.4)	539 (8.2)	596 (5.2)
Alcohol (no consumption)	603 (24.3)	1413 (23.8)	1938 (29.6)	4835 (42.1)
Physical activity (metabolic equivalents/week) [mean (SD)]	22.4 (24.6)	21.2 (22.9)	20.8 (23.1)	20.0 (23.1)
Sitting at work or away from home or while driving (> 20 h/week)	589 (23.7)	1238 (20.9)	1301 (19.8)	2019 (17.6)
Sitting at home while watching TV/VCR (> 20 h/week)	147 (5.9)	278 (4.69)	275 (4.2)	388 (3.4)

Table 1 (continued)

Characteristic No. (%)	To cope with stress, I try to find comfort in my religion or spiritual beliefs			
	Not at all ($n=2485$)	A little bit ($n=5932$)	A medium amount ($n=6556$)	A lot ($n=11,476$)
Other sitting at home, e.g., reading, mealtimes, at desk (> 20 h/week)	186 (7.5)	349 (5.9)	433 (6.6)	788 (6.9)
Sleep over a 24-h period (≤5 h)	112 (4.5)	261 (4.4)	237 (3.6)	384 (3.4)
Rotating night shift work (≥20 yrs.)	14 (0.6)	27 (0.5)	29 (0.4)	67 (0.6)
DASH style dietary pattern (8–40) [mean (SD)]	24.2 (5.4)	23.9 (5.1)	24.0 (5.0)	24.3 (5.0)
Total calories (kcal/day) [mean (SD)]	1747 (529)	1786 (533)	1803 (544)	1845 (551)
Berkman-Syme Social Network Index (0–12) [mean (SD)]	6.0 (2.1)	6.4 (2.0)	6.7 (1.9)	7.2 (2.0)
Social–emotional support (communicate with confidant once or more/day)	1071 (43.1)	2577 (43.4)	2862 (43.7)	5445 (47.5)
Religious service attendance (more than once a week)	4 (0.2)	46 (0.8)	357 (5.5)	3578 (31.2)

Table 2 Baseline characteristics of study participants for the obesity analysis by categories of religious service attendance, Nurses' Health Study II, 2001

Characteristic No. (%)	How often do you go to religious meetings or services?				
	Never or almost never ($n=5882$)	Less than once/month ($n=3082$)	1–3 times/month ($n=4292$)	Once/week ($n=7540$)	More than once/week (n = 3739)
Age (yrs.) [mean (SD)]	47.4 (4.4)	46.9 (4.4)	46.2 (4.5)	46.3 (4.6)	46.3 (4.6)
Household income (≥ $100 000 USD)	2131 (36.2)	1125 (36.5)	1537 (35.8)	2370 (31.4)	961 (25.7)
Geographic region of residence in the USA (Northeast)	1854 (31.5)	1122 (36.4)	1513 (35.3)	2700 (35.8)	834 (22.3)
Country of birth (USA)	5332 (90.7)	2836 (92.0)	3965 (92.4)	7000 (92.8)	3440 (92.0)
Race (white)	5509 (93.7)	2904 (94.2)	4077 (95.0)	7099 (94.2)	3531 (94.4)
Perceived stress score (0–16) [mean (SD)]	4.1 (3.0)	4.3 (2.9)	4.2 (2.8)	4.1 (2.8)	4.0 (2.6)
Child abuse (0–6), most severe	125 (2.1)	38 (1.2)	65 (1.5)	84 (1.1)	64 (1.7)
Parental ownership of home at birth or infancy	2991 (50.9)	1580 (51.3)	2300 (53.6)	4079 (54.1)	1999 (53.5)
Paternal education at infancy (≥ 4 years of college)	1341 (22.8)	701 (22.7)	1013 (23.6)	1625 (21.6)	841 (22.5)
Maternal education at infancy (≥ 4 years of college)	578 (9.8)	305 (9.9)	495 (11.5)	730 (9.7)	418 (11.2)
Age at menarche (≥ 15 yrs.)	489 (8.3)	259 (8.4)	340 (7.9)	618 (8.2)	310 (8.3)
Birthweight (≥ 10 lbs.)	50 (0.9)	21 (0.7)	38 (0.9)	86 (1.1)	44 (1.2)
Preterm birth (≥ 2 weeks premature)	356 (6.1)	188 (6.1)	295 (6.9)	480 (6.4)	259 (6.9)
Breastfed as infant	1754 (29.8)	924 (30.0)	1244 (29.0)	2310 (30.6)	1349 (36.1)
Oral contraceptive use (current)	656 (11.2)	361 (11.7)	479 (11.2)	783 (10.4)	288 (7.7)
Parity (nulliparous)	1751 (29.8)	684 (22.2)	566 (13.2)	999 (13.3)	473 (12.7)
Menopausal hormone therapy use (among postmenopausal women)	647 (11.0)	314 (10.2)	356 (8.3)	700 (9.3)	359 (9.6)
Depression	611 (10.4)	284 (9.2)	356 (8.3)	550 (7.3)	216 (5.8)
Received a physical exam in the last 2 years	4772 (81.1)	2574 (83.5)	3617 (84.3)	6339 (84.1)	3201 (85.6)
Smoking (current smoker)	697 (11.9)	311 (10.1)	281 (6.6)	338 (4.5)	108 (2.9)
Alcohol (no consumption)	1497 (25.5)	774 (25.1)	1155 (26.9)	2665 (35.3)	2056 (55.0)
Physical activity (metabolic equivalents/week) [mean (SD)]	22.7 (24.5)	22.0 (23.4)	21.0 (23.1)	20.0 (22.8)	18.1 (21.3)
Sitting at work or away from home or while driving (> 20 h/week)	1358 (23.1)	671 (21.8)	799 (18.6)	1341 (17.8)	622 (16.6)

Table 2 (continued)

Characteristic No. (%)	How often do you go to religious meetings or services?				
	Never or almost never ($n=5882$)	Less than once/month ($n=3082$)	1–3 times/ month ($n=4292$)	Once/week ($n=7540$)	More than once/ week (n = 3739)
Sitting at home while watching TV/VCR (> 20 h/week)	359 (6.1)	112 (3.6)	147 (3.4)	271 (3.6)	109 (2.9)
Other sitting at home, e.g., reading, mealtimes, at desk (> 20 h/week)	451 (7.7)	180 (5.8)	234 (5.5)	448 (5.9)	326 (8.7)
Sleep over a 24-h period (≤ 5 h)	249 (4.2)	128 (4.2)	151 (3.5)	283 (3.6)	88 (2.4)
Rotating night shift work (≥ 20 yrs.)	34 (0.6)	12 (0.4)	26 (0.6)	37 (0.5)	19 (0.5)
DASH style dietary pattern (8–40) [mean (SD)]	24.5 (5.4)	24.1 (5.0)	24.2 (5.0)	23.9 (4.9)	24.3 (4.9)
Total calories (kcal/day) [mean (SD)]	1755 (534)	1788 (543)	1829 (549)	1822 (540)	1873 (546)
Berkman-Syme Social Network Index (0–12) [mean (SD)]	6.0 (2.1)	6.5 (2.0)	6.7 (1.9)	7.0 (1.8)	7.9 (1.8)
Social–emotional support (communicate with confidant once or more/day)	2722 (46.3)	1371 (44.5)	1837 (42.8)	3428 (45.5)	1741 (46.6)
Religious or spiritual coping (a lot)	725 (12.3)	595 (19.3)	1439 (33.5)	4506 (59.8)	3335 (89.2)

with the highest household income (≥ $100 000 USD) reported lower levels of R/S. On the other hand, participants reporting higher levels of R/S were less likely to smoke cigarettes and consume alcohol, but they also reported higher daily caloric intake, as well as social–emotional support, social networks, and having received a physical exam in the last 2 years.

In the R/S coping analysis, there were 4420 incident obesity cases over 322,054 person-years of follow-up, and in the religious service attendance analysis, there

Table 3 Religious or spiritual coping, religious service attendance, and incident obesity in the Nurses' Health Study II, 2001–2015

Exposure	Cases	Person-years	Hazard ratio (95% confidence interval)		
			Model 1[a]	Model 2[b]	Model 3[c]
Religious or spiritual coping					
Not at all	386	31,309	Reference	Reference	Reference
A little bit	926	67,345	1.11 (0.98, 1.25)	1.05 (0.93, 1.19)	1.05 (0.92, 1.18)
A medium amount	1111	78,226	1.12 (1.00, 1.27)	1.09 (0.96, 1.24)	1.09 (0.96, 1.24)
A lot	1997	145,174	1.09 (0.98, 1.21)	1.08 (0.95, 1.23)	1.10 (0.96, 1.25)
P_{trend}			0.44	0.30	0.17
Religious meetings or service attendance					
Never or almost never	1016	76,256	Reference	Reference	Reference
Less than once per month	607	42,264	1.12 (1.01, 1.24)	1.08 (0.97, 1.20)	1.08 (0.97, 1.10)
1–3 times per month	665	49,001	1.05 (0.95, 1.16)	1.00 (0.90, 1.12)	1.01 (0.90, 1.13)
Once a week	1164	91,298	0.96 (0.88, 1.05)	0.91 (0.82, 1.01)	0.92 (0.83, 1.02)
More than once a week	573	43,339	1.01 (0.91, 1.12)	0.94 (0.83, 1.06)	0.94 (0.82, 1.07)
P_{trend}			0.26	0.04	0.06

[a]Model 1 adjusted for age and questionnaire cycle

[b]Model 2 additionally adjusted for the other R/S covariate; demographic covariates (household income [< $50 000, $50 000–$74 999, $75 000–$99 999, ≥ $100 000 USD], geographic region of residence in the USA [Northeast, South, West, Midwest], country of birth [USA/Other]), race [White, Black, Asian, Hispanic, Other]); stress covariate (tertiles); childhood and adolescence covariates (abuse covariate [0–6], parental ownership of home at birth or infancy [yes, no], paternal education at infancy [< high school, high school, 1–3 years of college, ≥ 4 years of college], maternal education at infancy [< high school, high school, 1–3 years of college, ≥ 4 years of college], age at menarche [< 12, 12, 13, 14, ≥ 15], birthweight [< 5.5 lbs., 5.5–6.9 lbs., 7.0–8.4 lbs., 8.5–9.9 lbs., ≥ 10 lbs.], preterm birth [full term/ ≥ 2 weeks premature], breastfed as infant [yes, no]); clinical covariates (received a physical exam in the last 2 years [yes, no], oral contraceptive use [never, past, current], parity [0, 1, 2, 3, 4, 5, ≥ 6], menopausal status and hormone replacement therapy [premenopausal, postmenopausal/never received HRT, postmenopausal/past HRT, postmenopausal/current HRT, postmenopausal/missing HRT, dubious menopause], depression [yes, no])

[c]Model 3 additionally adjusted for lifestyle covariates (cigarette smoking [never, past, current], alcohol [none, 0.1–5.0, 5.1–10.0, 10.1–15.0, 15.1–29.9, ≥ 30.0 g/day], physical activity [metabolic equivalents or METs per week, quintiles], sitting at work or away from home or while driving [0–1, 2–5, 6–20, 21–40, > 40 h/week], sitting at home while watching TV/VCR [0–1, 2–5, 6–20, 21–40, > 40 h/week], other sitting at home [e.g., reading, meal times, at desk; 0–1, 2–5, 6–20, 21–40, > 40 h/week], sleep over a 24-h period [≤ 5, 6, 7, 8, ≥ 9 h/day], rotating night shift work [0, 1–2, 3–9, 10–19, ≥ 20 years], DASH style diet [quintiles], total calories [kcal/day, quintiles]); and social integration covariates (Berkman-Syme Social Network Index [quartiles], social–emotional support [no confidant, sees or talks with confidant < once/month, > once per month < once/week, > once/week < once/day, ≥ once/day])

were 4025 incident obesity cases over 302,158 person-years of follow-up, from 2001–2015. R/S coping and religious service attendance had little evidence of an association with obesity, across all models (Table 3). In the fully adjusted model, compared to women who did not use R/S to cope with stress, the associations were as follows: a little bit (HR = 1.05, 95% CI: 0.92–1.18), a medium amount (HR = 1.09, 95% CI, 0.96–1.24), and a lot (HR = 1.10, 95% CI, 0.96–1.25) (P_{trend} = 0.17). Similarly, compared to women who never or almost never attend religious meetings or services, the fully adjusted associations were as follows: less than once/month (HR = 1.08, 95% CI: 0.97–1.10), 1–3 times/month (HR = 1.01, 95% CI, 0.90–1.13), once/week (HR = 0.92, 95% CI: 0.83–1.02), and more than once/week (HR = 0.94, 95% CI: 0.82–1.07) (P_{trend} = 0.06).

For weight change and percentage weight change, there was little evidence of an association with R/S coping or religious service attendance. These findings were consistent in all models (Table 4). In the fully adjusted model, women indicating they use R/S to cope a little bit (0.02 kg/year, 95% CI, − 0.02 to 0.05), a medium amount (0.01 kg/year, 95% CI, − 0.03 to 0.05), or a lot (0.02 kg/year, 95% CI, − 0.02 to 0.05), had minimal differences in weight change relative to women who did not use R/S to cope with stress (P_{trend} = 0.66). For religious service attendance, in the fully adjusted model, women indicating they attend religious meetings or services less than once/month (0.01 kg/year, 95% CI, − 0.03 to 0.05), 1–3 times/month (0.02 kg/year, 95% CI, − 0.02 to 0.07), once/week (0.02 kg/year, 95% CI, − 0.02 to 0.06), or more than once/week (− 0.01 kg/year, 95% CI, − 0.06 to 0.04), had minimal differences in annual weight change relative to women who never or almost never attend religious meetings or services (P_{trend} = 0.80). Similar results were found for annual percentage weight change (Table 4). As a sensitivity analysis, we excluded participants with obesity at baseline, and the results were similar (not shown).

Also, across all models, there was little evidence of effect modification of R/S coping, religious service attendance, and obesity by level of perceived stress (Table S3). Similar results were observed for weight change and percentage weight change when interactions were assessed with perceived stress (Tables S4, S5) and BMI (Tables S6, S7).

Finally, there was little evidence from the causal mediation analysis for mediation by lifestyle factors and social integration in the association between each R/S measure and obesity (Table S8), weight change (Table S9), and percentage weight change (Table S10).

Discussion

Among female nurses in the NHS II, we prospectively assessed the association between R/S coping, religious service attendance, obesity, and weight change. There was consistently little evidence of any association. Our findings are congruent with the only comparable prospective study, with temporal ordering of exposure, confounders, and outcome, by Chen and VanderWeele (2018), who found little evidence of an association between religious service attendance and overweight/obesity

Table 4 Religious or spiritual coping, religious service attendance, and annual weight change in the Nurses' Health Study II, 2001–2015

	Annual weight change (kg) (95% confidence interval)			Annual weight change (%) (95% confidence interval)		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 1[a]	Model 2[b]	Model 3[c]
Religious or spiritual coping						
Not at all	Reference	Reference	Reference	Reference	Reference	Reference
A little bit	0.03 (0.00, 0.07)	0.02 (−0.02, 0.06)	0.02 (−0.02, 0.05)	0.04 (0.00, 0.09)	0.03 (−0.02, 0.08)	0.03 (−0.02, 0.08)
A medium amount	0.02 (−0.01, 0.06)	0.01 (−0.03, 0.05)	0.01 (−0.03, 0.05)	0.03 (−0.01, 0.07)	0.02 (−0.03, 0.07)	0.02 (−0.03, 0.07)
A lot	0.02 (−0.01, 0.05)	0.01 (−0.03, 0.05)	0.02 (−0.02, 0.05)	0.03 (−0.01, 0.07)	0.02 (−0.03, 0.08)	0.03 (−0.02, 0.08)
P_{trend}	0.71	0.94	0.66	0.70	0.64	0.38
Religious meetings or service attendance						
Never or almost never	Reference	Reference	Reference	Reference	Reference	Reference
Less than once per month	0.02 (−0.02, 0.05)	0.01 (−0.03, 0.05)	0.01 (−0.03, 0.05)	0.02 (−0.02, 0.07)	0.01 (−0.04, 0.06)	0.02 (−0.03, 0.07)
1–3 times per month	0.03 (0.00, 0.07)	0.02 (−0.02, 0.06)	0.02 (−0.02, 0.07)	0.04 (−0.01, 0.08)	0.03 (−0.02, 0.08)	0.03 (−0.02, 0.09)
Once a week	0.02 (−0.01, 0.05)	0.01 (−0.03, 0.05)	0.02 (−0.02, 0.06)	0.02 (−0.01, 0.06)	0.02 (−0.03, 0.07)	0.03 (−0.02, 0.08)
More than once a week	−0.02 (−0.05, 0.02)	−0.02 (−0.06, 0.03)	−0.01 (−0.06, 0.04)	−0.03 (−0.07, 0.02)	−0.02 (−0.08, 0.04)	−0.01 (−0.07, 0.05)
P_{trend}	0.96	0.86	0.80	0.91	0.93	0.70

[a]Model 1 adjusted for age and interval

[b]Model 2 additionally adjusted for BMI; the other R/S covariate; demographic covariates (household income [<$50 000, $50 000–$74 999, $75 000–$99 999, ≥$100 000 USD], geographic region of residence in the USA [Northeast, South, West, Midwest], country of birth [USA/Other]), race [White, Black, Asian, Hispanic, Other]); stress covariate (tertiles); childhood and adolescence covariates (abuse covariate [0–6], parental ownership of home at birth or infancy [yes, no], paternal education at infancy [<high school, high school, 1–3 years of college, ≥4 years of college], maternal education at infancy [<high school, high school, 1–3 years of college, ≥4 years of college], age at menarche [<12, 12, 13, 14, ≥15], birthweight [<5.5 lbs., 5.5–6.9 lbs., 7.0–8.4 lbs., 8.5–9.9 lbs., ≥10 lbs.], preterm birth [full term, ≥2 weeks premature], breastfed as infant [yes, no]); clinical covariates (received a physical exam in the last 2 years [yes, no], oral contraceptive use [never, past, current], parity [0, 1, 2, 3, 4, 5, ≥6], menopausal status and hormone replacement therapy [premenopausal, postmenopausal/never received HRT, postmenopausal/past HRT, postmenopausal/current HRT, postmenopausal/missing HRT, dubious menopause], depression [yes, no])

[c]Model 3 additionally adjusted for lifestyle covariates (cigarette smoking [never, past, current], alcohol [none, 0.1–5.0, 5.1–10.0, 10.1–15.0, 15.1–29.9, ≥30.0 g/day), physical activity [metabolic equivalents or METs per week, quintiles], sitting at work or away from home or while driving [0–1, 2–5, 6–20, 21–40, > 40 h/week], sitting at home while watching TV/VCR [0–1, 2–5, 6–20, 21–40, > 40 h/week], other sitting at home [e.g., reading, meal times, at desk; 0–1, 2–5, 6–20, 21–40, > 40 h/week], sleep over a 24-h period [≤5, 6, 7, 8, ≥9 h/day], rotating night shift work [0, 1–2, 3–9, 10–19, ≥20 years], DASH style diet [quintiles], total calories [kcal/day, quintiles]); and social integration covariates (Berkman-Syme Social Network Index [quartiles], social–emotional support [no confidant, sees or talks with confidant < once/month, > once per month < once/week, > once/week < once/day, ≥ once/day

among adolescents transitioning into young adulthood in an outcome-wide analysis. Their study was based on GUTS, which is a cohort study of children of NHS II participants; therefore, the study populations may be similar across psychosocial and biological factors. Our findings are also consistent with the prospective ACL study regarding use of R/S as a coping mechanism. However, the ACL study found evidence of an inverse association for men, which indicates the potential importance of interaction effects by sex for R/S measures. More generally, our findings are relatively consistent with longitudinal research on R/S and body weight, across different measures of R/S (Chen & VanderWeele, 2018; Cline & Ferraro, 2006; Feinstein et al., 2012; Kobayashi et al., 2015; Pasch et al., 2008; Suh et al., 2019; van Lenthe et al., 2000).

On the other hand, our findings partially differ from the ACL study, which found an inverse association between religious service attendance and obesity, and a positive association between R/S media practice (reading religious books; watching or listening to religious programs on the television or radio) and obesity over 8 years of study for women. Methodologically, we had a much larger sample, six years longer of follow-up, more than one point-in-time measure for R/S, a broader range of covariates, assessed the social mechanisms of action, and used multiple waves of data to ensure temporal ordering of the exposure, covariates, and outcome. This study operationalized R/S coping and religious service attendance as categorical variables to detect nonlinear associations, along with trend analyses, while the ACL study operationalized and analyzed religious service attendance (1[never] to 6 [once/week]) and religious consolation or seeking spiritual comfort and support in dealing with problems (1[never] to 4 [almost always]) as continuous variables. Also, we examined two measures of R/S, while they investigated five. Demographically, the NHS II is predominantly White, middle-aged, female nurses, compared to a nationally representative sample of middle-aged participants in the USA.

Finally, we found no support for the hypothesized social mechanisms of action of R/S on obesity and weight change, including effect modification of R/S coping and religious service attendance by perceived stress or BMI, as well as mediated pathways through social integration and several lifestyle factors.

Strengths and Limitations

This study addresses critical methodological issues in previous work (Yeary et al., 2017). Also, it is the only study to examine the association of two theoretically salient dimensions of R/S simultaneously with obesity and weight change, as well as test longstanding hypotheses on the potential social mechanisms of action through effect modification and mediation analyses. We used a prospective study design with a large sample size and relatively long duration of follow-up, a comprehensive list of covariates, and the repeated measures of R/S variables and covariates allowed us to clarify temporality between the exposure, covariates, and outcome, which is critical to develop high-quality evidence (VanderWeele, 2015). We updated the exposure over the course of follow-up, while most empirical R/S research uses one assessment of the exposure, which implies stability of this concept over time (Pargament,

2002). In the mediation analysis, we implemented methodological advances within the causal inference approach (VanderWeele, 2015). Finally, the response rate across the NHS II cohort surveys is very high, enhancing internal validity.

One limitation of the study is low external validity, as the population is mainly White, female, nurses in the USA. We were also limited to analyzing available R/S measures (Fetzer Institute, 1999; Mishra et al., 2017); other dimensions of R/S may be important. The homogenization of religious denominations is problematic, as social regulations governing lifestyle behaviors associated with body weight are wide ranging; for example, Seventh-day Adventists have low levels of obesity (Cline & Ferraro, 2006), which reflect restrictive health promoting lifestyle practices (e.g., adequate exercise, rest, healthy diet, abstention from alcohol and tobacco), because theologically, bodies are the temples of the Holy Spirit, and must, therefore, be cared for accordingly (Medina-Remon et al., 2018; Seventh-day Adventist Church, 2020). Behavior that is inconsistent with these norms is a form of deviance or moral failure. In contrast, there is some evidence that obesity is high among Baptists (Cline & Ferraro, 2006), which may be partially explained by the prominent role of high calorie food within the context of religious functions and less restrictive norms in relation to excess food consumption (Cline & Ferraro, 2006; Sack, 2001).

Conclusion

In a prospective cohort study of female nurses in the USA, we found no significant association between R/S coping, religious service attendance, obesity, and weight change. These findings suggest that R/S does not play a clinically important role as a psychosocial determinant of body weight in this sample. Future studies should focus on longitudinal designs that investigate the association between multiple dimensions of R/S, particularly religious denomination, obesity, and other plausible chronic diseases. An examination of these associations across diverse sociodemographic groups and cross-national research, with strict attention to temporality, confounding, and social mechanisms of action, is required to build a stronger body of research evidence.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10943-021-01368-6.

Author Contributions NDS contributed to study concept and design, data extraction and statistical analysis, interpretation of data, drafting of manuscript, critical revision of the manuscript for important intellectual content, and approval of final manuscript for submission. ETW, MSF, TJV, YZ, FBH, and AES performed interpretation of data, critical revision of the manuscript for important intellectual content, and approval of final manuscript for submission.

Funding This study was funded by the National Institutes of Health (U01 CA176726) and the John Templeton Foundation (Grant Number 48424).

Availability of Data and Material The study protocol and procedures to obtain and access data from the Nurses' Health Studies are described at https://www.nurseshealthstudy.org/researchers.

Code Availability Upon request.

Declarations

Conflict of interest The authors have no conflicts of interest or competing interests to declare that are relevant to the content of this article.

Ethical Approval The study protocol was approved by the Institutional Review Boards of the Brigham and Women's Hospital and Harvard T.H. Chan School of Public Health (Boston, USA), consistent with the Declaration of Helsinki.

Consent to Participate/Consent for Publication The Institutional Review Boards allowed participants' completion of questionnaires to be considered as implied consent.

References

Ano, G. G., & Vasconcelles, E. B. (2005). Religious coping and psychological adjustment to stress: A meta-analysis. *Journal of Clinical Psychology, 61*(4), 461–480. https://doi.org/10.1002/jclp.20049

Carver, C., Scheier, M., & Weintraub, J. (1989). Assessing coping strategies: A theoretically based approach. *Journal of Personality and Social Psychology, 56*(2), 267–283.

Centers for Disease Control and Prevention. (2020). *National Center for Chronic Disease Prevention and Health Promotion Data, Trend and Maps*. Centers for Disease Control and Prevention. Retrieved March 1, 2020 from https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html

Chen, Y., & VanderWeele, T. J. (2018). Associations of religious upbringing with subsequent health and well-being from adolescence to young adulthood: An outcome-wide analysis. *American Journal of Epidemiology, 187*(11), 2355–2364. https://doi.org/10.1093/aje/kwy142

Cline, K. M., & Ferraro, K. F. (2006). Does religion increase the prevalence and incidence of obesity in adulthood? *Journal for the Scientific Study of Religion, 45*(2), 269–281. https://doi.org/10.1111/j.1468-5906.2006.00305.x

Dodor, B. A., Robinson, M. A., Watson, R., Meetze, D., & Whicker, R., Jr. (2018). The impact of religiosity on substance abuse and obesity in African Americans. *Journal of Religion and Health, 57*(4), 1315–1328. https://doi.org/10.1007/s10943-017-0501-2

Feinstein, M., Liu, K., Ning, H., Fitchett, G., & Lloyd-Jones, D. M. (2012). Incident obesity and cardiovascular risk factors between young adulthood and middle age by religious involvement: The Coronary Artery Risk Development in Young Adults (CARDIA) study. *Preventive Medicine, 54*(2), 117–121. https://doi.org/10.1016/j.ypmed.2011.11.004

Ferguson, T. W., Andercheck, B., Tom, J. C., Martinez, B. C., & Stroope, S. (2015). Occupational conditions, self-care, and obesity among clergy in the United States. *Social Science Research, 49*, 249–263. https://doi.org/10.1016/j.ssresearch.2014.08.014

Fetzer Institute. (1999). *Multidimensional measurement of religiousness/spirituality for use in health research: A report of the Fetzer Institute/National Institute on Aging Working Group*. Health Research Program Area of the John E. Fetzer Institute.

Goodarzi, M. O. (2018). Genetics of obesity: What genetic association studies have taught us about the biology of obesity and its complications. *The Lancet Diabetes and Endocrinology, 6*(3), 223–236. https://doi.org/10.1016/S2213-8587(17)30200-0

Harvard School of Public Health. (2013). *Nurses' Health Study II*. Harvard School of Public Health. Retrieved October 1 from https://nurseshealthstudy.org/about-nhs/history

Hill, P. C., Pargament, K. I., Hood, R. W., McCullough, J., Michael, E., Swyers, J. P., Larson, D. B., & Zinnbauer, B. J. (2000). Conceptualizing religion and spirituality: Points of commonality, points of departure. *Journal for the Theory of Social Behaviour, 30*(1), 51–77. https://doi.org/10.1111/1468-5914.00119

Hruby, A., Manson, J. E., Qi, L., Malik, V. S., Rimm, E. B., Sun, Q., Willett, W. C., & Hu, F. B. (2016). Determinants and consequences of obesity. *American Journal of Public Health, 106*(9), 1656–1662. https://doi.org/10.2105/AJPH.2016.303326

Hu, F. B., Li, T. Y., Colditz, G. A., Willett, W. C., & Manson, J. E. (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA, 289*(14), 1785–1791. https://doi.org/10.1001/jama.289.14.1785

Incollingo Rodriguez, A. C., Epel, E. S., White, M. L., Standen, E. C., Seckl, J. R., & Tomiyama, A. J. (2015). Hypothalamic-pituitary-adrenal axis dysregulation and cortisol activity in obesity: A systematic review. *Psychoneuroendocrinology, 62*, 301–318. https://doi.org/10.1016/j.psyneuen.2015.08.014

Kim, K. H., Sobal, J., & Wethington, E. (2003). Religion and body weight. *International Journal of Obesity and Related Metabolic Disorders, 27*(4), 469–477.

Kobayashi, D., Shimbo, T., Takahashi, O., Davis, R. B., & Wee, C. C. (2015). The relationship between religiosity and cardiovascular risk factors in Japan: A large-scale cohort study. *Journal of the American Society of Hypertension, 9*(7), 553–562. https://doi.org/10.1016/j.jash.2015.04.003

Koenig, H. (1997). *Is religion good for your health?* Haworth Press.

Koenig, H. (2012). Religion, spirituality, and health: The research and clinical implications. *ISRN Psychiatry, 2012*, 278730. https://doi.org/10.5402/2012/278730

Koenig, H., King, D., & Carson, V. B. (2012). *Handbook of Religion and Health* (2nd ed.). Oxford University Press.

Kortt, M. A., & Dollery, B. (2014). Religion and BMI in Australia. *Journal of Religion and Health, 53*(1), 217–228. https://doi.org/10.1007/s10943-012-9621-x

Levin, J. S., & Vanderpool, H. Y. (1989). Is religion therapeutically significant for hypertension? *Social Science and Medicine, 29*(1), 69–78. https://doi.org/10.1016/0277-9536(89)90129-9

Liu, M. Y., Li, N., Li, W. A., & Khan, H. (2017). Association between psychosocial stress and hypertension: A systematic review and meta-analysis. *Neurological Research, 39*(6), 573–580. https://doi.org/10.1080/01616412.2017.1317904

Logan, J. G., & Barksdale, D. J. (2008). Allostasis and allostatic load: Expanding the discourse on stress and cardiovascular disease. *Journal of Clinical Nursing, 17*(7b), 201–208. https://doi.org/10.1111/j.1365-2702.2008.02347.x

Lycett, D. (2015). The association of religious affiliation and body mass index (BMI): An analysis from the Health Survey for England. *Journal of Religion and Health, 54*(6), 2249–2267. https://doi.org/10.1007/s10943-014-9975-3

McEwen, B. S., & Stellar, E. (1993). Stress and the individual. Mechanisms leading to disease. *Archives of Internal Medicine, 153*(18), 2093–2101. https://doi.org/10.1001/archinte.1993.00410180039004

Medina-Remon, A., Kirwan, R., Lamuela-Raventos, R. M., & Estruch, R. (2018). Dietary patterns and the risk of obesity, type 2 diabetes mellitus, cardiovascular diseases, asthma, and neurodegenerative diseases. *Critical Reviews in Food Science and Nutrition, 58*(2), 262–296. https://doi.org/10.1080/10408398.2016.1158690

Mishra, S. K., Togneri, E., Tripathi, B., & Trikamji, B. (2017). Spirituality and religiosity and its role in health and diseases. *Journal of Religion and Health, 56*(4), 1282–1301. https://doi.org/10.1007/s10943-015-0100-z

Nathenson, S. L., & Wen, M. (2012). Religiousness, physical activity and obesity among older cancer survivors: Results from the Health and Retirement Study 2000–2010. *The International Journal of Religion and Spirituality in Society, 2*(3), 129–144. https://doi.org/10.18848/2154-8633/cgp/v02i03/51016

Noriea, A. H., Patel, F. N., Werner, D. A., & Peek, M. E. (2018). A narrative review of physician perspectives regarding the social and environmental determinants of obesity. *Current Diabetes Reports, 18*(5), 24. https://doi.org/10.1007/s11892-018-0990-8

Paloutzian, R., & Park, C. (Eds.). (2014). *Handbook of the Psychology of Religion and Spirituality* (2nd ed.). Guilford Press.

Pargament, K. I. (2002). The bitter and the sweet: An evaluation of the costs and benefits of religiousness. *Psychological Inquiry, 13*(3), 168–181. https://doi.org/10.1207/S15327965PLI1303_02

Pargament, K. I., Koenig, H. G., & Perez, L. M. (2000). The many methods of religious coping: Development and initial validation of the RCOPE. *Journal of Clinical Psychology, 56*(4), 519–543. https://doi.org/10.1002/(sici)1097-4679(200004)56:4%3c519::aid-jclp6%3e3.0.co;2-1

Pargament, K. I., Smith, B. W., Koenig, H. G., & Perez, L. (1998). Patterns of positive and negative religious coping with major life stressors. *Journal for the Scientific Study of Religion*. https://doi.org/10.2307/1388152

Pasch, K. E., Nelson, M. C., Lytle, L. A., Moe, S. G., & Perry, C. L. (2008). Adoption of risk-related factors through early adolescence: Associations with weight status and implications for causal

mechanisms. *Journal of Adolescent Health, 43*(4), 387–393. https://doi.org/10.1016/j.jadohealth.2008.02.009

Pew Research Center. (2015). *America's changing religious landscape*.

Rimm, E. B., Stampfer, M. J., Colditz, G. A., Chute, C. G., Litin, L. B., & Willett, W. C. (1990). Validity of self-reported waist and hip circumferences in men and women. *Epidemiology, 1*(6), 466–473. https://doi.org/10.1097/00001648-199011000-00009

Sack, D. (2001). *Whitebread Protestants: Food and Religion in American Culture*. Palgrave.

Seventh-day Adventist Church. (2020). *Living Christian Behavior*. Retrieved May 1, 2020 from https://www.adventist.org

Suh, H., Hill, T., & Koenig, H. G. (2019). Religious attendance and biological risk: A national longitudinal study of older adults. *Journal of Religion and Health, 58*, 1188–1202. https://doi.org/10.1007/s10943-018-0721-0

Troy, L., Hunter, D. J., Manson, J. E., Colditz, G. A., Stampfer, M. J., & Willett, W. C. (1995). The validity of recalled weight amonger younger women. *International Journal of Obesity and Related Metabolic Disorders, 19*(8), 570–572.

van Lenthe, F. J., Droomers, M., Schrijvers, C. T., & Mackenbach, J. P. (2000). Socio-demographic variables and 6 year change in body mass index: Longitudinal results from the GLOBE study. *International Journal of Obesity and Related Metabolic Disorders, 24*(8), 1077–1084. https://doi.org/10.1038/sj.ijo.0801236

VanderWeele, T. (2015). *Explanation in Causal Inference: Methods for Mediation and Interaction*. Oxford University Press.

Williams, E. P., Mesidor, M., Winters, K., Dubbert, P. M., & Wyatt, S. B. (2015). Overweight and obesity: Prevalence, consequences, and causes of a growing public health problem. *Current Obesity Reports, 4*(3), 363–370.

World Health Organization. (2018). *Fact sheets: Obesity and overweight*. World Health Organization. Retrieved June 25 from https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight

Yeary, K. H. K., Sobal, J., & Wethington, E. (2017). Religion and body weight: A review of quantitative studies. *Obesity Reviews, 18*(10), 1210–1222. https://doi.org/10.1111/obr.12569

Authors and Affiliations

Nicholas D. Spence[1,2,3,4] · Erica T. Warner[3,4,5] · Maryam S. Farvid[6] · Tyler J. VanderWeele[6,7] · Ying Zhang[8] · Frank B. Hu[6,9,10] · Alexandra E. Shields[3,4,5]

1 Department of Sociology, University of Toronto, 725 Spadina Avenue, Office 334, Toronto, ON M5S 2J4, Canada

2 Department of Health and Society, University of Toronto, Toronto, ON, Canada

3 Harvard/MGH Center on Genomics, Vulnerable Populations, and Health Disparities, Mongan Institute, Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA

4 National Consortium on Psychosocial Stress, Spirituality, and Health, Massachusetts General Hospital, Boston, MA, USA

5 Harvard Medical School, Boston, MA, USA

6 Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, MA, USA

7 Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, MA, USA

8 Sleep Medicine Epidemiology, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

[9] Department of Nutrition, Harvard T.H. Chan School of Public Health, Boston, MA, USA

[10] Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA