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The distinct roles of spirituality and religiosity in physical and mental health after collective trauma: a national longitudinal study of responses to the 9/11 attacks

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Abstract Researchers have identified health implications of religiosity and spirituality but have rarely addressed differences between these dimensions. The associations of religiosity and spirituality with physical and mental health were examined in a national sample ($N = 890$) after the September 11, 2001 terrorist attacks (9/11). Health information was collected before 9/11 and health, religiosity, and spirituality were assessed longitudinally during six waves of data collection over the next 3 years. Religiosity (i.e., participation in religious social structures) predicted higher positive affect ($\beta = .12$), fewer cognitive intrusions ($\beta = -.07$), and lower odds of new onset mental (incidence rate ratio [IRR] = .88) and musculoskeletal (IRR = .94) ailments. Spirituality (i.e., subjective commitment to spiritual or religious beliefs) predicted higher positive affect ($\beta = .09$), lower odds of new onset infectious ailments (IRR = 0.83), more intrusions ($\beta = .10$) and a more rapid decline in intrusions over time ($\beta = -.10$). Religiosity and spirituality independently predict health after a collective trauma, controlling for pre-event health status; they are not interchangeable indices of religion.

Introduction

Spirituality and religiosity have been positively associated with physical and mental health (Koenig et al. 2001; Oman and Thoresen 2005; Seybold and Hill 2001). Substantial variability exists in findings across studies, however, pointing to the importance of examining how different aspects of religious experience relate to specific health outcomes (Hackney and Sanders 2003). One recurring question is whether spirituality and religiosity have distinct associations with health (Seybold and Hill 2001).

Spirituality and religiosity are substantively related to each other, as both are connected to the idea of the sacred (i.e., things set apart from the ordinary, connected to the divine; Pargament 1997; Pargament et al. 2005); nonetheless, useful distinctions can be drawn. Although definitions vary, *spirituality* is typically aligned with subjective, personal beliefs, whereas *religiosity* is identified with traditional, institutionally related practices and behaviors (Hill and Pargament 2003; Koenig 2009). Spirituality occurs both within and separate from religious institutions (Hill and Pargament 2003). To examine their separate associations with health, we focused on the commonly identified differences between them; we define *religiosity* as participation in religious social structures and *spirituality* as the subjective, individual, lived-out commitment to spiritual or religious beliefs.

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There is some evidence that spirituality and religiosity associate with different outcomes. For example, among bereaved parents, religious participation relates to greater perceived social support and meaning, whereas importance of religion relates to cognitive processing and finding meaning (McIntosh et al. 1993; see also Jansen et al. 2010; Markides et al. 1987). One way to study differences in the roles of spirituality and religiosity in health is to examine them in a group of people coping with a singular stressful event. Examining outcomes after a negative event is especially pertinent, as spirituality and religiosity may help people manage such experiences, which in turn can influence health (e.g., Hackney and Sanders 2003; Koenig et al. 2001; McIntosh et al. 1993; Pargament 1997; Park 2005). The present study used the context of the September 11, 2001 terrorist attacks against the United States (9/11) to examine similarities and differences in how spirituality and religiosity are related to physical and mental health in a large national sample. Moreover, we used a longitudinal design with pre-event health information. There is little longitudinal research examining links between religiosity, spirituality and health. This aspect of the present design allowed investigation of changes in levels and relations of variables, including new onset ailments, as the coping process unfolds. By following respondents for 3 years after a fixed, collective event that generated notable distress nationwide (Silver et al. 2002), we were able to determine whether spirituality and religiosity differentially predicted physical and mental health over time.

Mental health and adjustment

Most studies find less depression and anxiety among religious individuals, though findings are mixed (Koenig et al. 2001), and differ depending on what aspect of religion is assessed (Hackney and Sanders 2003; Shreve-Neiger 2004). Specific to coping, religion is related to greater positive affect and less dysphoria following stressful events (McIntosh et al. 1993; Pargament 1997; Park and Cohen 1993). These outcomes may result from individuals' internalized religious beliefs: spirituality may provide an interpretive framework that aids adjustment to an event (McIntosh 1995). Adjustment to negative events may also result from social aspects of religious involvement: religious service attendance increases exposure to social support, thus promoting well-being (Ellison and George 1994; Koenig and Larson 2001). Because they may operate via different mechanisms, spirituality and religiosity may relate independently to positive affect, anxiety and depression following a collective stressor.

Adjustment following a traumatic event is reflected in more than affect, anxiety and depression. It also involves attempts to cognitively process or make sense of the event (Greenberg 1995; Tait and Silver 1989). Traumatic events often lead to struggles to reconcile the experience of the event with beliefs about the world (Janoff-Bulman 1992; Park and Folkman 1997). This process can be manifest through involuntary, intrusive thoughts of the event (Horowitz 1997; Lepore et al. 1996; Silver et al. 1983). Ongoing intrusions often indicate that the individual has not been able to integrate the event successfully, and thus may signal and cause continued distress (Silver et al. 1983; Tait and Silver 1989). However, early processing may allow people to successfully integrate the event, thus facilitating adjustment (e.g., Davis et al. 1998; Lepore et al. 1996; McIntosh et al. 1993; Silver et al. 1983; Taylor 1983). Spirituality may provide schemata that help individuals more easily assimilate events into their worldviews, facilitating shorter, more effective processing of traumatic events (McIntosh 1995; Siegel et al. 2001). This would be reflected by a more rapid decline in intrusions as the event is integrated, a pattern suggested by prior research (McIntosh et al. 1993). Religiosity may facilitate interpretation and assimilation of traumatic events because social interactions, especially in religious contexts (Ladd and McIntosh 2008), can offer opportunities to interpret traumatic events collaboratively (Lepore et al. 1996; Pennebaker and Harber 1993; Tait and Silver 1989).

Physical health

Spirituality and religiosity may affect physical health by improving health behaviors, providing social resources, or changing psychological responses, especially when dealing with stress (Flannelly et al. 2004; Oman and Thoresen 2005). Spirituality is likely to affect health through psychological processes, such as altering cognitive appraisals of events (Newton and McIntosh 2009, 2010), decreasing a need for control, or enhancing a sense of control (McIntosh and Spilka 1990) or coherence (cf. George et al. 2002) that may decrease stress, and thus improve health outcomes (Koenig et al. 2001; Oman and Thoresen 2005). Religiosity may provide social support via clergy, support groups, and integration in a social network (George et al. 2002; Ladd and McIntosh 2008). Because social support enhances health (Cohen 2004; House et al. 1988; Krause 2006), religiosity should predict better physical health outcomes.

Given the importance of stress to theorized mechanisms, we examined ailments likely to be linked to the experience of stress. Extreme stress, such as 9/11, can trigger a neurohormonal cascade of events that may support coping in the short run, but can threaten health if it does not abate (McEwen 1998, 2008). This stress can impair immune function, leading to higher incidence of infection (Kemeny and Schedlowski 2007). To the extent that spirituality and religiosity decrease stress, they should predict lower rates

of infectious ailments after a stressful event (Koenig et al. 2001). Consistent with this, religious service attendance is associated with enhanced immune function (Lutgendorf et al. 2004). In addition, persistent exposure to cortisol and other stress hormones may lead to negative effects on bone density, can increase blood pressure, promote atherosclerotic changes in arteries, and increase the risk of myocardial infarction (Brown et al. 2004). Musculoskeletal ailments have also been associated with another form of allostatic load (hypothalamic–pituitary–adrenal or HPA axis hyporesponsiveness), wherein low cortisol responses to stress allow increased secretion of inflammatory cytokines that promote autoimmune and other inflammatory diseases, many of which can affect the musculoskeletal system (Boscarino 2004; McEwen 1998). Based on these physiologic mechanisms, any factors that reduce stress should reduce cardiovascular and musculoskeletal ailments. As spirituality and religiosity are hypothesized to decrease stress, they should each lead to reduced cardiovascular and musculoskeletal ailments in the context of extreme stress. However, the evidence is not conclusive. Lower levels of religious service attendance have been related to higher rates of death from circulatory disease (e.g., Oman et al. 2002), but recent work indicates that spirituality and religiosity do not relate to cardiovascular morbidity and mortality (Feinstein et al. 2010; Schnall et al. 2010). Little work has examined musculoskeletal ailments and religious variables. Links between spirituality, religiosity, and these ailments may be most evident in stressful contexts. This study examines these connections in the context of a collective trauma.

The present study

We examined the association of spirituality and religiosity with mental (anxiety and depression, positive affect, cognitive intrusions) and physical (i.e., infectious disease, cardiovascular ailments, musculoskeletal ailments) health in the years following the 9/11 attacks, a collective traumatic experience (Schlenger et al. 2002; Silver et al. 2002), and one for which religion was a common way of coping (Ai et al. 2005; Schuster et al. 2001). We were able to obtain health information collected *before* 9/11, and we assessed physical and mental health, spirituality, and religiosity longitudinally during six waves of data collection over the next 3 years. By employing a longitudinal design, an early assessment of response, pre-event data for some key variables, and a large, nationally representative sample, this study also addressed methodological limitations that have plagued research on stressful events in general (cf. Silver et al. 2006) and on religion and health in particular (see Flannelly et al. 2004; Oman and Thoreson 2005, for reviews). We hypothesized that across the 3 years

following 9/11, spirituality and religiosity would independently predict more positive affect and less anxiety and depression, higher initial levels and faster rate of decline of cognitive intrusions, and lower incidence of infectious, cardiovascular, and musculoskeletal ailments.

Method

Participants and procedure

Data were collected through Internet-based surveys of a large, nationally representative sample recruited following 9/11 (Silver et al. 2002; 2006) in collaboration with Knowledge Networks Inc. (KN). KN is a survey research organization that maintains a Web-enabled research panel of potential respondents recruited using stratified random-digit-dial telephone sampling. Panel members participate in brief surveys 3–4 times a month and are compensated with Internet access (if needed), points used to obtain merchandise, and cash incentives for certain surveys. For this study, participants earned the equivalent of approximately $10 per survey. KN maintains the anonymity of panel participants. Members may leave the panel at any time, and receipt of the Web TV and Internet access is not contingent upon completion of any specific survey. Data indicate that the KN panel does not respond significantly differently over time to surveys than more "naïve" survey respondents (Dennis 2001). Informed consent was obtained for all participants, and procedures were approved by the University of Denver and University of California, Irvine Institutional Review Boards.

Data used in the present study were collected at several time points (see below).[1] At each wave, panel members were notified that a survey was available in their password-protected email accounts. Surveys were confidential, self-administered and accessible any time of day for a designated 3–4 week period. Completion times were approximately 30–45 min for each survey.

Pre-9/11 health survey

Between June 2000 and September 9, 2001, 45,938 adult KN panelists completed an online health survey, modified from the Centers for Disease Control's National Center for Health Statistics annual National Health Interview Survey

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[1] A larger sample of the KN panel was also asked questions by Knowledge Networks about their coping strategies and acute stress response to the attacks approximately 9–14 days after 9/11 (see Silver et al. 2002). Since these variables have been examined earlier and were not of interest to the present set of analyses, we excluded that prior wave of data collection for simplicity, and focus on the restricted sample described herein.

(U.S. Department of Health and Human Services 2000). Respondents were asked "Has a medical doctor *ever* diagnosed you as suffering from any of the following ailments?" with prompts for 35 physical and mental health ailments. Responses to this survey closely tracked prevalence estimates from the 2000 National Health Interview Survey (Baker et al. 2003). Items from this survey provided the baseline assessments for our respondents (see below).

Assessment of psychological variables

In November and December of 2001, approximately 2 months after 9/11, we designed a survey that was fielded to 1,643 adults from the KN panel; 1,382 completed it (84% participation rate). This sample consisted of a random sub-sample of the national KN sample ($n = 933$), as well as an oversample of respondents from cities that had experienced recent community traumas ($n = 449$) (see Silver et al. 2006). In March and April of 2002 (Wave 2), and again in September and November of 2002 (Wave 3), this sample was re-surveyed. A total of 1,141 (90% participation rate) completed Wave 2 and 1,098 (79% participation rate) completed Wave 3. Three more surveys were administered to this subsample in March and April of 2003 (Wave 4, $N = 667$, 79% participation rate), September and October of 2003 (Wave 5, $N = 639$, 76% participation rate), and September to November of 2004 (Wave 6, $N = 695$, 84% participation rate; approximately 50% of the Wave 1 sample).

Post 9/11 health surveys

Annual health surveys, patterned after the pre-9/11 health assessment, were administered. The first was fielded October-December, 2002 ($N = 711$, 77% participation rate), the second October, 2003-March, 2004 ($N = 646$, 70% participation rate), and the final one during September–November, 2004 ($N = 843$, 81% participation rate).

Measures

Dependent variables

Mental health status At each health survey, physician-diagnosed Anxiety Disorder and Depression were used to compute an index of physician-diagnosed *mental health ailments* (0 = none, 1 = Anxiety Disorder or Depression, 2 = both).

Cognitive intrusions At each wave, 9/11-related *cognitive intrusions* were measured with other clusters of posttraumatic stress symptoms (numbing/avoidance and hyper-arousal). These were assessed at Waves 1 and 2 using the Impact of Events Scale-Revised (IES-R; Weiss and Marmar 1997). Internal consistencies at both waves for all subscales

were very good (αs .84–.89). At Waves 3 through 6, 9/11-related intrusions and other posttraumatic stress symptoms were measured using the conceptually similar PTSD Checklist (PCL; Blanchard et al. 1996) in order to make assessments of posttraumatic stress more consistent with DSM-IV criteria for probable posttraumatic stress disorder. Internal consistencies for this measure were good at all waves for all subscales (αs .81 to .89); mean scores were computed as an index of *cognitive intrusions* of the attacks.

Positive affect At each wave, participants reported the frequency of experiencing eight different positive emotions (affection, joy, love, happiness, contentment, caring, pride, and fondness) within the past week (cf. Diener et al. 1995). Internal consistency in this sample was excellent at all waves (αs > .91); the mean score was computed as an index of *positive affect*.

Physical health status A physician used the International Classification of Diseases Version 9 (ICD-9) standards (World Health Organization 1999) to classify the 35 Health Survey ailments into ICD-9 disease system categories. Individual variables representing the total count of the separate ICD-9-based categories of infectious (e.g., physician-diagnosed hepatitis or herpes), musculoskeletal (e.g., physician-diagnosed arthritis or back pain), and cardiovascular (e.g., physician-diagnosed hypertension or heart problems) ailments were created.

Primary predictor variables: religiosity and spirituality

Religiosity As noted above, *religiosity* was defined as participation in religious social structures. In this study, it was operationalized as attendance at religious services. To assess attendance before 9/11, respondents answered the question, "Before the events of September 11th, how often did you attend services or meetings of a spiritual or religious organization?" using a 5-point scale (1 = "Never, 3 = "Sometimes," 5 = "All the time").

Spirituality Spirituality was defined as the subjective, individual, lived-out commitment to spiritual or religious beliefs. In this study, it was assessed using a modified two-item Intrinsic subscale of the 9-item Religious Orientation Scale (Gorsuch and McPherson 1989): "My whole approach to life is shaped by my spiritual or religious beliefs" and "I try hard to live all my life according to my religious or spiritual beliefs"), assessed on a 5-point scale ranging from 1 "strongly disagree" to 5 "strongly agree." This scale exhibited excellent reliability (α = .83).

Control variables

Demographics KN provided age, gender, marital status, ethnicity, education, and household income. KN imputed

missing values for income with mean income scores for respondent's census block.

9/11-related exposure At Wave 1, participants reported their experiences related to the 9/11 attacks. Using this information, we coded their 9/11 exposure on a scale from 0 to 2, where 0 represented indirect exposure following the attacks (e.g. via non-live or print media), 1 represented indirect exposure via live media coverage, and 2 represented being directly exposed to the attacks.

Stressful events Lifetime exposure to *stressful events* was assessed at Wave 1 by asking participants whether they had ever experienced each of 37 negative events (e.g., natural disaster, child abuse) and the age(s) at which they occurred. From these data, an index of the total number of stressful events individuals experienced was calculated.

Health risk factors and somatization Smoking and body mass index (BMI) were assessed in the pre-9/11 health survey as general risk factors for morbidity. At each wave of health data collection, individual differences in reporting physical symptoms were assessed in two ways. First, the total number of physician-diagnosed physical health ailments was computed. Second, respondents completed the somatization subscale from the 18-item Brief Symptom Inventory (BSI-18; Derogatis 2001). Reliability was excellent for all assessments (all αs > .80).

Analytic strategy

Analyses were conducted using Stata 9.0 (Stata Corp. College Station, TX). Analyses of the associations of religiosity and spirituality with mental and physical health outcomes were done using multilevel regression models (mixed effects or hierarchical linear models; Singer and Willett 2003). Multilevel modeling provided an efficient way to examine whether religiosity and spirituality would predict outcomes across multiple waves without increasing Type I error. It also allowed for the prediction of change in cognitive intrusions in the form of the interaction between time (months since 9/11) and spirituality and religiosity. The construction of all multilevel models presented herein involved screening two sets of control variables before entering the variables for spirituality and religiosity. These sets of control variables were demographic (age, gender, ethnicity, education, income level) and trauma/mental health history (pre-9/11 mental health, number of lifetime stressful events, and exposure to the 9/11 attacks). In addition, each model that examined a physical ailment included that ailment assessed pre-9/11 in the first block, new onset mental health ailments in the second block, and a third block with physical health risk factors (smoking, BMI) and somatization (total number of ailments reported, BSI-somatization). Significant variables from each block were retained for the final models.

Treatment of missing data

Following recruitment into the study, there was varying attrition over time. This type of missing data is acceptable in multilevel modeling, because individuals contribute to estimation of the model at particular time points even if they cannot do so at all time points (Singer and Willett 2003). Missing data on particular measures within a wave were managed by listwise deletion of cases with missing data on a given variable. This resulted in only small reductions in *n*s, since each variable was missing data on less than 2% of cases.

Results

Sample demographics and characteristics

The initial sample ($N = 1,382$) was 71.1% White, 9.2% African American, 10.8% Hispanic, and 8.3% other ethnicities (e.g., Asian American, Native American). Females comprised 51.1% of the sample, and ages ranged from 18 to 101 ($M = 48.1$). Of the 1,196 respondents (86.5%) who reported their religious identity, most respondents identified as Christian (70.7%), with 1.8% Jewish, 12.6% "other" (including 4 Muslims),[2] and 14.3% "none." At baseline, 15.2% of the sample reported a prior diagnosis of anxiety or depression, 9.5% reported a prior doctor-diagnosed infectious ailment, 21.5% reported a prior doctor-diagnosed cardiovascular ailment, and 34.8% reported a prior doctor-diagnosed musculoskeletal ailment. During the study, 1-year incidence for these ailment categories averaged 14.5% for anxiety or depression, 10.0% for infectious ailments, 27.8% for cardiac ailments, and 29.2% for musculoskeletal ailments. Mean levels of religiosity and spirituality, assessed on a 1–5 scale with 5 representing highest levels, were 2.85 and 3.30, respectively. As expected, religiosity and spirituality were highly correlated, but not identical, constructs ($r = .60$).

Analysis of non-participants

Individuals who received but did not respond to the Wave 1 survey did not differ significantly from respondents in terms of income, education, gender, marital status, or ethnicity. Respondents were, however, significantly older ($M = 48.1$ years) than non-respondents ($M = 40.0$ years; $t (1,371) = 8.33$, $P < .001$). Patterns of non-response after

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[2] Given the generally representative nature of our sample, this suggests that Muslims were greatly underrepresented. However, because our surveys were conducted in the context of the 9/11 attacks, it is possible that a larger number of our participants were Muslim but did not want to disclose their religious identities.

Wave 1 were examined using Stata's *xtgee* module (a multilevel application that allows for binomial distributions), with participation at each wave (yes/no) as the time-varying dependent variable. At each subsequent wave, non-participants tended to be younger ($M = 43.0$ years) than those who continued to participate ($M = 50.4$ years; OR = 1.02, $P < .001$) and reported fewer lifetime negative events on average (7.78) than did continuing participants (8.76; OR = 1.02, $P < .05$), but there were no differences on any key study variables.

Mental health and adjustment

Multilevel regressions, fit using Stata's *xtreg* module, examined associations of spirituality and religiosity with mental ailments (anxiety and depression) and positive affect over the 36 months following 9/11. As shown in Table 1, both religiosity ($\beta = .12$, $P < .001$) and spirituality ($\beta = .09$, $P < .01$) predicted higher levels of positive affect, and religiosity, but not spirituality, predicted lower incidence of mental ailments (IRR = 0.88, $P < .05$).

An additional multilevel model tested the hypothesis that religiosity and spirituality would predict both levels and rate of decline of cognitive intrusions. To evaluate whether religiosity and spirituality predicted *change* in intrusions over time, we tested the interactions of religiosity and spirituality with time. The religiosity X time interaction was not significant, and was therefore dropped from the final model, but religiosity did predict lower overall levels of intrusions ($\beta = -.07$, $P < .05$; see Table 1). The spirituality X time interaction was significant ($\beta = -.10$, $P < .01$), and recentering spirituality at 1 SD above and below its

mean revealed that, consistent with our predictions, the decline in cognitive intrusions was greater at high ($\beta = -.20$, $P < .001$) versus low ($\beta = -.14$, $P < .001$) levels of spirituality (see Fig. 1); combining results, it can be seen that spirituality is associated with higher levels of intrusions at Wave 2 and more rapid declines over time.

Physical health

To test the hypothesis that spirituality and religiosity would predict decreased incidence of physical ailments, which were count variables, multilevel Poisson regression models were built using Stata's *xtpois* module (to address over-dispersion, negative binomial models were also examined using Stata's *xtnbreg* module; results were substantively identical). Poisson regression models yield regression coefficients that can be anti-logged and interpreted as incidence rate ratios (IRRs). An IRR is the ratio by which the predicted count of the outcome variable (e.g., number of physical ailments) would change given a one-unit increase in the predictor. IRRs of <1 indicate a relative decrease in the outcome's incidence while IRRs of >1 indicate a relative increase in the outcome's incidence, and IRRs = 1 indicate no association between the predictor and the outcome. The final models, which included control variables that significantly predicted incidence of ailment categories in their respective screening blocks, are shown in Table 2. Results indicated that spirituality, though not religiosity, predicted decreased incidence of infectious ailments (IRR = 0.83, $P < .05$). Conversely, religiosity predicted decreased incidence of musculoskeletal ailments (IRR = 0.94, $P < .05$), but spirituality did not. Neither

Table 1 Multilevel regression models for mental health (N = 890)

Variable	New onset Mental Ailments IRR (95% CI)	Positive Affect β	Positive Affect B (95% CI)	Cognitive Intrusions β	Cognitive Intrusions B (95% CI)
Time (months post-9/11)	1.02 (1.01, 1.03)***	−.002	−0.000 (−0.001, 0.001)	−.09**	−0.005 (−0.008, −0.002)
Age		.000	0.000 (−0.001, 0.003)	.06**	0.002 (0.001, 0.003)
Female gender	1.87 (1.42, 2.46)***	.08**	0.11 (0.04, 0.17)	.11***	0.12 (0.07, 0.17)
Hispanic ethnicity				.06**	0.11 (0.03, 0.19)
Income		.12***	0.02 (0.01, 0.03)	−.09***	−0.01 (−0.02, −0.01)
Pre-9/11 mental ailments	4.11 (3.46, 4.90)***	−.15***	−.21 (−0.27, −0.15)	.10***	0.12 (0.07, 0.17)
Pre-9/11 stressful events	1.01 (0.99, 1.03)				
9/11 exposure				.13***	0.14 (0.09, 0.18)
Religiosity	0.88 (0.79, 0.98)*	.12***	0.06 (0.03, 0.08)	−.07*	−0.03 (−0.06, −0.01)
Spirituality	1.04 (0.92, 1.17)	.09**	0.05 (0.02, 0.08)	.10**	0.05 (0.02, 0.07)
Spirituality X Time				−.10**	−0.002 (−0.003, −0.001)

IRR incidence rate ratio. N for new onset mental ailments was 785; for other models, it was 890. All models displayed significant fit (all Ps < .001)

* $P < .05$ ** $P < .01$ *** $P < .001$
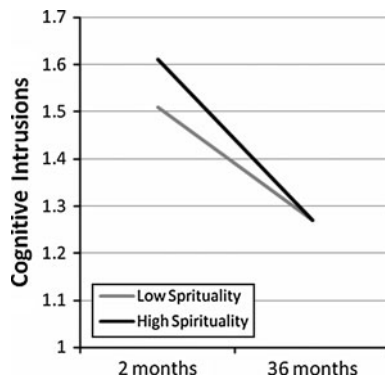
Fig. 1 Change in cognitive intrusions over the 3 years post-9/11, graphed by level of spirituality. For the graph, high and low values of spirituality are one standard deviation above and below the sample mean, respectively. The total range of the cognitive intrusions scale was 1–5, but 85% of individuals in this sample scored between 1 and 2

spirituality nor religiosity was a significant predictor of the incidence of cardiovascular ailments. Based on these models, estimated adjusted incidence rates of infectious and musculoskeletal ailments at high and low levels of spirituality and religiosity are shown in Fig. 2.

Discussion

This is one of the first large-scale, longitudinal studies to examine how spirituality and religiosity independently predict mental and physical health after a major traumatic event. We addressed many methodological limitations of

prior research, including the need for pre-event measures of health status, prompt assessment of outcomes post-event, and multiple subsequent post-event assessments. The association between spirituality, religiosity and health outcomes were robust after controlling for confounding factors (age, gender, ethnicity, education, marital status, income, pre-9/11 health, smoking, BMI, stressful event history, and 9/11 exposure). This significantly strengthens the evidence for the influence of spirituality and religiosity on health. In addition, by controlling for somatization, we minimized the likelihood that our measures of physical health ailments were confounded by respondents' tendency to somatize.

Religiosity was associated with more positive affect, lower incidence of mental ailments, fewer cognitive intrusions, and decreased incidence of musculoskeletal ailments during 3 years following 9/11. It was not associated with infectious or cardiovascular ailments or a reduction in cognitive intrusions across time. In contrast, spirituality was associated with more positive affect, fewer infectious ailments, higher levels of cognitive intrusions, and a steeper decline in intrusions. It was not associated with mental, musculoskeletal, or cardiovascular ailments. Finding that spirituality and religiosity independently associate with different outcomes, combined with studies also suggesting they function separately (e.g., Jansen et al. 2010; Markides et al. 1987; McIntosh et al. 1993), indicates that despite their association spirituality and religiosity are distinct phenomena. The influence of each on health and stress processes needs to be examined individually.

Table 2 Multilevel poisson regression models for incidence of physical ailments ($N = 785$)

Variable	Infectious IRR (95% CI)	Cardiovascular IRR (95% CI)	Musculoskeletal IRR (95% CI)
Time (months post-9/11)	1.02 (1.00, 1.03)*	1.01 (1.00, 1.02)**	1.06 (0.87, 1.76)***
Pre-9/11 infectious ailments	4.91 (3.21, 7.53)***		
Pre-9/11 cardiac ailments		2.90 (2.52, 3.35)***	
Pre-9/11 musculoskeletal ailments			1.31 (1.05, 1.07)***
Age in years		1.03 (1.02, 1.03)***	1.01 (1.21, 1.42)***
Female gender	0.95 (0.64, 1.42)		1.14 (0.97, 1.33)
African American ethnicity		1.24 (0.87, 1.76)	0.66 (0.45, 0.97)*
New onset mental ailments	1.23 (0.96, 1.58)	0.98 (0.84, 1.15)	0.91 (0.81, 1.01)
Pre-9/11 stressful events	1.02 (0.99, 1.06)	1.00 (0.99, 1.02)	1.01 (0.99, 1.02)
Smoking	1.43 (0.89, 2.30)		
BMI		1.01 (0.99, 1.03)	
Total past year physical diagnoses		1.09 (1.06, 1.12)***	1.16 (1.13, 1.18)***
Somatization	1.10 (0.76, 1.61)		
Religiosity	1.05 (0.88, 1.25)	1.04 (0.96, 1.13)	0.94 (0.88, 0.99)*
Spirituality	0.83 (0.69, 0.99)*	0.99 (0.90, 1.09)	1.04 (0.97, 1.12)

IRR incidence rate ratio. All models displayed significant fit (all Ps $< .001$)

* $P < .05$ ** $P < .01$ *** $P < .001$
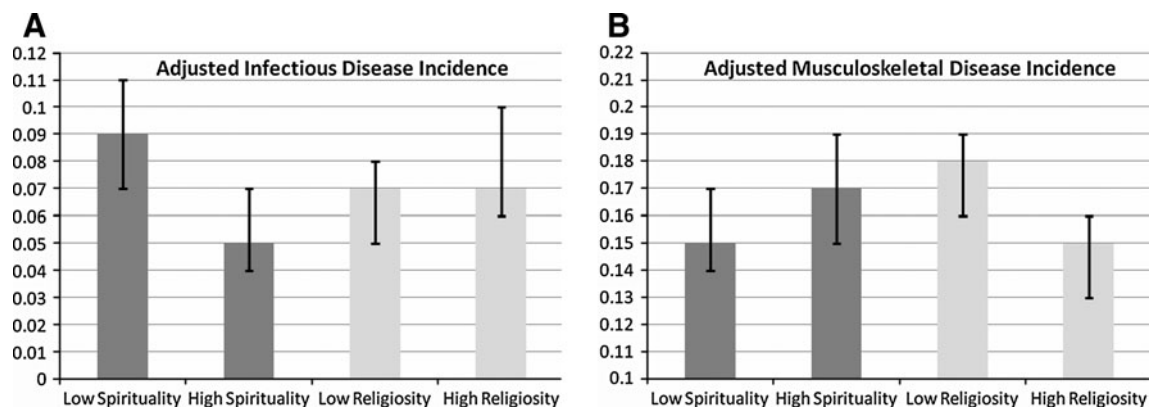
Fig. 2 *Panel A* Estimated incidence of new onset infectious ailments in the 3 years post-9/11, adjusted for model variables (see Table 2) and graphed by high and low levels of spirituality and religiosity. *Panel B* Estimated incidence of new onset musculoskeletal ailments in the 3 years post-9/11, adjusted for model variables (see Table 2) and graphed by high and low levels of spirituality and religiosity. For the graphs, high and low values of spirituality and religiosity are one standard deviation above and below the sample mean, respectively

Mental health and adjustment

Both religiosity and spirituality predicted greater positive affect. As religious variables are consistently associated with positive affect (Loewenthal et al. 2000), research should focus on how they enhance positive emotions and the effects of this.

Spirituality and religiosity differed in their relation to cognitive intrusions of the attacks. Religiosity predicted fewer intrusions over time, whereas spirituality predicted both more intrusions and a more rapid decline across the 3 years. This pattern reinforces earlier work examining religion and cognitive processing after a traumatic loss (McIntosh et al. 1993). It further supports the interpretation that high levels of spirituality may be related to amplified processing of a traumatic event, and that such processing leads to less need for processing with time. Why the difference between spirituality and religiosity? Perhaps people high in spirituality are especially focused on beliefs or have a greater need to integrate events into their belief systems, regardless of their degree of religious participation. These individuals may engage in more thought about disturbing events that facilitates more effective integration of the events. Religiosity, reflecting greater social participation, may provide social pressure or resources that decrease the need or ability to engage in as much cognitive processing. Further work should examine potential differences in the motivation for meaning or understanding in spirituality and religiosity, and consider differences in health and coping outcomes.

Greater religiosity predicted fewer reports of physician-diagnosed mental health ailments (anxiety, depression), but there was no association with spirituality. One possibility is that for these specific disorders, the social aspect of religion, perhaps via social integration or support, provides the most protection. However, a meta-analysis suggested that institutional religion (which included attendance) predicted more distress (which included depression and anxiety), and personal devotion (which included intrinsic religion) predicted less distress, with generally larger effects for personal devotion (Hackney and Sanders 2003). One question for future research to address is whether the relation of spirituality and religiosity to mental health outcomes depends on whether they are measured in a stressful context. Perhaps the social support from religion has a stress-buffering, rather than a direct, effect on mental health.

Physical health

Regarding physical health, neither spirituality nor religiosity predicted cardiovascular ailments. The absence of a relation is similar to two recent studies (Feinstein et al. 2010; Schnall et al. 2010), and extends the null result to the context of a collective trauma. The variability across studies and the difficulty in finding an association suggest that if there is any effect on cardiovascular ailments, it may be specific to religious or spiritual variables not measured in these studies, or that there is a moderating factor that needs to be identified.

Religiosity, but not spirituality, predicted fewer musculoskeletal ailments. This suggests that the social aspect of religion is associated with fewer problems with these ailments. Perhaps frequent social and physical activity associated with religious service attendance is protective of the development of musculoskeletal ailments. Although reverse influence is also possible (those who have musculoskeletal ailments may have difficulty attending services), the fact that religiosity at Wave 1 predicted new onset ailments presents a strong case that attendance is protective. Especially given the relative absence of other work

exploring religiosity, spirituality, and diagnosis of musculoskeletal ailments, future work should explore the consistency, and then possible mechanisms, responsible for these findings.

Finally, spirituality, but not religiosity, predicted fewer infectious ailments in the 3 years following 9/11. This is consistent with work showing that religion predicts immune system functioning beyond social support (Lutgendorf et al. 2004), and that an intrinsic religious orientation is correlated with fewer reported illnesses (McIntosh and Spilka 1990). The specific relationship with spirituality suggests that psychological resources such as control (McIntosh and Spilka 1990), coherence and meaning (George et al. 2002; Park 2005), and alterations in cognitive appraisal (Newton and McIntosh 2009, 2010) may be particularly relevant in decreasing stress-related immunosupressive outcomes.

Limitations and future directions

Several limitations of this study point to areas for future research. First, there may be self-report biases related to spirituality, religiosity, and the outcomes. However, the pattern would need to be specific, as the association of spirituality and religiosity varied by ailment, and somatization was controlled; further, any bias in a specific ailment would need to be altered by 9/11 or the passage of time, as a consistent bias would be controlled by the baseline. Additionally, our health measure had been benchmarked against the National Health Interview Survey, which itself has been validated against medical records (U.S. Department of Health and Human Services 1994). Nonetheless, self-report measures of physician-diagnosed ailments are subject to recall biases and may reflect the respondents' interpretations of their medical encounters. Without medical record corroboration, we cannot assume that all individuals reporting physician-diagnosed ailments had true disease, nor that all true disease was reported. Future research should confirm self-reports using medical records.

A second set of limitations involve our measures of religiosity and spirituality. Religiosity was assessed with self-reported attendance at religious services. Participation in a religious social structure may involve more than this (e.g., study or prayer groups) and social integration and interaction can vary within the same level of attendance. Similarly, there are many definitions of spirituality. By focusing solely on internalization, the content of beliefs, for example, was omitted. Future work should incorporate more complete measures of both constructs. However, we share Koenig's (2009) concern to avoid operationalizations of spirituality that include components (e.g., existential well-being, meaning) that may themselves be indicators of good mental health. In both cases, measures of the content of the beliefs, or the rituals and attitudes of the religious social context, would be helpful; the association of religion and well-being may differ across faith groups (Park et al. 1990), and people of different faiths appraise stressful events differently (Newton and McIntosh 2009). Finally, religiosity and spirituality were assessed post-9/11. Stronger inferences can be made when investigating the role of spirituality and religion in adjustment to stress if these are measured before the onset of the stressor.

Third, we cannot rule out potential biases in our sample due to attrition, and thus decreasing representativeness over time. However, retention rates were relatively high, ranging from 76 to 90% from wave to wave, and with approximately 50% of the original sample retained after 3 years. In addition, our analyses of non-respondents at each wave indicated that they differed from respondents only by age and number of lifetime traumas, not by religiosity, spirituality, nor any health outcome. Nonetheless, we welcome future epidemiological research conducted with even more rigorous panel methods.

Conclusion

Across 3 years, with numerous controls, religiosity and spirituality were independently and differentially related to mental and physical health. Both predicted positive affect, and neither predicted cardiovascular ailments. Religiosity alone predicted fewer mental health ailments and lower levels of cognitive intrusions. Spirituality alone predicted fewer infectious ailments, more cognitive intrusions and a faster decline in intrusions. As these findings focused on responses to a collective trauma, our outcomes are tied to stress and coping processes. Other avenues through which spirituality and religiosity may influence health may lead to different patterns. Future work should compare their influence on health across a variety of indicators and contexts. The resulting patterns will illuminate processes through which spirituality and religiosity together and separately influence mental and physical health.

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