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Abstract

The current study investigated gender effects on the influence of self-reported religiosity and spirituality on cardiovascular and cortisol responses to a laboratory stressor among young adults. Participants with higher composite religiosity/spirituality scores, religiosity, levels of forgiveness and frequency of prayer showed lower cortisol responses. Greater composite religiosity/spirituality, religiosity, frequency of prayer and attendance at services were associated with lower blood pressure in males and elevated blood pressure in females. Findings suggest that spiritual and/or religious individuals may experience a protective effect against the neuroendocrine consequences of stress, though cardiovascular benefits may vary by gender. This work represents an important step in the convergence of multiple realms of research by linking physiological measures with indicators of individual belief systems.

Keywords

cardiovascular, cortisol, reactivity, religiosity, spirituality, stress

Introduction

IN THE PAST several years, a number of reviews and meta-analyses of epidemiological, medical and psychological studies have provided important contributions to the study of religiosity and health outcomes (Matthews et al., 1998; McCullough, Hoyt, Larson, Koenig, & Thoreson, 2000). The most consistent and robust finding that has emerged from these reviews relates religious service attendance to reduced all-cause mortality, with generally stronger results for women than for men. Some critics of this research have suggested that many studies linking religion and health suffer from methodological weaknesses including lack of control for potentially confounding variables (Sloan, Bagiella, & Powell, 1999). Recent reports have provided a response to this criticism by controlling for potential confounders such as gender, social support, age and income, while still confirming the service attendance and mortality link (Hummer, Rogers, Nam, & Ellison, 1999; Oman & Reed, 1998; Strawbridge, Shema, Cohen, & Kaplan, 2001). As methods for asking and answering questions in this area of inquiry improve, the focus of research is shifting to answer the question of what may account for this relationship.

The study of the pathways linking religious involvement and health represents an exciting threshold of knowledge and an important research priority (Thoreson & Harris, 2002). A number of explanatory mechanisms have been suggested to explain this connection, including healthy behaviors, social resources, coping resources, promotion of positive emotions (e.g. forgiveness), as well as the calming benefits of certain belief systems, religious rites and personal faith (Ellison & Levin, 1998; McCullough et al., 2000; Strawbridge et al., 2001). Another framework by which to explore mediators of the relationship between religiosity and health is a model of physiological variables such as neurohormonal and cardiovascular function (Seeman, Dubin, & Seeman, 2003). A large literature linking stressful experiences with negative physiological outcomes and long-term risk for disease offers a context for thinking about relationships between religion and health. Two patterns of physiological arousal have been associated with long-term health risk—sustained or chronic elevation of physiological indices and acute reactivity to situational stressors. Sustained or chronic elevations of cortisol, regulated by the hypothalamic-pituitary-adrenal (HPA) axis, may increase the risk of cognitive disorders, diabetes, cardiovascular disease and other illnesses (McEwen, 1998). Heightened cardiovascular arousal has been associated with the development of hypertension and associated organ damage in several studies (Georgiades, Lemne, de Faire, Kindvall, Fredrickson, 1997; Manuck, Kasprowicz, & Muldoon, 1990), as well as the progression of cardiovascular disease (Lynch, Everson, Kaplan, Salonen, & Salonen, 1998). The reactivity hypothesis suggests that over time, pronounced, repeated or prolonged stress responses contribute to the etiology of hypertension, heart disease, infectious diseases and other illnesses (Markovitz & Matthews, 1991).

Individual differences in reactivity may partially account for differences in long-term risk for cardiovascular and other diseases. Religious and spiritual commitment may represent one source of individual variability in stress response that accounts for differential risk. However, research on neurohormonal function and religiosity is extremely limited. An important stride in this area was recently made by Ironson and colleagues (2002), who reported an association of higher spirituality/religiousness scores with lower cortisol levels in long-term AIDS survivors. Blood pressure has been studied by a number of researchers interested in the physiological impact of religious commitment. In 1989, Levin and Vanderpool (1989) reviewed 20 published studies of the effects of religion on blood pressure and suggested that religion, conceived broadly as commitment and affiliation, represents a protective factor against high blood pressure and hypertension. More recently, Koenig and colleagues (1998) reported that regular church participation and prayer in a sample of older adults led to a reduction in the occurrence of diastolic hypertension. Hixson, Gruchow and Morgan (1998) provided data in support of the blood pressure lowering effect of various dimensions of religiosity, including beliefs, religious activities and religious coping, in a group of middle-aged women. A recent review of these and other studies concluded that reasonable evidence exists to support the

association between religion/spirituality and lower blood pressure in addition to less hypertension (Seeman et al., 2003).

Accumulating evidence suggests a stronger link for women in the protective effect of religious and spiritual commitment on health outcomes (McCullough et al., 2000; Strawbridge et al., 2001). Women have reported stronger religious commitment than men overall, which may to some degree account for varying health results (Andersen, 2000). McCullough and colleagues (2000) conclude from their meta-analytic review of religious involvement and mortality that researchers should consider gender as a potential moderating factor. This suggestion has been reflected in studies of attendance and mortality, but not yet in studies of physiological outcomes and religious commitment. Despite the current lack of data, we would expect similar gender differences in the protective effect of religious commitment on physiological indices such as neurohormonal and cardiovascular responses.

Findings that link religiosity to lower physiological arousal and stress responses may provide valuable insight into the relationship between individual protective factors and health over the life span. In order to better understand the relationship between religion and indices of long-term health, authors of a recent review have emphasized the need to study more specific features of religion and related domains (Thoreson & Harris, 2002). Important work has been conducted in the related domain of spirituality, which considers a more 'basic' dimension of personal belief systems (Elkins, Hedstrom, Hughes, Leaf, & Saunders, 1998), and may exist as separate from organized religion. At a recent panel, spirituality was defined as the individual's search for the sacred, and the experiences that arise in an attempt to articulate one's ultimate reality (Larson, Swyers, & McCullough, 1997). Though a handful of studies have noted positive health-related outcomes associated with spirituality and spiritually oriented interventions (Kurtz, Wyatt, & Kurtz, 1995; McBride, Arthur, Brooks, & Pilkington, 1998; Schuler, Gelberg, & Brown, 1994), the larger health literature has primarily focused only on measures of religion (George, Larson, Koenig, & McCullough, 2000). One exception lies in research on 'spiritual practices' such as relaxation, meditation and yoga mantras and their effects on blood pressure and cardiovascular rhythms (Seeman et al., 2003).

Although broadly conceived measures of religious and spiritual commitment have been related to health outcomes, less is known about the impact of specific faith-related practices aside from church attendance. In contrast to looking at behavioral or structural aspects of religion such as church attendance, Ellison and Levin (1998) suggest taking into account the functional aspects of religion (i.e. coping strategies, belief frameworks) as a way to understand the mechanisms by which health is influenced. Practices that have been previously linked to health outcomes include prayer (Pargament, 1997), religious coping (Pargament et al., 1990) and forgiveness (Toussaint, Williams, Musick, & Everson, 2001).

The current study uses a multidimensional approach to examine relationships among religiosity, spirituality and cortisol and cardiovascular measures. While previous studies have evaluated blood pressure and religiosity, to our knowledge neither spirituality nor religiosity has been considered in relation to cortisol reactivity to an acute stressor. We hypothesized that both religiosity and spirituality would be associated with lower cardiovascular and cortisol levels and decreased reactivity to a computerized, reaction-time task. Based on research that has demonstrated a stronger relationship between religious commitment and health outcomes for women than for men, we expected religiosity/spirituality to exert a more protective effect on cortisol and blood pressure responses for women in this sample. Additionally, we used exploratory analyses to examine the relationships between physiological measures and more specific features of religious and spiritual commitment such as church attendance, prayer, meditation, forgiveness and religious coping.

Methods

Participants

Sixty undergraduate students (age 17–39, mean 21.1) participated. The sample included 32 females and 28 males, representing a variety of ethnic backgrounds (74% Caucasian, 7% African-American, 7% Hispanic, 5% Asian, 7% 'other'). A wide range of religious affiliations

was reported (31% Catholic, 6% Jewish, 15% Protestant, 6% Mormon, 10% Christian, 3% Muslim, 2% Jehovah's Witness, 5% 'own beliefs', 22% Agnostic/Atheist/no answer). Preliminary analyses of questionnaire data from the BMMRS (described below) found that 27 percent of this sample (n = 16) reported they were not at all religious, 40 percent slightly religious (n = 24), 27 percent moderately religious (n = 16) and 7 percent very religious (n = 4). Twelve percent of participants reported they were not at all spiritual (n = 7), 35 percent slightly spiritual (n = 21), 35 percent moderately spiritual (n = 21) and 18 percent very spiritual (n = 11). Forty-seven percent reported attending religious services once a month or more. To qualify, participants could not be experiencing significant health problems or taking medications that could affect cardiovascular or cortisol measures (e.g. anti-depressants, prednisone, atenolol). Participants were requested to refrain from smoking, drinking caffeine or alcohol, eating or exercising in the hour prior to their participation, and their compliance was verbally queried prior to participation. Participants received course credits for their involvement.

Measures

Assessment of cortisol Saliva samples were collected for determination of baseline cortisol and reactivity to a computer task. Samples were obtained with Salivette sampling devices (Sarstedt, Rommelsdorf, Germany), which require participants to saturate a small cotton swab with saliva by holding the swab in their mouths for a 2-minute period. One sample was collected prior to the task ('baseline'), one immediately following the task ('post-task1') and one 20 minutes after the task ('post-task2'). Samples were immediately frozen at 0°F, and stored for 1–3 months. They were then shipped on dry ice to Salimetrics (State College, PA) for analysis of free cortisol.

Assessment of blood pressure Blood pressure and heart rate were monitored with an Omega 5600 Portable blood pressure monitor (Invivo Research, Orlando, FL), with the cuff positioned on participants' non-dominant arm. The Omega 5600 uses an oscillometric method of measurement to provide systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) at one-minute intervals. Ten minutes of baseline blood pressure readings were taken at one-minute intervals when participants first arrived at the lab. The blood pressure monitor was then stopped prior to the beginning of the computer task in order to avoid distracting participants. However, between each of three computer trials, two minutes of blood pressure readings were taken. A final five minutes of readings were obtained following completion of the task.

Assessment of religiousness/spirituality Participants completed a short form (29 items) of the Brief Multidimensional Measurement of Religiousness/Spirituality (BMMRS; Fetzer Institute, 1999), designed specifically for use in health research. Key dimensions included daily experiences, forgiveness, private religious practices, coping, commitment and overall self-ratings. As an initial analysis, we were interested in a comprehensive measure of the many dimensions represented by this instrument. A total score was calculated ('composite religiosity/spirituality') by summing items from the key dimensions and was included as a continuous variable in statistical analyses. The composite religiosity/spirituality score showed good reliability (α = .90). One strength of the BMMRS is its ability to directly assess specific domains of religiousness/spirituality. Two items included in the composite score were independently evaluated: overall religiosity ('To what extent do you consider yourself a religious person?') and overall spirituality ('To what extent do you consider yourself a spiritual person?'). These variables are referred to as 'religiosity' and 'spirituality', and were treated as ordinal variables in analyses. Respondents had four response options: 'very', 'moderately', 'slightly' and 'not at all'. Exploratory analyses evaluated the effects of specific religious or spiritual practices, including frequency of prayer, meditation and attendance at religious services (single item questions), forgiveness and the use of religious coping. The forgiveness subscale (α = .76) includes 3 items assessing the degree to which participants forgive themselves and others, and feel forgiven by God. The religious coping subscale (α = .69) is composed of 5 items rated from 1 ('not at all') to 4 ('a great deal'), including items such as, 'To what extent is

your religion involved in understanding or dealing with stressful situations in any way?'

Computer task Participants completed a reaction-time computer task similar to the 'Stroop' task (Stroop, 1935). In previous studies, similar tasks have been shown to elicit significant cardiovascular reactivity (Steptoe, Cropley, & Joekes, 2000). The task consisted of a modified version of the 'dot probe' detection task (MacLeod, Matthews, & Tata, 1986) in which social threat and/or neutral word pairs were presented on a computer screen. The words quickly disappeared and one was replaced by a dot. Participants identified as quickly as possible the spatial location of the dot on the screen ('upper' or 'lower') by striking specified keys on the keyboard. A loud buzzer indicated incorrect responses.

In each of 2 trials, 96 word pairs were presented. Word pairs included 48 social threat words (e.g. loser) matched with 48 equal length neutral words (e.g. couch) and 48 neutral-neutral pairings. On a third trial, participants were shown two strings of letters; the first was presented for 20 milliseconds, and the second for 500 milliseconds. Participants indicated if the first was a real word or a random string of letters. Because of the extremely short presentation time of the first word, this trial was typically very frustrating for participants, and correct responses were at the level of chance (49%). Total time to complete this task was 20–25 minutes. A brief measure of mood taken before and after the task found a significant increase in negative mood ($t(56) = 3.3$, $p < .01$) and a decrease in positive mood ($t(56) = -3.5$, $p < .001$), suggesting the distressing nature of the task.

Procedure

Participants were scheduled between 1.00 and 5.00 p.m. on weekdays. After resting for 5 minutes and signing a consent form, 10 minutes of baseline blood pressure readings were taken at 1-minute intervals. The first saliva sample (baseline) was obtained approximately 20 minutes after the participant arrived. The blood pressure monitor was stopped, and participants then began the computer task. Between each of 3 computer trials, 2 minutes of blood pressure readings were taken. Following completion of the computer task, a final 5 minutes of recovery blood pressure readings were obtained. The second saliva sample was taken immediately following the task, and the third was taken 20 minutes later. Participants completed questionnaires following completion of the computer task.

Data analysis

Preliminary analyses For cortisol analyses, one outlier participant's data were removed from analyses due to cortisol levels approximately eight standard deviations above the mean, and saliva samples from three participants were of insufficient quantity to be analyzed. Correlational and *t*-test analyses were conducted in order to determine necessary covariates for statistical models. The following variables were evaluated as potential covariates: age, body mass index (BMI), use of oral contraceptives (coded as '1' for females taking oral contraceptives and '0' for males and all other females), average caffeine intake, caffeine intake on the day of participation, time of day of participation, family income, recent exercise, recent meals and smoking status. Of these, only time of participation and use of oral contraceptives were associated with cortisol levels (ps < .05), and were included as covariates in all models for cortisol. A significant repeated measures effect of the task on salivary cortisol was found, $F(2,104) = 3.7$, $p = .03$ (see Table 1), suggesting significant cortisol responses for the sample as a whole.

Complete blood pressure data were not available for one participant due to equipment problems. Preliminary analyses evaluated potential covariates for blood pressure models. BMI was linearly related to SBP and DBP ($p < .05$) and was included as a covariate in all models for blood pressure. Participant gender was related to blood pressure (females had significantly lower SBP and DBP; ps < .01), however it was also associated with religious and spiritual variables. Females reported higher spirituality ($p = .04$), forgiveness ($p = .02$), frequency of prayer ($p = .03$) and near-significant higher composite religiosity/spirituality ($p = .06$) than males. Gender was included as an independent variable in statistical models for blood pressure, and was evaluated for interactive effects with religious/spiritual variables.

Table 1. Descriptive statistics[a]

	Overall	*Women*	*Men*
Composite religiosity/spirituality	65.7 (19.2)	70.8 (20.0)	59.8 (16.8)
Religiosity	2.1 (.9)	2.3 (.86)	1.9 (.9)
Spirituality	2.6 (.92)	2.8 (.88)	2.3 (.91)
SBP (mmHg)			
Baseline	107.3 (.94)	100.8 (1.3)	113.9 (1.4)
Task 1	108.2 (1.3)	102.1 (1.7)	114.4 (1.9)
Task 2	107.2 (1.0)	101.4 (1.3)	113.1 (1.5)
Task 3	108.2 (.94)	101.5 (1.3)	115.0 (1.4)
Recovery	107.8 (1.1)	101.8 (1.5)	113.8 (1.6)
Cortisol (µg/dl)			
Baseline	.162 (.020)	.154 (.021)	.169 (.031)
Post-task1	.198 (.024)	.180 (.026)	.216 (.038)
Post-task2	.191 (.027)	.173 (.029)	.209 (.042)

[a] Data represent means (SD) for composite religiosity/spirituality, religiosity and spirituality. For SBP, data represent means (SE) evaluated at covariate BMI = 23.1; for cortisol, data represent means (SE) evaluated with time of participation held constant at the mean of 2:46 p.m.

Preliminary analyses did not find a repeated measures effect of the task on BP, suggesting the task did not significantly elevate blood pressure for the sample as a whole.

Primary analyses First, we were interested in evaluating the impact of the composite measure of religiosity/spirituality on cortisol responses to the task, and if these responses differed by gender. A model of repeated measures General Linear Models (GLM; SPSS 11.0) was conducted, with cortisol at each time period as the dependent variables, composite religiosity/spirituality, gender and the composite religiosity/spirituality by gender interaction as between-subjects factors, period (baseline, post-task1, post-task2) as within-subjects factors and time of participation and oral contraceptive use as covariates. If the composite score by gender interaction was not significant, we planned to drop the interaction term from the model and test for effects of the composite score across the entire sample. Following a significant repeated measures effect, univariate GLMs with post-task1 and post-task2 cortisol as dependent variables were conducted controlling for baseline cortisol. These additional models were run in order to obtain a more complete picture of the impact of religiosity/spirituality on cortisol responses. Next, we examined the separate impact of religiosity and spirituality on cortisol responses following the same strategy as described above. Exploratory analyses were conducted in the same manner (following a significant finding for the composite score) in order to explore the contribution of specific religious and spiritual practices. For exploratory analyses, a Bonferroni correction of $\alpha = .01$ was used to control the error rate.

For cardiovascular analyses, blood pressure and heart rate readings were averaged for the baseline, first trial, second trial, third trial and recovery periods, to provide five repeated measures. Repeated measures GLMs were conducted with blood pressure or heart rate at each time period as dependent variables, religious/spiritual measures and gender as between-subjects factors, period (baseline, Trial 1, Trial 2, Trial 3 or recovery) as within-subjects factors, and BMI as a covariate.

Results

Cortisol analyses

Interaction of religious/spiritual variables and gender First, we evaluated the interaction of gender and composite religiosity/spirituality on overall cortisol and cortisol responses

(repeated measures effects) to the reaction-time task. The composite religiosity/spirituality by gender interaction was not related to overall cortisol, and did not show a significant repeated measures effect on cortisol reactivity to the task.

Religious/spiritual variables and cortisol

Because the gender by composite religiosity/spirituality interaction was not significant, the interaction term was removed from the model, and the hypothesis was tested that in the sample as a whole, participants higher on composite religiosity/spirituality would show lower overall cortisol and less reactivity to the task. Composite religiosity/spirituality did not show a main effect on overall cortisol levels. However, a significant repeated measures ($F(2,104) = 3.7$, $p = .03$) effect was found for composite religiosity/spirituality, as evidenced by smaller increases from baseline to post-task1 ($F(1,52) = 4.0$, $p = .05$) and baseline to post-task2 ($F(1,52) = 4.3$, $p = .04$) for those with higher composite religiosity/spirituality scores (see Fig. 1). Changes from baseline to post-task1 and post-task2 remained significant after controlling for baseline cortisol (post-task1: $F(1,51) = 4.4$, $p = .04$; post-task2: $F(1,52) = 4.8$, $p = .03$).

Because of the significant results of the repeated measures analysis with the composite religiosity/spirituality variable, we evaluated the separate effects of religiosity and spirituality on cortisol. A significant repeated measures ($F(2,104) = 3.1$, $p = .05$) effect was found for religiosity, in which greater religiosity was associated with lesser reactivity from baseline to post-task1 ($F(1,52) = 4.2$, $p = .05$) (see Fig. 2). The change from baseline to post-task1 and post-task2 was significant after controlling for baseline cortisol (post-task1: $F(1,51) = 4.9$, $p = .03$; post-task2: $F(1,52) = 4.2$, $p = .05$). Examination of Fig. 2 suggested these results were largely due to elevated reactivity among those who rated themselves 'not at all religious' relative to those who endorsed any degree of religiosity. Post-hoc analyses comparing the 'not at all' group to all other groups combined found that the 'not at all' group had significantly higher overall cortisol, and greater cortisol reactivity ($ps < .01$) relative to all other groups. Spirituality ratings were not related to cortisol reactivity.

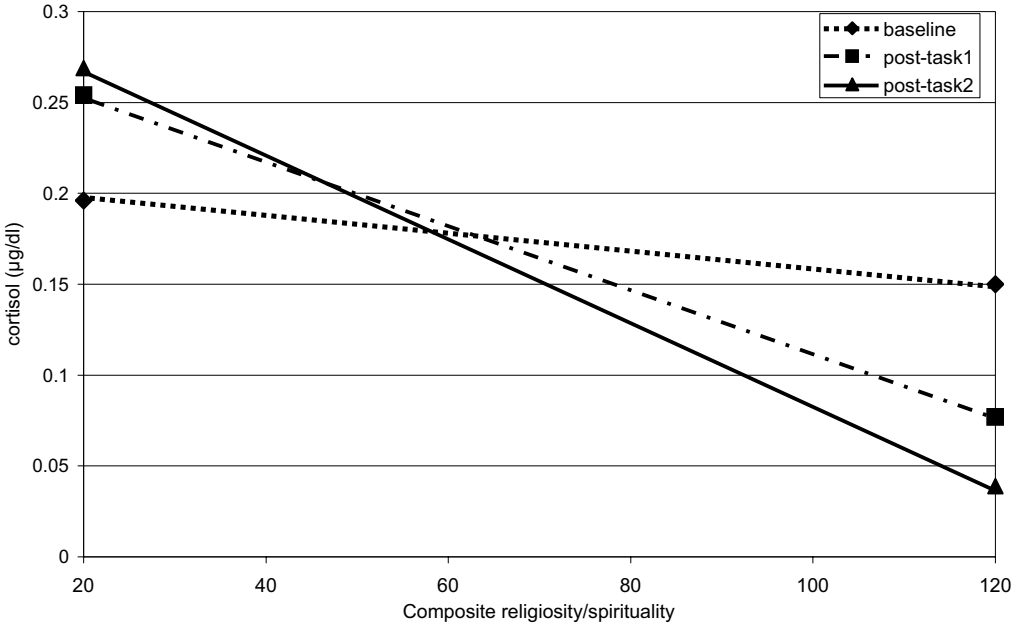

Figure 1. Cortisol response by Composite Religiosity/Spirituality score.[a]

[a] Data represent regression lines; composite religiosity/spirituality is a continuous variable; covariates fixed at the mean time of participation = '2.45 p.m.', and no oral contraceptive use

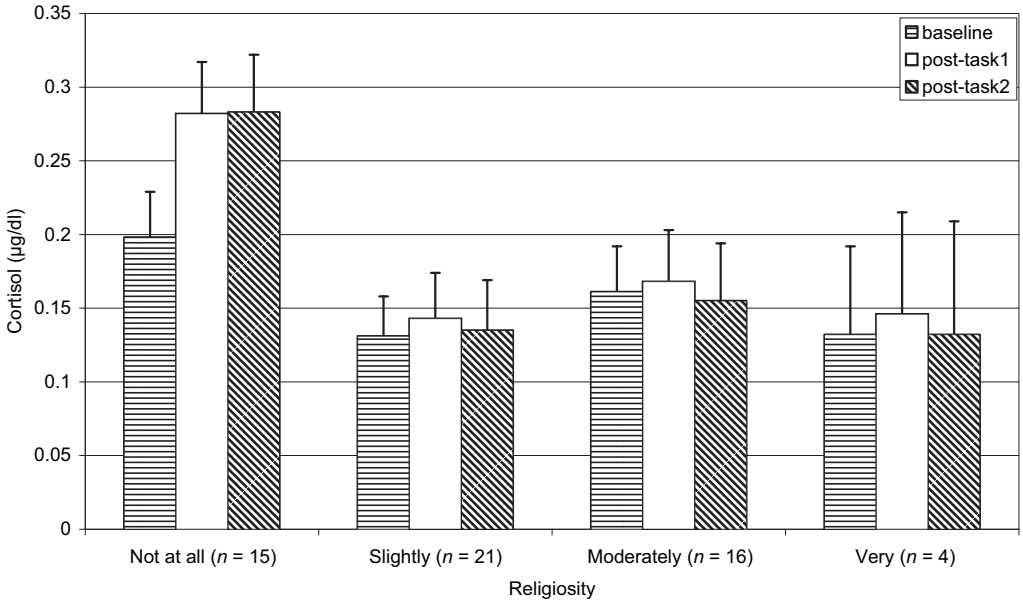

Figure 2. Self-rated religiosity and cortisol response (mean, SE).[a]
[a] Categories are from forced-choice responses to the following question: 'To what extent do you consider yourself a religious person?'

Exploratory analyses Given the significant effect of composite religiosity/spirituality score on cortisol responses, we next conducted exploratory analyses of specific religious or spiritual practices. Significant repeated measures effects on cortisol were found for frequency of prayer ($F(2,104) = 4.9$, $p < .01$), and forgiveness ($F(2,104) = 5.4$, $p < .01$), in which greater frequency of prayer or greater forgiveness was associated with lower cortisol reactivity to the task. Attendance at services, religious coping and meditation did not reach significance.

Cardiovascular analyses

Interaction of religious/spiritual variables and gender First, we evaluated the interaction of composite religiosity/spirituality and gender on overall blood pressure and blood pressure reactivity to the task. A significant interaction of gender by composite religiosity/spirituality on overall SBP was found ($F(1,54) = 5.5$, $p = .02$), such that for females, higher composite religiosity/spirituality was associated with higher overall SBP, while for males, higher religiosity/spirituality was associated with lower SBP (see Fig. 3). Post-hoc analyses were conducted for each gender separately to determine the significance of the slopes. For women, higher composite religiosity/spirituality was associated with a significant increase in SBP ($F(1,28) = 6.7$, $p = .02$), although for men the association of composite religiosity/spirituality with decreased blood pressure was not significant ($p = .15$). Next, we evaluated religiosity and found a similar pattern by gender ($F(1,54) = 15.4$, $p < .001$). Because only one male reported high religiosity, the moderate and high religious groups were combined, and the interaction remained highly significant ($F(1,54) = 15.3$, $p < .001$) (see Fig. 4). Post-hoc analyses of slopes found that for men, a significant decrease in SBP was associated with higher religiosity ($F(1,23) = 15.4$, $p < .001$), while the increase in SBP associated with higher religiosity was not significant for women ($p = .16$). The interaction of spirituality and gender was not significant, although a trend for lower SBP associated with higher spirituality was found ($F(1,55) = 3.1$, $p = .09$).

Very similar effects of religious/spiritual variables were found for diastolic blood pressure. A significant composite religiosity/spirituality score by gender interaction ($F(1,54) = 7.1$, $p = .01$),

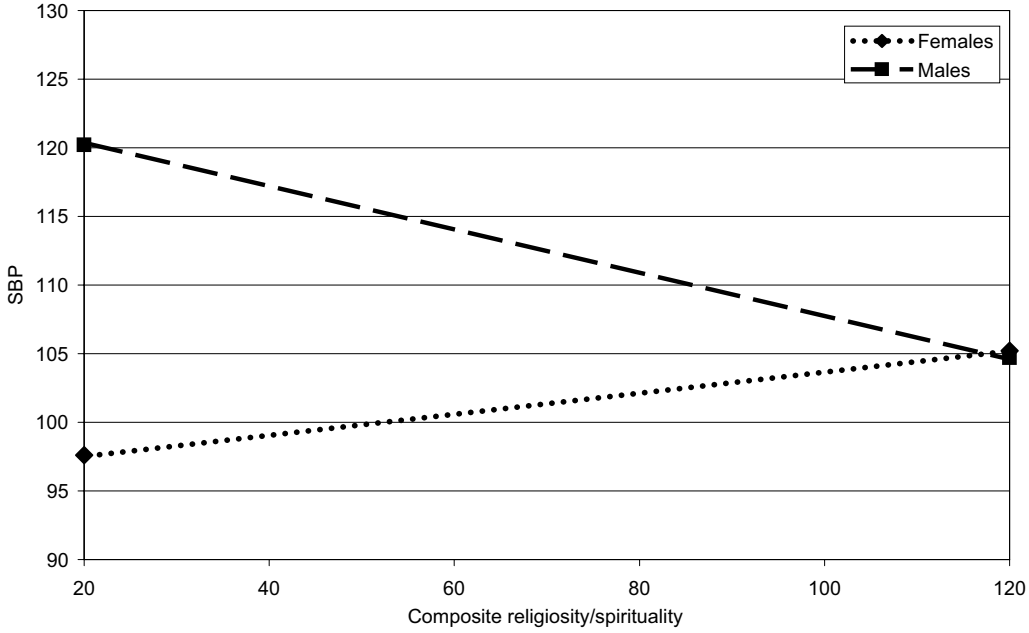

Figure 3. Mean SBP by gender and composite religiosity/spirituality score.[a]
[a] Data shown represent regression lines using covariate BMI fixed at the mean value of 23

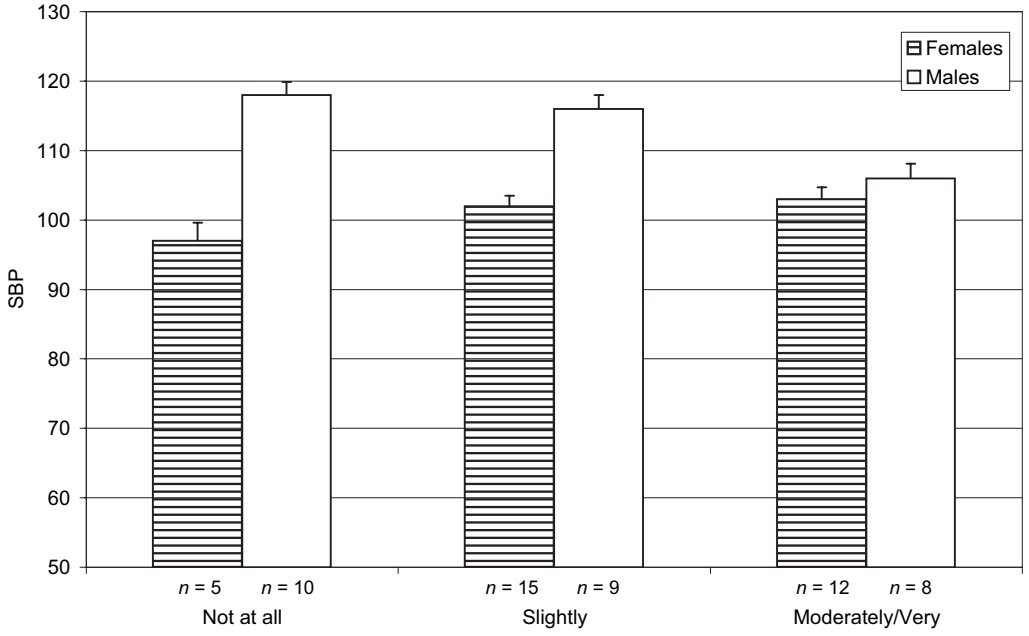

Figure 4. Self-rated religiosity and overall SBP (mean, SE).

and religiosity by gender interaction ($F(1,54) = 16.8$, $p < .001$) were found, again showing lower DBP with increasing scores for males, and higher DBP for females as scores increased. For the composite score, post-hoc analyses of slopes neared significance for males ($p = .08$) and females ($p = .08$). For religiosity, post-hoc analyses of slopes were highly significant for males ($F(1,24) = 15.8$, $p = .001$), but not for females ($p = .20$). Composite religiosity/spirituality scores, religiosity and spirituality were not significantly related to heart rate measures.

Exploratory analyses Given a significant gender by composite religiosity/spirituality interaction on SBP, exploratory analyses of specific religious practices (using $\alpha = .01$) were conducted. Significant interactions of gender and prayer ($F(1,54) = 6.7$, $p = .01$), and gender and religious attendance ($F(1,54) = 7.1$, $p = .01$) on overall SBP were found. Higher attendance was associated with decreasing SBP for males ($F(1,24) = 6.9$, $p = .015$), and was not related to SBP in females ($p = .60$). Higher frequency of prayer was associated with increased SBP for females ($F(1,29) = 7.6$, $p = .01$), and was unrelated to SBP for males ($p = .23$). For DBP, analyses were significant for frequency of prayer by gender ($F(1,54) = 10.6$, $p < .01$) and attendance at services by gender ($F(1,54) = 6.7$, $p = .01$), with a pattern similar to that of SBP. Religious attendance was near-significant for males ($F(1,24) = 4.1$, $p = .055$), but was not significant for females ($p = .24$). Higher frequency of prayer was associated with increased DBP in females ($F(1,29) = 9.7$, $p < .01$), and was associated with a trend toward decreased DBP in males ($F(1,24) = 3.5$, $p = .07$).

Discussion

The current study evaluated relationships among religiosity and spirituality, and indicators of cortisol and cardiovascular arousal and reactivity. We included spirituality in our investigation as an important extension of research on the health benefits of religiosity. Findings relating religiosity/spirituality to physiological outcomes suggest potential health benefits of religious and spiritual involvement, with stronger cardiovascular benefits for men. Religiosity in particular showed an association with lower cortisol reactivity for the sample as a whole, along with lower blood pressure for men. To our knowledge, this represents the first report of stress-related cortisol reactivity in relation to religiosity and spirituality, supporting potential physiological mechanisms as a link between religious and spiritual factors and health.

As expected, higher composite religiosity/spirituality scores, representing an aggregate of religious and spiritual commitment, religious coping and other religious/spiritual practices, were related to less cortisol increase across tasks. However, this finding did not differ by gender. These results partially confirm our hypothesis and support Ironson and colleagues' (2002) report of lower cortisol associated with high levels of spirituality and religiousness. Greater religiosity, assessed by the item 'To what extent do you consider yourself to be a religious person', was related to less cortisol increase across time periods. Interestingly, examination of the data suggested that this finding was largely due to elevated cortisol among those who rated themselves 'not at all religious' relative to those who endorsed any degree of religiosity. These results suggest that the magnitude of an individual's religious identification may be less important for exerting a protective effect on physiological outcomes than simply the presence of some degree of religious commitment. Powell, Shahabi and Thoresen (2003) articulate a similar conclusion in their recent review, stating that evidence does not support a link between depth of religious belief and physical health. Contrary to our prediction, spirituality, as assessed by the item 'To what extent do you consider yourself spiritual', was not related to cortisol measures.

Perhaps one of the more exciting findings of this study is the identification of sub-domains of the religious experience most strongly related to physiological stress indicators. Analyses of religious practices and cortisol revealed significant findings for frequency of prayer and forgiveness. Participants who reported greater forgiveness or frequency of prayer showed a decrease in cortisol across the task, whereas cortisol levels on average increased for those who reported never praying or were low on forgiveness. Religious coping, service attendance

and meditation practices were not significantly related to cortisol.

Trust in God, prayer and seeking strength from God have been cited as common coping mechanisms for dealing with stressful situations, while religion in general has been shown to play an important role in coping with stress (Pargament, 1997). Use of religious resources in situations that are perceived as threatening may affect how individuals assess the situation and their ability to cope (Pargament et al., 1990). For example, the practice of forgiveness may be a means by which individuals resist harmful negative emotions that can result from stress exposure (Toussaint et al., 2001). Though research on forgiveness has proliferated in the last few years, much remains to be further explored. For example, authors in this area have suggested that the relationship of the actual practice of forgiveness to religiousness and spirituality remains to be clarified (McCullough & Worthington, 1999). An interesting extension of this research might explore the extent to which the *religious* aspect of forgiveness is responsible for the health benefits of this practice. Similarly, future studies may want to consider specific types of prayer which have been identified (Poloma & Gallup, 1991), to refine current understanding of how prayer may provide healthful benefits in times of stress. It is possible that regular prayer, like the relaxation response (Benson, 1983), provides calming physiological benefits that alter sympathetic nervous activity over time, as evidenced by current findings linking prayer and cortisol decrease. Interestingly, frequency of meditation was not related to physiological measures. This was surprising given studies relating forms of meditation practices to lower physiological arousal and blood pressure (Seeman et al., 2003). It is possible that salutary benefits provided by meditation were not reflected in this sample because of the small number of participants who endorsed meditating once a week or more ($n = 7$). Furthermore, the wording of the item ('Within your religious or spiritual tradition, how often do you meditate?') may not have captured responses from individuals who do not view their meditation practice as a component of a religious or spiritual tradition.

The relationship of religious involvement to decreased cortisol reactivity represents a novel finding. Our findings for males linking cardiovascular measures and religiosity reinforce previous research (Levin & Vanderpool, 1989). However an intriguing, opposite pattern emerged for females. Males who rated themselves higher in composite religiosity/spirituality or religiosity had lower systolic blood pressure, in contrast to females who showed higher blood pressure as their composite religiosity/spirituality scores increased. Although both genders seemed to benefit from the protective effects of religious/spiritual commitment on cortisol, it appears that religion had a more protective effect on cardiovascular arousal for men. Our findings were somewhat surprising given that previous literature examining church attendance and longevity has generally found a more protective effect for women (McCullough et al., 2000). However, the current study represents a distinctly different design from previous work in that it assessed participants' immediate responses to an acute stressor. Further, while studies reporting protective effects of religion for women examined older populations over time, the current study evaluated a young adult population at a time in their lives that may be characterized by a number of transitions. Given these differences, a variety of explanations are possible. Thinking by feminist scholars suggests that within religions that do not emphasize women's experiences and perspective, women may not derive a sense of empowerment from their religious involvement (Hall, 1990). For women in these traditions, their religion may influence and even limit women's feelings of competence in stressful situations, making them less likely to derive protective benefits from their religion in times of challenge. In order to test this possible explanation, it will be important for future studies to explore more individualized experiences of religious and spiritual commitment, to further refine understanding of the different ways that religion may impact health and responses to stress.

Limitations of the current study should be considered when interpreting results. Our participants were university students, and results may not generalize to a larger population. However, existing literature on religious/spiritual factors and health has primarily studied older adults. Less is known about how these factors relate to health in other age groups.

Although the current sample may be experiencing changes in their beliefs, we believe this process makes young adults an exciting population for study, particularly as the current findings demonstrate that significant associations of religious/spiritual beliefs with physiological outcomes are already apparent. Further, the percentage of individuals in this sample who identified with a specific religious affiliation (78%) was comparable to the national norm of 81 percent (Kosmin, Mayer, & Keysar, 2001). Earlier criticisms of this area of research have identified potential confounders of the link between religion and health, including age, income, gender and social support. In this study we did not find age or income to be related to our outcomes, and we did not measure social support. However, recent studies on religious and spiritual factors that controlled for social support have showed that the relationship between beliefs and health persisted (Steffen, Hinderliter, Blumenthal, & Sherwood, 2001; Thoreson & Harris, 2002). Future studies that control for social support may further validate the distinct relationship between religious/spiritual commitment and health.

One limitation to this area of study in general lies in measurement issues. In the current study, self-rated spirituality was not significantly related to any of our physiological measures. The construct of spirituality represents a unique challenge to research, as its variable and personal nature makes it difficult to assess. The use of global indices to assess spirituality has in fact been criticized (Zinnbauer, Pargament, & Scott, 1999). Yet this diversity in meanings also represents the 'greatest strength' of spirituality as an indicator of internalized belief systems (Shahabi et al., 2002). We assessed spirituality by using overall self-ratings, leaving the definition itself open. An important direction in this line of research lies in the combination of qualitative and quantitative measures. Expanded methodological tools offer the potential to clarify individual conceptualizations of these domains and allow for the development of more refined and differentiated measures of spirituality.

In conclusion, the current study extended previous research on blood pressure and religiosity by including spirituality and cortisol in its exploration. Religious and spiritual commitments, conceived multi-dimensionally, showed relationships to lower blood pressure for men and lowered cortisol response for the entire sample. Lending further support to previous research on blood pressure and religion, findings suggest a protective effect of religiosity on cardiovascular health for men. Lower cortisol responses found in both men and women with greater religious commitment suggest less long-term risk of heart disease and other illnesses, and further advance knowledge of physiological pathways relating religiosity to health. It will be important for future research to more closely examine the health impact of functional aspects of religious or spiritual commitments, such as prayer and forgiveness, especially in regards to gender. Overall, our results provide important information about individual factors that may buffer long-term vulnerability to cardiovascular and other diseases.

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