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Daily Spiritual Experiences, Systolic Blood Pressure, and Hypertension among Midlife Women in SWAN

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Abstract

Background—There is reasonable evidence that religious beliefs and activities are associated with lower blood pressure and less hypertension. It is not known if daily spiritual experiences have similar effects.

Purpose—We examined the relationship between an eight-item version of the Daily Spiritual Experiences Scale (DSES) and systolic blood pressure (SBP) and hypertension.

Methods—With data from 1,060 Caucasian and 598 African-American midlife women participating in Study of Women's Health Across the Nation, in race-stratified models, we used regression equations, logistic regression, and mixed effects regression to estimate the relationship between DSES group and SBP and hypertensive status.

Results—We found little difference across DSES groups in adjusted mean SBP for either Caucasian or African-American women. Nor did DSES protect against 3-year increases in SBP, hypertensive status, or incident hypertension.

Conclusions—Daily spiritual experiences do not appear protective for SBP or hypertension in midlife women. Further research should examine factors that condition the religion–BP relationship.

Keywords

Blood pressure; Hypertension; Religion; Spirituality; Spiritual experiences

Introduction

The relationship between religion and blood pressure (BP) or hypertension has been the subject of a moderate body of research, and helpful reviews of this research have been published [1, 2]. While the findings from this research are not all consistent, a body of evidence has developed suggesting that higher levels of religious involvement (RI) are associated with lower blood pressure and reduced likelihood of hypertension. Employing a "levels-of-evidence" ranking system, the authors of a recent review of nine of these studies judged the evidence for this protective effect to be "reasonable" [3].

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While some of this evidence comes from small convenience samples [4,5], positive effects have also been reported from studies based on large representative populations [6–9], including NHANES III [10]. Most of this research has been cross-sectional [7–10]. For both of the population-based, longitudinal studies that have been reported, there were no longitudinal effects of RI on blood pressure or incidence of hypertension for the sample as a whole [6,11]. Some studies have reported protective effects for subgroups only, for example African-Americans but not Caucasians [12], or those who had experienced a stressful life event [11]. Protective effects have been reported for a variety of dimensions of RI including worship attendance [6,8,10], beliefs about the afterlife [11], cloistered religious life [13,14], and religious coping [12].

Evidence from other research points to the role of chronic stress, such as job stress, and psychological factors, such as hostility, depression, hopelessness, and loneliness, in the development of hypertension [15–19]. One hypothesis regarding the effect of RI on health that is especially relevant for cardiovascular (CV) health and hypertension is that higher levels of RI foster positive emotions and improve a person's ability to resist the negative health effects of stress [2,20–24].

A new measure of spiritual experiences, the 16-item Daily Spiritual Experiences Scale (DSES), measures the experience of connection to God or the transcendent and other everyday experiences that are seen to grow out of that, including gratitude, inner peace, and compassion [25,26]. It is assumed that these spiritual experiences contribute positively to health in part by fostering positive emotions and by buffering the negative effects of stress on health [26].

The aim of the present study was to examine the cross-sectional and longitudinal association between DSES scores and blood pressure and hypertension in a large, biracial sample. Based on the existing evidence, both about the contribution of psychosocial factors to hypertension and about the protective role of RI in relationship to BP and hypertension, we hypothesized that higher levels of daily spiritual experiences (DSES) would be associated with lower systolic blood pressure (SBP) and less increase in SBP over time. Further, we hypothesized that higher levels of DSES would be associated cross-sectionally with a lower likelihood of hypertension and, longitudinally, with a lower risk of developing hypertension.

Methods

Participants

This investigation was conducted with data from the Study of Women's Health Across the Nation (SWAN). SWAN is a longitudinal, multicenter, multi-ethnic, community-based study of middle-aged women designed to document changes in women's reproductive hormones and physical and mental health as women age and go through the menopausal transition. A complete description of the SWAN sampling and recruitment strategies is provided elsewhere [27]. To be eligible for the SWAN longitudinal cohort, women had to be between 42 and 52 years old, pre- or early perimenopausal (at least one menstrual period within the past 3 months), with an intact uterus and at least one ovary, with no recent use of reproductive hormones, and to have self-identified with one of the site's designated race/ethnic groups. SWAN was approved by the institutional review boards of the participating institutions, and study participants provided written informed consent.

While SWAN includes Caucasian, African-American, Hispanic, Japanese, and Chinese women, the present investigation was limited to the Caucasian women, who came from all seven of the SWAN study cities (Boston, Newark, Pittsburgh, Detroit, Chicago, Los Angeles, and Oakland, CA), and the African-American women who were recruited from Boston, Pittsburgh, Detroit, and Chicago. The Japanese and Chinese women were not included in the

present study because it is not clear if the DSES is a valid measure of religion/spirituality among Asian women. The Hispanic women were not included because of problems with missing data. This study is based on the 1,992 Caucasian and African-American women who completed the fourth annual SWAN interviews, conducted between 2000 and 2002, which included the main predictor variable, the DSES. Data from the fifth and sixth annual interviews for these women were also employed.

Women who were missing complete data on all the variables employed from the fourth annual SWAN interview were excluded from the study, leaving a final sample of 1,658 (83.2%) women. Of those who were dropped, 146 (7.3%) were missing all eight DSES items. An additional 60 (3%) were dropped because they were missing four to seven of the eight DSES items. An additional 128 women (6.4%) were dropped due to missing values for other study variables. The excluded cases did not differ significantly from those included in the study on any demographic factors.

Measures

The study employed two dependent variables: systolic blood pressure and hypertensive status. We selected SBP because of the evidence that it is a strong indicator of risk for CV morbidity and mortality in middle age and older adults [28,29] and because of the pattern of level or decreasing diastolic blood pressure that begins to be evident in this age group [30].

Blood pressure was measured according to a standardized protocol, with readings taken on the right arm, with the respondent seated and feet flat on the floor for at least 5 min prior to measurement. Respondents were instructed not to smoke or consume any caffeinated beverage for 30 min prior to their BP measurement. Appropriate cuff size was determined based on arm circumference. A standard mercury sphygmomanometer was used to record systolic and diastolic pressures at the first and fifth phase Korotkoff sounds. Two sequential values for each BP measure were completed, with a minimum 2-min rest period between measures. The average of these measures was employed in these analyses. Hypertension was defined as BP $\geq$140/90 or use of antihypertensive medications, the standard definition employed by the National Center for Health Statistics in the NHANES and by JNC-7 [28,31].

An eight-item version of original 16-item Daily Spiritual Experiences Scale was included in the self-administered questionnaire in the fourth annual SWAN interview. As mentioned above, the DSES is a new measure of spiritual experiences designed to assess feeling close to God (or the transcendent) and everyday experiences that grow out of that closeness ([25,26]; also see the DSES website: http://www.dsescale.org). The DSES appears to have good psychometric properties, including a high coefficient of internal consistency (0.95) and unidimensionality [26]. A six-item version of the measure was included in the 1998 General Social Survey, and moderate to high correlations (*r*s 0.40 to 0.76) were found with measures of RI [32]. Protestant and Catholic respondents also had higher DSES scores than those with no religious affiliation ($p<0.01$) [26]. Among 233 participants in SWAN, 16-item DSES scores were positively associated with optimism ($r=0.35$) and negatively associated with anxiety ($r=-0.39$), depression ($r=-0.22$), and perceived stress ($r=-0.20$) [26]. The coefficient of internal consistency for the eight items employed in the present study was 0.89. In a sample of Caucasian and African-American women from the Chicago site of SWAN, the correlation between this eight-item version of the DSES and the full 16-item version was 0.96.

The response choices for the DSES items, indicating the frequency of the specified experience, ranged from “more than once a day,” coded as 1, to “never,” coded as 6. For the present study, these scores were reversed so that a higher DSES score represented a higher frequency of daily spiritual experiences. This analysis employed the average score for the nonmissing DSES items. If responses to four or more items were missing, the average DSES score was coded as

missing. Where responses were missing for one, two, or three items, the average of the woman's nonmissing items was imputed.

In the version of the DSES included in SWAN, an additional response choice of "not applicable" was offered. Careful attention was given to how best to account for these responses in the analysis. The proportion of not-applicable responses varied by item, ranging from 11.1% for the item "I desire to be closer to, or in union with God," to 1.3% for the item "I accept others even when they do things that I think are wrong" (percents from the 1,992 women who completed the fourth annual interview). Preliminary analyses (not shown) revealed women with a greater number of not-applicable responses had lower levels of RI. Further, compared to African-American women with no not-applicable item responses, African-American women who had a few not-applicable responses (one to three items) had higher SBP (no not-applicable vs a few not-applicable: mean SBP 126.3±18.5 vs. 133.1±22.0, $t=-2.48$, $p<0.05$). This difference was not observed for the Caucasian women. In light of these findings, while not-applicable responses were coded as missing for purposes of estimating a respondent's DSES average, a dichotomous variable representing the not-applicable responses (none vs. 1–3) was also included as a covariate in the multivariable models. (Because not-applicable responses were coded as missing, women with four or more not-applicable responses were among those excluded, as described earlier.)

Since there has been limited prior research about DSES and physical health outcomes and because some studies of religion and health report nonlinear relationships [33–35], we decided not to assume the relationship between DSES and SBP was linear but rather created categories for the women's average DSES scores. We considered employing quartiles for participants' average DSES score, either based on the sample as a whole or race-specific quartiles. However, the very different distributions of the average DSES scores for the African-American and Caucasian women made both of those choices problematic. The four categories that were created were based on the woman's average DSES score, rounded to the nearest whole number. Because the DSES was negatively skewed, the first group consisted of women with average scores from 1 to 3. These corresponded to average responses of "never" to "some days." The remaining three groups consisted of women whose average DSES score was 4, 5, or 6, which corresponded, respectively, to responses of "most days," "daily," and "many times a day." This approach to modeling the DSES scores permits a simple interpretation of the DSES categories.

Study covariates included measures of demographic factors, health status, and stress. Age in years was treated continuously. Self-identified race was coded as Caucasian or African-American. Marital status was coded dichotomously, married vs. other. Three categories of education were employed: a high school diploma or less, some college, and a 4-year college degree or more. To assess financial strain, the women were asked, "How hard is it to pay for basics?" The three response choices, "very hard," "somewhat hard," and "not very hard at all," were treated as three categories. Body mass index (BMI) and heart rate (beats per minute) were treated continuously. Use of any antihypertensive medications and diagnoses with diabetes were treated as dichotomous variables (no vs. yes). Four categories were created for menopausal status: premenopausal or early perimenopausal, late perimenopausal or post menopause, surgical menopause, and use of endogenous hormones. The women responded to a list of 18 potentially stressful life events in the preceding year, including death of a family member or close friend, illness or injury in a family member or close friend, family or relationship stress, and financial or work-related stress. Women who reported experiencing four or more of these events (42.5%) were coded as having a high level of stress.

The following variables were measured at the fourth annual SWAN interview: DSES, age, marital status, and stressful life events. The following variables were measured at the fourth, fifth, and sixth annual SWAN interviews: SBP, diastolic BP (DBP), heart rate, BMI,

menopausal status, use of antihypertensive medications, and diagnosis of diabetes. Financial strain and education were assessed at the SWAN baseline interview.

Analysis

All the analyses of the relationship between DSES and SBP and hypertension were conducted in models stratified by race [36]. Two factors informed this decision. First, there is strong evidence of higher levels of RI among African Americans as compared to Caucasians [37–39]. Preliminary analyses (not shown) indicate this is also the case for the DSES. Second, there is some evidence that these differences in RI translate into Caucasian–African-American differences in the relationship between religion and BP [12].

The analysis began by calculating descriptive statistics for the study variables. Next, we examined the cross-sectional association between DSES and SBP using multiple regression equations. The first set of equations estimated the unadjusted association between DSES and SBP. The second set of equations adjusted these estimates for the effects of demographic and health variables as well as for the effect of not-applicable DSES responses. Dummy variables for study site were also included as covariates in these models to account for differences in recruitment. Adjusted general linear models, with a Tukey adjustment for multiple comparisons, were used to estimate the adjusted mean SBP for each DSES group. The analysis of the cross-sectional relationship between DSES and hypertension employed unadjusted and adjusted logistic regression equations similar to the multiple regression equations described for SBP.

Mixed effects models were employed to examine the effect of DSES on change in SBP over 3 years of follow-up. Two random effects were specified: a random intercept, which represented the individual variation in the womens' SBP at the fourth annual visit, and a random effect for slope, which represented the individual variation in the change over time of SBP. For these models, the fourth annual visit was set as time 0, and time was calculated as the number of months between the fourth annual visit and the fifth or sixth visits.

As was the case for the cross-sectional analysis of DSES and SBP, we created two models to examine the longitudinal relationship between DSES and SBP. The first, unadjusted model included terms for DSES category, time, and the interaction of DSES category with time. The interaction terms in these models provide a test of the effect of DSES on change in SBP. The second set of models adjusted these estimates for the effects of demographic and health variables as well as for the effect of not-applicable DSES responses. In these models, the health measures (heart rate, BMI, menopausal status, use of any blood pressure medications, and diagnosis of diabetes) were treated as time-dependent covariates. Again, study site was included in these models to account for differences in recruitment.

To examine the longitudinal relationship between DSES and hypertension, the analysis was restricted to women who did not meet the criteria for hypertension at the beginning of this study (SWAN year 4 follow-up). We then used unadjusted and adjusted logistic regression equations, as previously described, to model the relationship between DSES category and incident hypertension in the year 6 follow-up. Because of the reduced sample available for this analysis, DSES was treated dichotomously (at least daily vs. less than daily).

In an effort to clarify the results of these cross-sectional and longitudinal analyses, three additional post hoc analyses were conducted. In the first two post hoc analyses, the cross-sectional regression models and the longitudinal mixed effects regression models for SBP were re-estimated for samples restricted to women who were not taking any antihypertensive medications (n=1,311). In the third post hoc analysis, the cross-sectional regression models for SBP were re-estimated for a sample restricted to women who reported four or more stressful

life events in the preceding year (*n*=705). All of the analyses were performed using SAS ver 9.1.

Results

The characteristics of the sample are presented in Table 1. It can be seen that overall, the women had an average age of 50 years, the majority were married, had at least some college education, and were not experiencing any financial strain. On average, the women in the sample were obese, but only a small proportion had been diagnosed with diabetes. The average SBP was in the normal range; however, 20% of the women were using antihypertensive medications, and 29% of the women met the criteria for hypertension. Nearly half of the women (49%) reported at least daily spiritual experiences. Approximately two thirds (63.9%) of the women were Caucasian; 36.1% were African-American. Of the 1,658 women from the SWAN fourth-year interview with complete study information, 1,511 (91.1%) provided SBP and other data for the fifth-year interview, and 1,439 (86.8%) provided data for the sixth-year interview.

The results of the regression analysis of the cross-sectional relationship between DSES and SBP are presented in Table 2. From the table, it can be seen that, in both the unadjusted and adjusted models, higher levels of DSES were not significantly related to SBP for either the Caucasian or African-American women. From this table, it can also be seen that, for the African-American women, having one to three not-applicable responses to the DSES items was associated with significantly higher levels of SBP. Not-applicable responses were not associated with SBP for the Caucasian women.

Table 3 shows the adjusted mean SBP for the DSES groups for each race. The absence of any consistent pattern in SBP among the DSES groups and the generally small DSES group differences are evident in these results.

The results of the analysis of DSES and hypertensive status at baseline are presented in Table 4. From the table, it can be seen that, in both the unadjusted and adjusted models, for women in both race groups, the relationship between DSES category and hypertensive status was nonlinear and not significant.

The results of the analysis of the relationship between DSES and change in SBP are presented in Table 5. From the table, it can be seen that higher levels of DSES were not protective against increases in 3-year change in SBP for either the Caucasian or African-American women. In fact, for both Caucasian and African-American women, compared to those who reported the lowest levels of spiritual experiences, some of those who reported higher levels of spiritual experiences had increases in SBP over time. Specifically, compared to women who reported spiritual experiences some days or less, in models adjusted for demographic and health factors, there were significant differences for Caucasian women who reported spiritual experiences on a daily basis and for African-American women who reported spiritual experiences most days or many times a day. Figure 1 provides a graphical presentation of these DSES group differences in predicted SBP trend for both the Caucasian and African-American women. From the figure, it can be seen that for the Caucasian women in the three higher DSES groups, SBP remained the same or increased slightly over the 3 years of follow-up. In contrast, among Caucasian women in the lowest DSES group, SBP decreased over time. A similar pattern, with a more notable decrease in SBP for women in the lowest DSES group, can be seen for the African-American women.

The analysis of the relationship between DSES group and incident hypertension was restricted to 1,001 women (Caucasian women *n*=739; African-American women *n*= 262) who were not hypertensive at the beginning of this study, the year 4 follow-up interview, and for whom information was available to assess hypertensive status at the year 6 follow-up interview. Due

to the smaller sample size, DSES was treated dichotomously (at least daily vs. less than daily). Among these women, 89 women (8.9%) became hypertensive (Caucasian women *n*=42, 5.7%; African-American women *n*=47, 17.9%). Table 6 presents the results of the analysis of the relationship between DSES category and incident hypertension. From the table, it can be seen that, in both unadjusted and adjusted models, for women in both race groups, DSES category was not significantly associated with incident hypertension.

Three post hoc analyses were conducted in an effort to clarify the failure to find an inverse association between DSES and SBP in the preceding analyses. In the first two post hoc analyses, we repeated the cross-sectional linear regression models and the longitudinal mixed effects regression models, respectively, in samples restricted to women who were not taking antihypertensive medication. In this subsample, there were no significant unadjusted or adjusted cross-sectional relationships between DSES category and SBP (analyses not shown). Table 3 presents the adjusted mean SBP for each DSES group from these analyses. From the table, it can be seen that the patterns for this subsample of women not taking antihypertensive medications are similar to those for the sample as a whole (Table 3). The results of the longitudinal analysis among the medication-free subsample were also similar to those for the whole sample (results not shown), with the exception that the difference in the SBP trend between the two DSES groups for the Caucasian women was now no longer significant.

The development of the DSES was shaped, in part, by the assumption that greater RI increased host resistance to the negative health effects of stress. This assumption informed a post hoc analysis which restricted the analysis of the cross-sectional relationship between DSES and SBP to women who reported four or more stressful life events in the preceding year (*n*=705, 42.5% of the original sample). The adjusted DSES group means for SBP for the Caucasian and African-American women from this analysis are presented in Table 3. As in the analysis for the whole sample, none of the SBP differences among the DSES groups in this subsample were statistically significant.

Discussion

Contrary to our hypotheses, among the Caucasian and African-American midlife women in SWAN, higher levels of DSES were not associated with lower SBP. As shown in Table 3, there was very little difference in adjusted mean SBP for either the Caucasian or African-American women in the highest DSES group compared to those in the lowest. Nor did higher DSES protect against increases in SBP with age. In fact, for both Caucasian and African-American women, low, not high, DSES appeared to be protective against age-related increases in SBP. Similarly, there was no association between DSES category and hypertension. Among the Caucasian women, there was some evidence that higher levels of DSES might be protective for incident hypertension, but the relationship was not statistically significant, perhaps because of the small sample. The concordance of the null findings for both SBP and hypertension and the results from the post hoc analyses suggest these findings were not the result of confounding due to the use of antihypertensive medication.

The assumption that RI protects CV health by buffering the negative effects of stress [2,22, 23] led to the post hoc analysis of the DSES–SBP relationship in a subsample of women who reported high levels of stressful life events. As in the total sample of women, there was no cross-sectional relationship between DSES and SBP in this subsample. This is in contrast to the finding that, among elderly Japanese, only for those who reported the stress of death of a close friend or family member in the preceding year were higher religious beliefs associated with a lower likelihood of developing hypertension [11]. It has been shown that greater RI buffered the effects of nonfamily stressors, such as financial or health problems, on depressive symptoms, but exacerbated the effects of family-related stressors, such as problems in a marital

relationship or with children [40]. The possibility that the effects of RI on SBP may vary not only by the amount of stress but also by type of stress is an important area for further investigation.

Prior studies of RI and CV health and BP have found protective effects for religious affiliation, religious practices, religious coping, and religious beliefs [2,6,11,12]. Do the null findings in the present study suggest that, unlike dimensions of RI, DSES is an aspect of spirituality that is not protective for CV health or BP? It is likely that the cloistered Italian nuns, who have been found to have little age-related increase in BP over 30 years, have very high levels of DSES, such as feeling God's presence, being spiritually touched by the beauty of creation, or feeling a selfless caring for others [14]. It may be that only a very intense exposure to spiritual experiences, such as that of cloistered religious life, is protective for CV health. It is also possible that the protective effect among these cloistered women comes from their devotional practices or other aspects of their lifestyle, separate from or in combination with their spiritual experiences. It also may be that a single assessment of DSES is subject to variation based on current mood or stress and that multiple assessments over time may be necessary to obtain a more accurate measure of this exposure.

However, DSES may also suffer from measurement error, especially in comparison to measures of religious affiliation, practice, or belief. How should a respondent know if she is feeling close to God? What information will help her accurately report whether, and how often, she is feeling "deep inner peace?" Among other factors, respondent's religious backgrounds may play an important role in shaping their responses to these items [41,42]. This would be contrary to the belief that the DSES would accurately measure a universal dimension of religion or spirituality [26]. However, if there is greater measurement error for the DSES items, it would bias results toward null findings, such as those of the present study. Future investigation should examine whether the effects of DSES on health are conditioned on specific religious worldviews.

Other studies have found that RI is protective for CV health and BP. In light of those findings, how should we understand the fact that DSES was not protective for elevated SBP or hypertension in this sample? Is there something about this sample of midlife women that is different from the other samples in which an association has been reported? While the women in SWAN were generally healthy, many had elevated SBP (41% had SBP equal to or greater than 120 mmHg), including women who were taking antihypertensive medication. Perhaps RI and/or spirituality are more protective for men vs. women or for older vs. midlife adults. While two studies that found protective BP effects were based on samples of older adults [6,11], the results from NHANES III found an association between worship attendance and hypertension that was not modified by either age or gender [10]. Additionally, in the study of religious coping and ambulatory BP among young and middle age adults, the effects differed by race but not by age or gender [12].

The null findings for DSES in the present study caused us to take a second look at the research about RI and BP. Almost all the studies we examined tested relationships between several measures of RI and often several measures of BP (e.g., SBP, DBP, hypertension). For example, in their study of RI and BP in the Duke EPESE, Koenig and colleagues tested six cross-sectional effects [6]. Only half of them were significant. Similarly, in their study of the Japanese elderly, Krause and colleagues tested a total of 12 cross-sectional, longitudinal, main, and interaction effects [11]. Ten of them were nonsignificant, only one was protective, and in fact, one was harmful. Among nine recent studies, we found a conservative estimate of 80 separate tests of RI–BP effects, of which 58 (73%) found no association, 20 (25%) found a protective association, and two (2%) found harmful associations [4,6,7,9–12,14,43].

The null results of the present study are thus actually consistent with the 73% of the RI–BP effects where no association was found. The evidence that 25% of the tested RI–BP effects are protective suggests both that this protective association is not likely to be due to chance but also that it is conditional. Unfortunately, it is not clear from the limited existing research what factors, age, gender, measure of RI or spirituality, or others, condition the effect. It is quite possible that it is several factors together. Hopefully, future research about RI and spirituality and BP will be conducted with multiple measures of RI and/or spirituality and in diverse populations so that we can further our understanding of the conditions under which RI and/or spirituality are and are not protective for BP.

Multiple conditioning factors may help us understand the finding that African-American women with a few not-applicable DSES responses had higher SBP. Since the DSES items with the most not-applicable responses were the items that referred to God or religion, it is possible it was these items to which these African-American women responded “not applicable.” Historically, RI has played a central role in the life of African-Americans [44]. Selecting “not applicable” to “I find comfort in my religion/spirituality” and similar items may be an indication of alienation from religion and not just neutral disinterest. Other research has found such religious alienation or struggle to compromise recovery from illness and increase risk for mortality [45–47]. It may be that alienation from religion is a stressful experience that contributes to elevated SBP for midlife African-American women.

The findings from this study must be interpreted in light of several limitations. For example, the women in SWAN were not drawn from representative samples. Among other things, a high proportion of them report at least a college degree. Additionally, approximately 10% of the women were excluded because of missing DSES items; some of these were because their not-applicable responses were coded as missing. These women were more likely to be less religious than the others. However, in most cases, we have no information about how the women with missing DSES items differed from the rest, and we were not able to estimate the effect of these missing cases on these results. As we have already mentioned, it is unknown whether these findings are applicable to men or to older adults.

These limitations notwithstanding, this study permitted an examination of the relationship between DSES, a new measure of spiritual experiences, and SBP and hypertension, in a large, biracial, community-based sample of midlife women. We were able to examine not only the cross-sectional relationship between DSES and SBP and hypertension but also the relationship between DSES and change in SBP and incident hypertension over 3 years. Controls for important demographic and health covariates were included in the estimation of these effects. The effects were tested in the sample as a whole and in two sub-samples, women not taking any antihypertensive medications and women experiencing high levels of stress. While there is “reasonable evidence” [3] that RI is associated with protective BP and hypertension effects, the null findings from these models are consistent with the majority of RI–BP and hypertension effects tested in recent research. In addition to examining the relationship between DSES and BP and hypertension in men and older adults, further research should focus on other factors which may condition this relationship.

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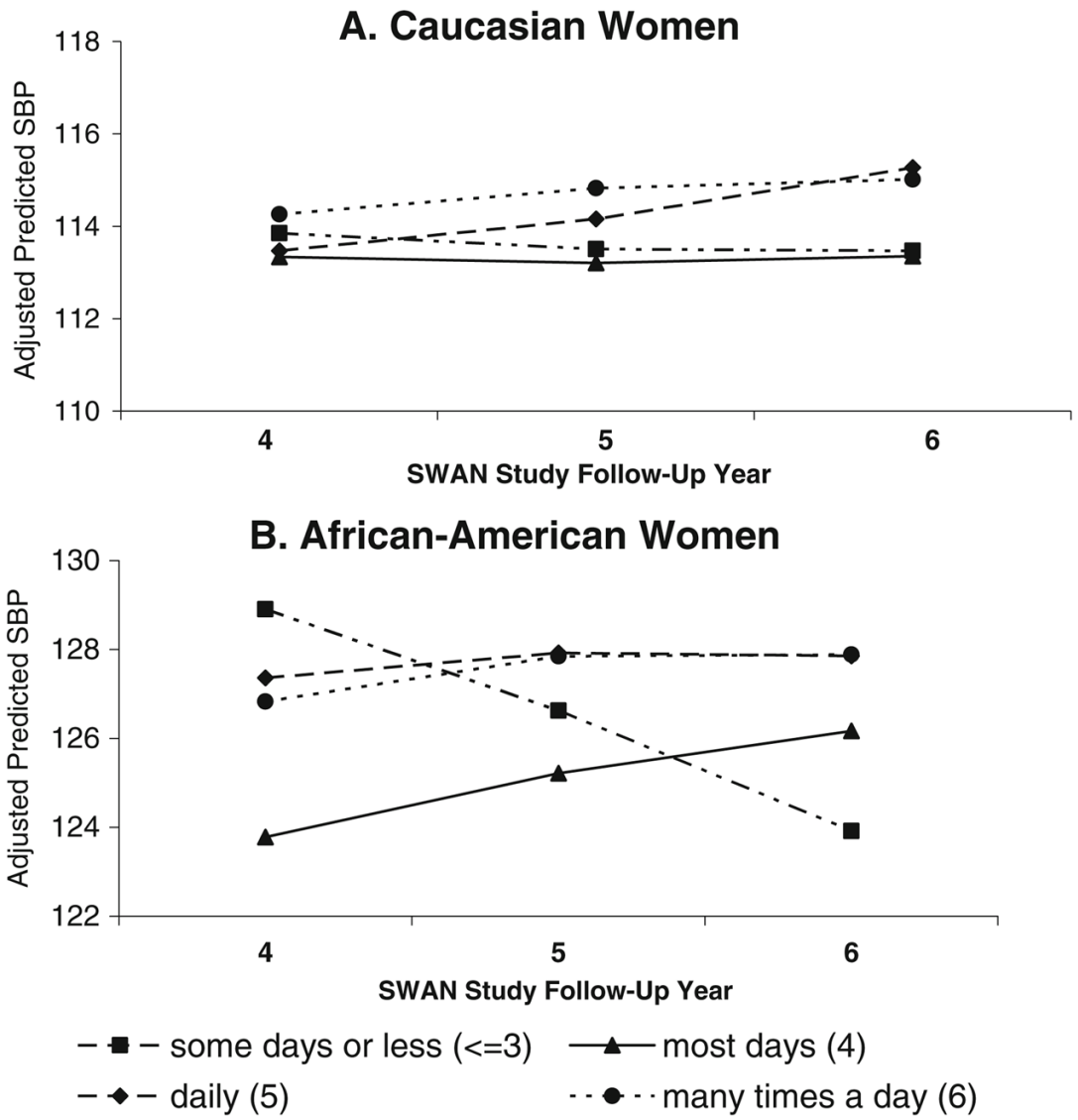

Fig. 1.

Change in predicted systolic blood pressure by Daily Spiritual Experiences category: Caucasian and African-American women. Predicted values from random effects regression models adjusted for demographics, health factors, study site, and sum DSES not-applicable responses

Table 1

Sample demographic and medical characteristics at fourth SWAN interview

Variable	Values	All (*n*=1658)	Caucasian (*n*=1060, 63.9%)	African-American (*n*=598, 36.1%)
DSES Category	Some days or less (≤3)	22.0%	29.5%	8.7%
	Most days (4)	29.3%	33.3%	22.2%
	Daily (5)	35.2%	29.2%	45.8%
	Many times a day (6)	13.5%	8.0%	23.2%
DSES item not applicable responses	None	87.5%	85.4%	91.3%
	1–3	12.5%	14.6%	8.7%
SBP (mm/Hg)	Mean, SD	118.4 (17.3)	113.6 (14.2)	126.9 (18.9)
Hypertension	Percent yes	29.0%	17.6%	49.0%
Age (years)	Mean, SD	50.0 (2.7)	50.0 (2.7)	49.9 (2.6)
Married	Percent yes	60.1%	69.0%	44.3%
Education	≤High school	17.5%	13.3%	24.9%
	Some college	34.2%	29.9%	41.8%
	College degree or more	48.3%	56.8%	33.3%
How hard to pay for basics	Not very	64.6%	70.9%	53.5%
	Somewhat	27.6%	24.3%	33.6%
	Very	7.8%	4.9%	12.9%
Menopausal status	Pre, early peri	50.8%	53.3%	46.3%
	Late peri, post	31.7%	29.5%	35.6%
	Surgical	5.3%	3.8%	8.0%
	Hormone use	12.2%	13.4%	10.0%
Diagnosed with diabetes	Percent yes	5.1%	3.2%	8.5%
Antihypertensive medication	Percent yes	20.9%	13.0%	35.0%
BMI	Mean, SD	30.1 (7.6)	28.6 (6.9)	32.7 (7.9)
Heart rate (beats/minute)	Mean, SD	69.9 (10.6)	69.4 (10.5)	70.8 (10.8)
Stressful life events	4 or more	42.5%	37.4%	51.7%

SD standard deviation

Table 2

Regression models predicting systolic blood pressure

Variable (reference group)	Values	Caucasian women		African-American women	
		Model 1	Model 2[a]	Model 1	Model 2[a]
DSES category (some days or less)	Most days	−0.37 (1.10)	−0.80 (0.94)	−6.69** (3.09)	−4.72 (2.87)
	Daily	−0.35 (1.14)	−1.34 (0.99)	−2.32 (2.86)	−2.11 (2.69)
	Many times a day	0.70 (1.74)	0.53 (1.50)	−2.90 (3.07)	−2.61 (2.86)
DSES items not applicable (none)	1–3		1.67 (1.08)		6.96*** (2.60)
Age	Age in years		0.83**** (0.15)		0.90*** (0.30)
Marital Status (not married)	Married		−0.01 (0.83)		−2.43 (1.50)
Education (≤ HS)	Post-HS		−0.74 (1.23)		1.10 (1.84)
	College or more		−2.27* (1.19)		−2.15 (2.03)
Pay for basics (not very hard)	Somewhat hard		−0.69 (0.88)		1.70 (1.61)
	Very hard		0.47 (1.79)		2.86 (2.32)
Menopausal status (pre/early peri)	Late peri/post		−1.36 (0.95)		−0.27 (1.78)
	Surgical		0.34 (1.98)		−4.03 (2.76)
	Hormones		−0.50 (1.16)		0.25 (2.55)
Diagnosed with diabetes (no)	Yes		2.71 (2.22)		2.91 (2.71)
Antihypertensive medication (no)	Yes		7.62**** (1.19)		8.05**** (1.59)
BMI			0.56**** (0.06)		0.36**** (0.10)
Heart rate	Beats/minute		0.13**** (0.04)		−0.03 (0.07)
Intercept		113.72**** (0.80)	35.44*** (8.50)	130.12**** (2.62)	62.01**** (16.23)

Values are unstandardized regression coefficients (SE)

* $p<0.10$;

** $p<0.05$,

*** $p<0.01$,

**** $p<0.001$

[a] Model 2 includes adjustment for study site

Table 3

Adjusted mean SBP by DSES category

Sample	DSES category	Caucasian women	African-American women
All women (*n*=1658)	Some days or less	114.2 (0.69)	129.5 (2.45)
	Most days	113.4 (0.64)	124.8 (1.52)
	Daily	112.8 (0.69)	127.4 (1.06)
	Many times a day	114.7 (1.32)	126.9 (1.49)
No antihypertensive medication (*n*=1311)	Some days or less	112.5 (0.70)	125.3 (2.84)
	Most days	111.5 (0.67)	120.8 (1.72)
	Daily	111.4 (0.73)	124.5 (1.27)
	Many times a day	112.8 (1.37)	122.6 (1.75)
High stress (*n*=705)	Some days or less	114.6 (1.22)	130.7 (3.49)
	Most days	114.3 (1.07)	126.0 (2.06)
	Daily	113.1 (1.24)	128.0 (1.52)
	Many times a day	116.0 (2.29)	127.1 (2.14)

All values are mean systolic blood pressure (SE) adjusted for demographics, health factors, study site, and sum DSES not-applicable responses. For both Caucasian and African-American women, with adjustment for multiple comparisons (Tukey), in none of the samples are the differences between women in the different DSES categories statistically significant

Table 4

Relationship between DSES category and prevalent hypertension

	Caucasian women		African-American women	
DSES category	**Model 1[a]**	**Model 2[b]**	**Model 1[a]**	**Model 2[b]**
Some days or less (reference group)	1.00	1.00	1.00	1.00
Most days	1.32 (0.88, 1.98)	1.51 (0.96, 2.39)	0.66 (0.35, 1.26)	0.71 (0.35, 1.42)
Daily	1.22 (0.80, 1.86)	1.19 (0.73, 1.94)	1.11 (0.61, 2.00)	1.08 (0.57, 2.07)
Many times a day	1.18 (0.63, 2.24)	0.90 (0.42, 1.93)	1.01 (0.54, 1.92)	1.03 (0.52, 2.06)

Odds ratios are odds of having hypertension.

[a] Model 1—unadjusted.

[b] Model 2 includes adjustment for demographics, health factors, study site, and sum DSES not-applicable responses

Table 5

Results from random effects models for relationship between DSES category and SBP

Variable (reference group)	Values	Caucasian women		African-American women	
		Model 1	Model 2[a]	Model 1	Model 2[a]
DSES category (some days or less)	Most days	−0.70 (1.09)	−0.85 (0.92)	−5.44* (3.07)	−3.57 (2.81)
	Daily	−0.61 (1.13)	−1.35 (0.97)	−1.57 (2.84)	−1.21 (2.62)
	Many times a day	0.33 (1.72)	0.15 (1.47)	−2.56 (3.04)	−1.87 (2.80)
Time		−0.04 (0.35)	−0.09 (0.35)	−2.54** (1.24)	−2.76** (1.26)
DSES category × time	Most days × time	0.26 (0.47)	0.29 (0.47)	4.06*** (1.46)	4.09*** (1.48)
	Daily × time	1.18** (0.49)	1.13** (0.49)	2.57* (1.35)	2.64* (1.36)
	Many times a day × time	0.98 (0.76)	1.39* (0.76)	2.96** (1.44)	3.21** (1.45)
DSES Items not applicable (none)	1–3		1.62* (0.92)		6.68*** (2.10)
Age	Age in years		0.72**** (0.12)		0.55** (0.24)
Marital Status (not married)	Married		0.34 (0.71)		−0.36 (1.21)
Education (≤ HS)	Post-HS		−0.36 (1.05)		0.57 (1.51)
	College or more		−2.26** (1.01)		−2.20 (1.64)
Pay for basics (not very hard)	Somewhat hard		−0.61 (0.76)		2.98** (1.32)
	Very hard		1.49 (1.52)		4.02** (1.91)
Menopausal status (pre/early peri)	Late peri/post		−0.84 (0.60)		1.49 (1.13)
	Surgical		0.46 (1.32)		−1.87 (1.94)
	Hormones		−0.13 (0.74)		2.84 (1.74)
Diagnosed with diabetes (no)	Yes		−0.21 (1.33)		−2.77* (1.49)
Antihypertensive medication (no)	Yes		5.39**** (0.83)		5.20**** (1.08)
BMI			0.63**** (0.05)		0.53**** (0.08)
Heart rate	Beats/minute		0.09**** (0.02)		−0.04 (0.03)
Intercept		113.91**** (0.79)	48.12**** (6.76)	129.26**** (2.60)	81.46**** (12.57)

Values are ML coefficients (SE) from mixed effects regression models

*$p<0.10$;

** $p<0.05$;

*** $p<0.01$;

**** $p<0.001$

[a]Model 2 includes adjustment for study site

Table 6

DSES category and incident hypertension

	Caucasian women (*n*=739)		African-American women (*n*=262)	
DSES category	**Model 1[a]**	**Model 2[b]**	**Model 1[a]**	**Model 2[b]**
Less than daily	1.00	1.00	1.00	1.00
At least daily	0.87 (0.45, 1.68)	0.82 (0.41, 1.65)	1.12 (0.57, 2.20)	1.08 (0.52, 2.25)

Odds ratios are odds of incident hypertension among those who are not hypertensive at baseline.

[a] Model 1, unadjusted.

[b] Model 2 includes adjustment for demographics, health factors, study site, and sum DSES not-applicable responses.