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An Examination of the Relationship between Multiple Dimensions of Religiosity, Blood Pressure, and Hypertension

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Abstract

Researchers have established the role of heredity and lifestyle in the occurrence of hypertension, but the potential role of psychosocial factors, especially religiosity, is less understood. This paper analyzes the relationship between multiple dimensions of religiosity and systolic blood pressure, diastolic blood pressure, and hypertension using data taken from the Chicago Community Adult Health Study, a probability sample of adults (N=3105) aged 18 and over living in the city of Chicago, USA. Of the primary religiosity variables examined here, attendance and public participation were not significantly related to the outcomes. Prayer was associated with an increased likelihood of hypertension, and spirituality was associated with increased diastolic blood pressure. The addition of several other religiosity variables to the models did not appear to affect these findings. However, variables for meaning and forgiveness were associated with lower diastolic blood pressure and a decreased likelihood of hypertension outcomes. These findings emphasize the importance of analyzing religiosity as a multidimensional phenomenon. This study should be regarded as a first step toward systematically analyzing a complex relationship.

Keywords

religion; religiosity; blood pressure; hypertension; USA

INTRODUCTION

High blood pressure, or hypertension, is a well known risk factor for cardiovascular disease, heart attack, heart failure, stroke, and kidney disease (e.g., Chobanian, Bakris, Black, Cushman, Green, Izzo, et al., 2003). It is also becoming increasingly more common in the U.S. Twenty-two percent of adults 18 years of age and over have been told by a doctor on two or more visits that they have hypertension and this percentage increases dramatically with age (Pleis &

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Lethbridge-Cejku, 2006). The Framingham Heart Study showed that the lifetime risk for developing hypertension was 90% for men and women who were non-hypertensive at 55 or 65 years old and survived to 80 or 85 years old (Vasan, Larson, Leip, Evans, O'Donnell & Kannel, 2001). While researchers have established the role of heredity and lifestyle in the occurrence of hypertension, the potential role of psychosocial factors, especially religiosity, is less well understood.

The idea that a relationship exists between religiosity and hypertension is not new. One of the first studies to examine this relationship was published over forty years ago (Scotch, 1963), and a detailed review of the evidence first appeared nearly twenty years ago (Levin & Vanderpool, 1989). Since then, Koenig, McCullough & Larson (2001) identified 16 studies of the relationship between religious involvement and blood pressure, 14 of which indicate that the more religious have lower blood pressure, especially lower diastolic blood pressure. Other researchers have concluded that there is "reasonable evidence" to suggest that religiosity is associated with lower blood pressure and less hypertension (Seeman, Dubin & Seeman, 2003). At the same time, much of the existing work is limited by sampling design (e.g., age-restricted and non-representative samples), measurement (e.g., relying on single item measures of religiosity such as service attendance or affiliation, or self-reports of hypertension), and a lack of adequate controls. Seeman et al. (2003), in particular, emphasizes the need for a more precise specification and a more systematic examination of the multiple dimensions of religiosity that might differentially affect health outcomes (61).

We address some of these issues by analyzing the relationship between religiosity and systolic blood pressure (SBP), diastolic blood pressure (DBP), and hypertension using data taken from the Chicago Community Adult Health Study, a probability sample of adults (N=3105) aged 18 and over living in the city of Chicago, IL. These data are especially useful in that they permit us to examine multiple dimensions of religiosity including beliefs about attendance, religious coping, meaning, congregational support and criticism, and forgiveness.

LITERATURE REVIEW

Religious Involvement, Blood Pressure, and Hypertension

An increasing number of studies have found a significant association between religious involvement and blood pressure such that individuals who report higher levels of involvement have lower SBP, lower DBP, and/or a lower risk of hypertension. In one of the most recent examples, Gillum and Ingram (2006) analyze data from a large, national sample of adults to examine the relationship between religious service attendance, blood pressure, and hypertension. After controlling for sociodemographic characteristics and health status, the results indicate that compared with those who never attend services, those who attend services weekly or more than weekly have a somewhat reduced prevalence of hypertension and lower blood pressure. Using a probability sample of adults aged 65 and over in North Carolina, Koenig, George, Hays, Larson, Cohen, and Blazer (1998) find that more frequent participation in religious activities (e.g., attend services, pray, study the Bible) is significantly related to lower blood pressure.

Other regional studies of community dwelling adults indicate that religious involvement is significantly associated with lower SBP and lower DBP (Graham, Kaplan, Cornoni-Huntley, James, Becker & Hames et al., 1978; Livingston, Levine, & Moore, 1991; Steffen, Hinderliter, Blumenthal, & Sherwood, 2001; Walsh, 1998), although it appears to be more strongly and consistently related to lower DBP (e.g., Hixson, Gruchow, & Morgan, 1998; Lapane, Lasater, Allan, & Carleton, 1997; Larson, Koenig, Kaplan, Greenberg, Logue, & Tyroler, 1997). Several studies of specific religious denominations or clergy outside the U.S. also find lower blood pressure and/or a lower risk for hypertension among members compared to non-members

(Fonnebo, 1992; Timio, Verdecchia, Venanzi, Gentili, Ronconi & Francucci et al., 1988; Webster & Rawson, 1979).

On the other hand, there are a number of studies that find no association between religious involvement and blood pressure. For example, Koenig, Moberg, and Kvale (1988) found no significant relationship between organizational religious activity, non-organizational religious activity, and intrinsic religiosity measures and hypertension among a small sample of medical outpatients aged 56 to 94. Similarly, Brown and Gary (1994) found no relationship between religiosity (i.e., affiliation, service attendance, and a 10-item religiosity scale) and self-reported hypertension among a sample of Black males. More recently, Yeager, Glei, Au, Lin, Sloan & Weinstein (2006) found no significant associations between religious involvement (i.e., service attendance, beliefs, and religious practices) and either SBP or DBP in a representative sample of older persons in Taiwan. In one study of older Mexican Americans, those who defined themselves as "very religious" were actually *more* likely to have hypertension than those who defined themselves as "less than very religious" (Levin & Markides, 1985). Maselko, Kubzansky, Kawachi, Seeman & Berkman (2007) also found that older men who attended religious services weekly had *higher* SBP than older men who attended services less often.

Primary Dimensions of Religiosity—The dimension of religiosity most often and most strongly associated with blood pressure and hypertension is religious service attendance (e.g., Gillum & Ingram, 2006; Graham et al., 1978; Koenig et al., 1998). However, other religious dimensions correlated with service attendance, such as private prayer, public participation, and spirituality may also affect blood pressure and hypertension. As mentioned before, Koenig et al. (1998) find that prayer in combination with service attendance and Bible study is related to lower blood pressure. Some clinical studies also suggest that transcendental meditation or repetitive prayer may lower blood pressure via the relaxation response (Benson, 1977; Schneider, Staggers, Alexander, Sheppard, Rainforth & Kondwani et al., 1995; Sudsuang, Chentanez & Veluvan, 1991). One study suggests that spirituality more strongly predicts cardiovascular responses to stress than religiosity in a sample of young adult women (Edmondson, Lawler, Jobe, Younger, Piferi & Jones, 2005). Although there are no studies that specifically examine public religious participation (i.e., active leadership roles) and blood pressure, this level of involvement presupposes that of regular attendance. Also, there is evidence that serving on a leadership council, for example, can improve social integration and health outcomes (Moen, Dempster-McClain, & Williams, 1992).

Additional Dimensions of Religiosity—The primary dimensions of religiosity described above may directly affect blood pressure and hypertension, but there are several additional dimensions of religiosity that have not been adequately considered in the literature on this topic. First, it is possible that the salutary relationship between attendance, blood pressure, and hypertension stem from individuals' beliefs about the spiritual and social benefits of attendance. For example, the symbolic and ritualistic act of attending worship services may contribute to feelings of inner peace and empowerment (Williams, 1994). The "psychodynamics of religious rites" have been hypothesized to reduce blood pressure and hypertension (Levin & Vanderpool, 1989: 74). As a communal activity among individuals who share beliefs and values, attendance may also promote social integration and support (Idler, 1987; Idler & Kasl, 1997), which are known to influence health and well-being (House, Landis, & Umberson, 1988).

A second possibility is that the relationship between religious involvement and blood pressure is partially explained by religious coping. While religious coping offers a meaningful context in which to understand and deal with challenging life events (e.g., illness, loss of a loved one), it may also have negative effects for those struggling with religious doubts (Koenig, 1994; Pargament, Smith, Koenig & Perez, 1998; Pargament, Koenig, Tarakeshwar & Hahn, 2001).

At least one study provides evidence that positive religious coping is related to lower blood pressure among African Americans, controlling for demographic characteristics and health behaviors (Steffen et al., 2001).

Religious beliefs and meaning may also play a role in the relationship between religious involvement and blood pressure. Religious beliefs or theodicy can provide a system of meaning through which individuals can interpret adverse circumstances and events. More specifically, belief in an afterlife or "existential certainty" may provide a great deal of comfort, which contributes to well-being (Ellison, 1991), and ultimately reduces the risk of hypertension (Krause, Liang, Shaw, Sugisawa, Kim & Sugihara, 2002).

Another possible explanation for the religious involvement-blood pressure link is the nature and degree of social support received by individuals from their congregations. Individuals who actively attend religious services have greater perceptions that support, if needed, is available from fellow members of the congregation (McIntosh, Silver, & Wortman, 1993). In addition, service attendance is associated with higher levels of both instrumental and emotional support (Ellison & George, 1994). Given these expectations, negative interactions with fellow congregation members may be unanticipated and therefore, particularly harmful (Krause, Ellison & Wulff 1999; Rook, 1990). In one study however, negative interaction affected the well-being of clergy, but not that of lay members (Krause et al., 1999).

Finally, forgiveness is another dimension of religiosity that may partially account for the association between religious involvement and blood pressure. The act of forgiveness is central to religiosity and spirituality (Gorsuch & Hao, 1993; Koenig, 1994). Although there is no consensus with regard to the definition of forgiveness in the literature, two important dimensions identified in previous work are forgiveness of others and forgiveness of oneself (Gorsuch & Hao, 1993; Hargrave & Sells, 1997; Toussaint, Williams, Musick & Everson, 2001). Past research indicates that forgiveness of self and forgiveness of others are associated with decreased psychological distress and better self-rated health (Toussaint et al., 2001).

In summary, the existing literature suggests that service attendance along with private prayer, public participation, and spirituality have direct, positive associations with blood pressure and/or hypertension. Less is known about other dimensions of religiosity (e.g., spiritual and social attendance beliefs, religious coping, congregational support), but there is evidence that each dimension is significantly related to one or both of the outcomes. It is possible that they explain, in part, the salutary relationship between religious involvement, blood pressure, and hypertension. In order to explore this relationship, we examine the independent association of service attendance and the primary dimensions of religiosity on these outcomes. We also examine each additional dimension of religiosity (i.e., spiritual and social attendance beliefs, positive and negative religious coping, beliefs and meaning, congregational support and criticism, forgiveness of self and others) as a potential mediator of this relationship.

DATA

The data for this analysis are taken from the Chicago Community Adult Health Study (CCAHS), which was designed to examine how environmental, social, psychological, and biological factors combine to affect adult health outcomes (Morenoff, House, Hansen, Williams, Kaplan, & Hunte, 2007). The CCAHS is a probability sample of adults (N=3105) aged 18 and over living in the city of Chicago, IL and stratified into 343 neighborhood clusters (NCs) as defined by the Project on Human Development in Chicago Neighborhoods (PHDCN) (Sampson, Raudenbush, & Earls, 1997). Each NC usually included two census tracts with meaningful physical and social identities and boundaries. Respondents in 80 focal areas previously defined by PHDCN were sampled at twice the rate of those in others. Face to face

interviews were conducted with one respondent per household between May 2001 and March 2003 for a response rate of 71.8 percent. All data and analyses are weighted to take account of the different rates of selection as well as household size and differential coverage and nonresponse across NCs. The weighted sample matches the 2000 Census population estimates for the city of Chicago in terms of age, race/ethnicity and sex.

MEASURES

Blood Pressure

Trained CCAHS interviewers collected three separate readings approximately one minute apart of systolic (SBP) and diastolic (DBP) blood pressure using highly reliable oscillographic devices certified by the European Society of Hypertension (O'Brien, Waeber, Parati, Staessen, & Myers, 2001). Note that most respondents had been seated for the interview at least 45 to 60 minutes prior to having their blood pressure readings taken. We analyze the average of the final two measures of SBP and DBP as continuous outcomes.

Hypertension

We also include a binary measure of hypertension as an outcome. Individuals were considered to be hypertensive if they (a) had an average SBP of 140 mmHg or higher, or an average DBP of 90 mmHg or higher, or (b) reported that they had taken antihypertensive medications in the last 12 months (Chobanian et al., 2003; Fields, Burt, Cutler, Hughes, Roccella, & Sorlie, 2004; Hajjar & Kotchen, 2003; Morenoff et al., 2007).

Primary religiosity variables

The primary religiosity variable included in this analysis is service attendance. Respondents were asked how often they usually attended religious services. The response categories range from (1) never to (7) more than once a week. In order to consider the possibility of a nonlinear relationship between service attendance and the outcomes, a series of dummy variables for attendance were tested in preliminary analyses (not shown). The size and direction of the estimates for the attendance categories were similar, so the continuous measure of service attendance is used. A two-item index of public religious activity (α=.66) measures respondents' participation in non-worship activities. The items ask (1) whether respondents consider themselves active members (e.g., serving on a committee, or helping organize meetings), and (2) whether respondents have held a leadership position in the congregation (e.g., Sunday school teacher or deacon) within the past five years. Frequency of prayer asks respondents how often they pray privately outside church. The response categories range from (1) never to (6) several times a day. The degree of spirituality asks respondents to rate their level of spirituality. The response categories range from (1) not spiritual at all to (4) very spiritual.

Mediating religiosity variables

We include a number of other religiosity measures in order to examine their role as mediators in the relationship between service attendance and the outcomes. Spiritual attendance beliefs is a three-item index (α =.77), which measures respondents' religious feelings about attending services. The items include: (1) "My faith is renewed when I attend religious services", (2) "I feel a sense of inner peace and harmony when I attend religious services," and (3) "When I attend religious services I feel the presence of God or a higher power." Social attendance beliefs is a three-item index (α=.72), which measures respondents' feelings about the social benefits of attending services. The items include: (1) "I feel accepted and understood when I am with people from my religious congregation," (2) "Attending religious services helps to establish me as a person in the community," and (3) "My religious congregation feels like a

family to me." Responses for all the items are reverse coded and range from (1) strongly disagree to (4) strongly agree.

Positive religious coping is measured using a two-item index (α=.85). The items include: (1) "I work together with God as partners," and (2) "I look to God for strength, support, and guidance." Negative religious coping is assessed using a single-item that asks respondents to respond to the following statement: "I feel God is punishing me for my sins or lack of spirituality."

Religious saliency is also assessed using a single-item, which asks respondents how much they carry religion over into all other dealings in their life. Response categories for all of the items are reverse coded and range from (1) not at all to (5) a great deal. Belief in eternal life is measured using the following item: "I believe in eternal life." The response categories are reverse coded and range from (1) disagree strongly to (4) agree strongly. Meaning or purpose is measured using a three-item index (α=.62). The items include: (1) "I have trouble finding peace of mind," (2) "I have a sense of direction and purpose in life," and (3) "I'm not sure my life adds up to much." The responses range from (1) agree strongly to (4) disagree strongly. Item 2 is reverse coded so that higher responses reflect more meaning.

The congregational support item asks respondents how much help and comfort would people in their congregation give them if they had a problem or were faced with a difficult situation. The response categories are reverse coded and range from (1) not at all to (5) a great deal. The congregational criticism item asks respondents how often people in their congregation are critical of the things they do. The response categories are reverse coded and range from (1) never to (5) very often.

Finally, two measures are used to assess forgiveness. Forgiveness of others is an index (α=.51), which consists of two items: (1) "I have grudges that I have held onto for months or years" and (2) "I have forgiven those who have hurt me." Item 2 of forgiveness of others is reverse coded so that higher values indicate more forgiveness. Forgiveness of self asks respondents to respond to the following statement: "I often feel that no matter what I do now I will never make up for the mistakes of the past." The response categories for all the items range from (1) agree strongly to (4) disagree strongly.

Sociodemographic and Physical Health Controls

Our sociodemographic controls include gender (female=1), three dichotomous variables for race/ethnicity (non-Hispanic black=1; Hispanic=1; others=1) where non-Hispanic white is the reference category, marital status (married=1), age (years), and education (years). We include two dichotomous measures of immigrant generation: First-generation immigrants are individuals born outside the U.S., and second-generation immigrants are individuals who have at least one parent born outside the U.S. All other individuals are classified as third- or higher-generation immigrants, which is the reference category. We measure family income using two dichotomous variables (less than $5000 per year=1; between $5000 and $50,000 per year=1. The reference category is greater than $50,000 per year. We also add a dichotomous variable for missing responses on income (missing=1). The *physical health* controls include Body Mass Index (BMI), calculated as (body weight in kilograms)/(height in meters)^2 and smoking status (current smoker=1),which are both known to be associated with the outcomes. Models for the continuous blood pressure measures (SBP and DBP) also control for whether the respondent reported having taken antihypertensive medications in the last 12 months (yes=1).

ANALYTICAL STRATEGY

We use OLS regression to analyze the continuous measures of diastolic and systolic blood pressure, and logistic regression to analyze the dichotomous measure of hypertension. For each outcome, Model 1 includes service attendance and the primary religiosity variables. Model 2 adds the sociodemographic and physical health controls. Model 3 adds all of the mediating variables (spiritual and social attendance beliefs, positive and negative coping, religious beliefs and meaning, congregational support and criticism, and forgiveness). We also tested each set of mediating variables in separate models (not shown) that included service attendance, the primary religiosity variables, and the sociodemographic and health controls. Note that all models also include a dichotomous variable indicating congregational membership (member=1).

RESULTS

Descriptive Statistics and Bivariate Associations

Table 1 presents the unweighted descriptive statistics (i.e., range, mean, and standard deviation) for each study variable, as well as the weighted bivariate associations between each study variable and each outcome (i.e., SBP, DBP, and hypertension). For the primary religiosity variables (attendance, private prayer, public participation, and spirituality) the results indicate that higher levels of these activities are associated with higher SBP and DBP, and an increased likelihood of being hypertensive. This pattern is particularly strong for public participation and SBP, public participation and hypertension, and spirituality and SBP. For the mediating religiosity variables, there are also some unexpected patterns. While spiritual attendance beliefs are not significantly related to SBP or DBP, social attendance beliefs are significantly associated with increased SBP, slightly increased DBP, and a 13% higher likelihood of being hypertensive. The relationship between positive religious coping and the outcomes is also significant and in the same direction, but the pattern is reversed and not significant for negative religious coping.

Religious saliency and belief in eternal life are both significantly associated with higher SBP, slightly higher DBP, and an increased likelihood of being hypertensive (16% and 25%, respectively). Religious meaning however, is significantly associated with decreased SBP, DBP, and a lower likelihood of being hypertensive. Interestingly, congregational criticism is also significantly associated with decreased SBP, DBP, and a lower likelihood of being hypertensive. Congregational support, on the other hand, is not significantly associated with either SBP or DBP, and increased support is associated with a 13% increase in the odds of being hypertensive. Forgiveness of others and forgiveness of self are also differentially related to the outcomes. Forgiveness of others is associated with higher levels of SBP, DBP, and an increased likelihood of being hypertensive. Forgiveness of self is associated with lower SBP, DBP, and a lower likelihood of being hypertensive. Note that a separate correlation analysis (not shown) indicates that the primary religiosity variables are significantly correlated with the mediating religiosity variables with a few minor exceptions. In general, the correlation coefficients are moderately strong and in the anticipated direction. For example, congregational criticism is negatively associated with attendance (-.55***), while congregational support is positively associated with attendance (.39***).

In general, the relationship between the sociodemographic and physical health controls and the outcomes follow expected patterns. Women have significantly lower SBP and DBP, and a lower likelihood of being hypertensive than men. Currently married persons however, have higher levels of SBP, DBP, and an increased likelihood of being hypertensive compared to those who are not married. Older age is associated with a small increase in levels of SBP, DBP, and a small increase in the likelihood of being hypertensive. The associations for race/ethnicity

suggest that Non-Hispanic blacks have significantly higher levels of SBP and DBP, and are 83% more likely to be hypertensive than Non-Hispanic Whites. The opposite is true for both Hispanics and other races (American Indian, Asian, Pacific Islander). Immigrant generation is significantly related to the outcomes such that 2nd generation immigrants have significantly lower levels of SBP and DBP, and are significantly less likely than 3rd or higher generation immigrants to be hypertensive. Higher levels of education are also associated with lower levels of SBP and DBP, although only the former is statistically significant. Income is related to the outcomes such that those who report family income less than $5,000 per year and those who report family income between $5,000 and $49,999 per year have significantly lower DBP compared to those who earn $50,000 per year or more. Not surprisingly, higher BMI is significantly associated with higher SBP, DBP, and an increased likelihood of being hypertensive. Current smokers also have higher SBP and DBP, but a lower likelihood of being hypertensive, although none of these coefficients are statistically significant.

Diastolic Blood Pressure

Table 2 shows the weighted OLS regression models of DBP. The first model includes only the primary religiosity variables. Both attendance and prayer are associated with slightly lower DBP, while public participation is associated with higher DBP, but these differences are not significant. Spirituality is the only statistically significant predictor of DBP in this model. The estimate (1.19***) suggests that those who report higher levels of spirituality have higher levels of DBP. The second model adjusts for the sociodemographic and health controls. The estimates for attendance, prayer, and public participation remain insignificant. The relationship between spirituality and DBP remains positive, although it is reduced by 58% with the addition of the controls.

Five separate models (not shown) tested the association of each set of mediating religiosity variables (spiritual and social attendance beliefs, positive and negative coping, saliency, congregational support and criticism, and forgiveness) on DBP. With the exception of meaning and forgiveness of self, none of the religiosity variables have a significant association with DBP. The addition of these variables also does little to change the relationship between the primary religiosity variables and DBP. In Model 3, which includes all of the mediating religiosity variables, the patterns observed in previous models remain much the same. For the primary religiosity variables, spirituality continues to be positively related to DBP (.74*). The estimates for attendance, prayer, and public participation continue to be statistically insignificant, although the relationship between attendance and DBP is consistently negative. Note that with the exception of the first model, all subsequent models explain approximately 15% of the variation in DBP.

Systolic Blood Pressure

The weighted OLS regression models of SBP are shown in Table 3. In Model 1, which includes only the primary religiosity variables, attendance is negatively related to SBP, while prayer, public participation, and spirituality are positively related to SBP. Only the estimate for spirituality is statistically significant (1.12*). When sociodemographic and physical health controls are included in Model 2, the estimate for spirituality changes direction and is reduced to insignificance. The estimates for attendance and prayer are slightly reduced, while the estimate for public participation changes direction. None of these estimates are statistically significant.

Five separate models (not shown) test the association between each set of mediating religiosity variables (spiritual and social attendance beliefs, positive and negative coping, saliency, congregational support and criticism, and forgiveness) and SBP. With the exception of social attendance beliefs, none of the religiosity variables have a significant association with SBP.

The addition of these variables also does little to change the association of the primary religiosity variables with SBP. When all the mediating variables are included in Model 3, the estimates for the primary religiosity variables remain relatively unchanged. Only the social attendance beliefs variable, which is positively related to SBP, is statistically significant (.58*). The fully adjusted model explains approximately 33% of the variation in SBP.

Hypertension

Table 4 shows the weighted logistic regression models for hypertension. In Model 1, which is unadjusted, all of the primary religiosity variables are associated with small increases in the likelihood of being hypertensive, although only prayer is statistically significant (1.11***). With the addition of sociodemographic and health controls in Model 2, the estimate for prayer is only slightly reduced such that more frequent prayer is associated with an 8% increase in the odds of being hypertensive. Five separate models (not shown) test the association between each set of mediating religiosity variables (spiritual and social attendance beliefs, positive and negative coping, saliency, congregational support and criticism, and forgiveness) and hypertension. With the exception of meaning, congregational criticism, and forgiveness of self none of the religiosity variables are significantly related to hypertension. The addition of these variables also does little to change the association between the primary religiosity variables and hypertension. In Model 3, which includes all of the mediating variables, only meaning and congregational criticism remain significant. Increased meaning is associated with 7% lower likelihood of being hypertensive. Interestingly, congregational criticism is significantly associated with hypertension, such that churchgoers who feel more criticized have a 10% lower likelihood of being hypertensive. The fully adjusted model explains about 42% of the variance in hypertension.

DISCUSSION

The major goal of this study was to examine the relationship of religious involvement with blood pressure, and hypertension. Unlike previous studies on this topic, we systematically analyzed the relationship between multiple dimensions of religiosity and several biological markers (i.e., DBP, SBP, and hypertension) using a representative sample of adults. Our analysis reveals several important findings and suggests possible directions for further research. The first and most striking pattern is that religious attendance is not significantly related to hypertension, DBP, or SBP across models. Previous research shows that compared to other measures of religiosity, service attendance is the strongest predictor of blood pressure, although the data used in several of these studies are limited by either age (e.g., Koenig et al., 1998) or gender (e.g., Graham et al., 1978).

The use of elderly samples in past research is particularly significant, since the likelihood of developing hypertension increases dramatically with age (e.g., Chobanian et al., 2003; Pleis & Lethbridge-Cejku, 2006). It is possible that the lack of an observed association between attendance and the outcomes is explained by the relatively young CCAHS sample, which has an average age of 43 years. It is also possible that the context in which the data were collected explains the lack of an association with attendance. One recent study, which found no relationship between religious involvement, including attendance, and either SBP or DBP, was conducted in Taiwan (Yeager et al., 2006). Yet, it is unclear how the context of data collected in Chicago, IL might be different from that of national data. Recall that Gillum and Ingram (2006) find a significant relationship between attendance, blood pressure, and hypertension using data from a nationally representative sample of adults age 20 and over.

Second, the pattern of the religiosity findings is different for each outcome. For example, spirituality, meaning, and forgiveness of self are significantly associated with DBP in the full model, but only social attendance beliefs reach significance in the full model for SBP. Further,

meaning and congregational criticism are the significant predictors of hypertension in the full model. This finding reiterates the need to consider religiosity as a multidimensional phenomenon. The existing literature on this topic also suggests that the religiosity association is stronger for DBP than SBP (e.g., Koenig et al., 2001). Our findings provide some support for this observation given that fewer measures of religiosity significantly predict SBP.

Third, none of the religious dimensions examined here (beliefs about attendance, coping, meaning, congregational support and criticism, forgiveness) appeared to mediate or otherwise change the relationships between attendance, prayer, public participation, or spirituality and the outcomes. In other words, none of the observed relationships between these primary variables and the outcomes are explained by the additional religiosity dimensions considered in this analysis.

Fourth, meaning and forgiveness have notable associations with both DBP and hypertension. More specifically, increased meaning and forgiveness of self are associated with lower DBP. Increased meaning is also associated with a small decrease in the likelihood of being hypertensive. Forgiveness of self is also associated with a small decrease in the likelihood of being hypertensive, although it does not achieve significance in the full model. In addition, these variables appear to operate independently of the primary religiosity variables. This finding is particularly interesting given that the measures of meaning and forgiveness of self are not specifically religious. For example, meaning includes items, such as “I have a sense of direction and purpose in life,” and forgiveness of self is measured by the item, “I often feel that no matter what I do now I will never make up for the mistakes of the past.” Of course, the provision of meaning and the act of forgiveness are central to religiosity and spirituality (e.g., Gorsuch & Hao 1993; Koenig, 1994), but both appear to be more important predictors of blood pressure and hypertension in a broader sense.

Fifth, while meaning and forgiveness of self have positive relationships with blood pressure and hypertension, other dimensions of religiosity appear to have negative relationships with the outcomes. For example, there were significant *positive* associations between spirituality and DBP across models. Prayer was also positively associated with hypertension, although it is not significant in the full model. It is unclear why higher levels of spirituality and more frequent prayer are associated with worse outcomes, although this finding is consistent with a similar analysis of mental health outcomes using the same data (Sternthal, Williams, Musick, & Buck, *under review*). Interestingly, belief in the social benefits of attendance was associated with increased SBP, while feeling criticized by one’s congregation was associated with reduced risk of hypertension. Again, it is unclear why these particular religious dimensions seem to have negative associations, but similar patterns have been observed in other studies (Levin & Markides, 1985; Maselko et al., 2007; Yeager et al., 2006).

We did conduct additional analyses (not shown) in order to explore the possibility that these findings are due to variations across certain demographic groups. Specifically, we tested a series of interactions between attendance and age, gender, and race/ethnicity. None of the interaction terms were significant, which suggests that the patterns identified here are not due to differences within and between these groups. We should also note that there are limitations associated with using the CCAHS data in this study, including that it is cross-sectional and that it is limited to a particular geographic region. However, it does contain both a wide range of religiosity variables and biological markers. Further, while these data do not permit us to examine the possibility of reverse causality in the relationship between religiosity and the outcomes, it is unlikely that blood pressure and hypertension prevent religious involvement since they do not impair mobility and often have no signs or symptoms (Koenig et al., 2001). It is also possible that unobserved heterogeneity or unmeasured confounding affect the findings, but we do control for those predictors known to affect religiosity and blood pressure

in previous studies (e.g., age, race, gender, smoking, BMI). Although this study reveals that many of the primary and mediating religiosity variables are either not significant or have relatively small associations with blood pressure and hypertension, it is the first to simultaneously examine multiple dimensions of religiosity using a representative sample of adults. This study is a necessary first step toward untangling the complex pathways whereby religiosity influences blood pressure and hypertension.

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Table 1

Unweighted Descriptive Statistics and Bivariate Associations[a] with Blood Pressure Outcomes for All Study Variables (N=3105)

	Range	Mean	Std. Dev	Systolic	Diastolic	Hypertensive
Primary Religiosity Variables						
Attendance	1-7	3.90	2.07	.69***	.17	1.12
Private prayer	1-6	4.30	1.67	.94***	.27*	1.17***
Public participation	0-2	.33	.63	2.45***	.97*	1.43***
Spirituality	1-4	2.96	.87	1.98***	1.22***	1.26***
Mediating Religiosity Variables						
Spiritual attendance beliefs	3-12	10.72	1.57	.43	.11	1.11***
Social attendance beliefs	3-12	9.39	1.89	1.01***	.25*	1.13***
Positive religious coping	2-10	7.51	2.44	.74***	.25**	1.13***
Negative religious coping	1-5	1.54	1.00	-.35	-.34	.98
Religious saliency	1-6	3.85	1.70	.89***	.28*	1.16***
Belief in eternal life	1-4	3.35	.93	.96*	.60*	1.24***
Religious meaning	3-12	10.13	1.92	-.58**	-.29*	.95**
Congregational support	1-5	3.45	1.07	.46	.04	1.13***
Congregational criticism	1-5	2.42	1.35	-1.13***	-.51**	.82***
Forgiveness of others	2-8	6.40	1.53	1.24***	.43**	1.14***
Forgiveness of self	1-4	2.84	1.09	-1.49***	-.71***	.83***
Sociodemographic and Physical Health Controls						
Female	0-1	.60	.49	-7.34***	-3.28***	.86*
Married	0-1	.35	.48	1.69*	1.65***	1.29**
Age (years)	18-92	42.5	16.46	.60***	.18***	1.08***
Race/Ethnicity (ref=Non-Hispanic white)						
Non-Hispanic black	0-1	.40	.49	4.24***	1.62**	1.83***
Hispanic	0-1	.26	.44	-2.35*	-1.57**	.79*
Other	0-1	.03	.16	-4.66*	-.11	.71
Immigrant generation (ref=3rd generation or higher)						
1st generation immigrant	0-1	.25	.43	-1.58	-.92	.66***
2nd generation immigrant	0-1	.12	.33	-3.87**	-2.47***	.60***

	Range	Mean	Std. Dev	Systolic	Diastolic	Hypertensive
Education	0-20	12.71	3.51	-.75***	-.10	.92
Family Income (ref=$50K or more/yr)						
Less than $5K/yr	0-1	.25	.43	.02	-2.08**	1.08
Between $5K/yr and less than $50K/yr)	0-1	.56	.50	.50	-2.11***	1.25*
Body Mass Index (BMI)	11.29-64.83	28.60	6.77	.78***	.47***	1.08***
Current Smoker	0-1	.26	.44	.09	.78	.85
Blood Pressure Outcomes[b]						
Systolic Blood Pressure (SBP)	70.0-241.0	122.83	21.70	--	--	--
Diastolic Blood Pressure (DBP)	41.0-131.5	77.56	12.47	--	--	--
Hypertensive	0-1	.33	.47	--	--	--

[a] Bivariate associations are weighted and calculated using OLS regression (b) for SBP and DBP and logistic regression (OR) for hypertension.

[b] N=2860 for the SBP and DBP outcomes.

* $p \leq .05$;

** $p \leq .01$;

*** $p \leq .001$ (two-tailed tests)

Table 2

Weighted OLS Regression Estimates for Diastolic Blood Pressure (N=2860)[a,b]

	Model 1	Model 2	Model 3
Primary Religiosity Variables			
Attendance	-.12	-.03	-.17
Prayer	-.04	.07	.04
Public Participation	.54	-.18	.05
Spirituality	1.19***	.69*	.74*
Mediating Religiosity Variables			
Attendance Spiritual			-.08
Attendance Social			.13
Positive Coping			.10
Negative Coping			-.38
Saliency			-.16
Eternal Life			.33
Meaning			-.37**
Congregational Support			-.31
Congregational Criticism			-.31
Forgive Others			.22
Forgive Self			-.45*
R^2	.01	.14	.15

[a] All models control for congregational membership. Models 2 and 3 include the sociodemographic and physical health controls as well as an indicator of whether the respondent reported having taken antihypertensive medications in the last 12 months.

[b] Estimates are reported as unstandardized coefficients.

* $p \leq .05$;

** $p \leq .01$;

*** $p \leq .001$ (two-tailed tests)

Table 3

Weighted OLS Regression Estimates for Systolic Blood Pressure (N=2860)[a,b]

	Model 1	Model 2	Model 3
Primary Religiosity Variables			
Attendance	-.10	-.07	-.06
Prayer	.39	.35	.35
Public Participation	.49	-1.27	-1.33
Spirituality	1.12*	-.15	-.10
Mediating Religiosity Variables			
Attendance Spiritual			-.35
Attendance Social			.58*
Positive Coping			.20
Negative Coping			-.34
Saliency			-.14
Eternal Life			-.10
Meaning			-.32
Congregational Support			-.69
Congregational Criticism			.32
Forgive Others			.30
Forgive Self			-.36
R^2	.01	.33	.33

[a] All models control for congregational membership. Models 2 and 3 include the sociodemographic and physical health controls as well as an indicator of whether the respondent reported having taken antihypertensive medications in the last 12 months.

[b] Estimates are reported as unstandardized coefficients.

* $p \leq .05$;

** $p \leq .01$;

*** $p \leq .001$ (two-tailed tests)

Table 4

Weighted Logistic Regression Estimates for Hypertension (N=3105)[a,b]

	Model 1	Model 2	Model 3
Primary Religiosity Variables			
Attendance	1.01	1.02	.98
Prayer	1.11***	1.08*	1.05
Public Participation	1.13	.88	.91
Spirituality	1.06	.91	.89
Mediating Religiosity Variables			
Attendance Spiritual			1.02
Attendance Social			1.01
Positive Coping			1.04
Negative Coping			1.02
Saliency			1.01
Eternal Life			1.04
Meaning			.93*
Congregational Support			.97
Congregational Criticism			.90*
Forgive Others			1.05
Forgive Self			.93
R^2	.03	.42	.42

[a] All models control for congregational membership. Models 2 and 3 include the sociodemographic and physical health controls.

[b] Estimates are reported as odds ratios.

* $p \leq .05$;

** $p \leq .01$;

*** $p \leq .001$ (two-tailed tests)