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Research Article

## Baseline Religion Involvement Predicts Subsequent Salivary Cortisol Levels Among Male But not Female Black Youth

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### Abstract

**Background:** Compared to Whites, Blacks are exposed to higher levels of chronic stress in the United States. As a result, major Black-White differences exist in the baseline and response of cortisol. Yet, the potential association between baseline religiosity and subsequent cortisol levels of Blacks are not known.

**Objectives:** In the current study we aimed to determine the association between baseline religious behaviors and daytime salivary cortisol level among male and female Black youth.

**Materials and Methods:** With a longitudinal design, data came from wave 1 (1994) and wave 6 (2000) of a cohort from an urban area in the Midwest of the United States. The study followed 227 Black adolescents (109 males and 118 females) for six years. Socio-demographics and religious behaviors (frequency of participation in religious activities) were measured at baseline. Base morning cortisol level at wave 6 was the outcome. We fitted a linear regression model to test the association between baseline religiosity at wave 1 and cortisol level at wave 6, while baseline age, socio-economics, and psychological symptoms were controlled.

**Results:** In the pooled sample, frequency of participation in religious activities at baseline was negatively associated with mean cortisol level at follow up ( $r = -0.29, P > 0.01$ ) among all, males ( $r = -0.38, P > 0.01$ ), but not females ( $r = -.20, P > 0.05$ ). Frequency of participation in religious activities remained a significant predictor of subsequent cortisol level ( $b = -0.283, 95\% \text{ CI} = -.107 - -.022$ ) while the effect of age, socioeconomic, and psychological symptoms were controlled. We could only find such an association among male Black youth ( $b = -0.368, 95\% \text{ CI} = -.148 - -.024$ ) but not female Black youth ( $b = -0.229, 95\% \text{ CI} = -.113 - 0.011$ ).

**Conclusions:** Religiosity has been used as a coping mechanism among Blacks. Religiosity may also be related to stress regulation among Black youth. Future studies need to test complex associations between race, sex, religiosity, chronic stress, coping, and function of hypothalamo-pituitary-adrenal (HPA). It is not known whether male Black youth who are and those who are not religious differently cope with stress associated with daily discrimination and living in disadvantaged neighborhoods.

**Keywords:** African Americans, Ethnic Groups, Women, Men, Religion, Spirituality, Cortisol, Pituitary-Adrenal System, Hypothalamo-Hypophyseal System

## 1. Background

In the United States, Blacks are being exposed to higher levels of chronic and severe stress (1-4). Blacks are more likely than Whites to be exposed to stress early on in life during childhood, adolescence, and young adulthood (5). Due to differential profile of exposure to stressors, Blacks have more elevated stress profile in their teens and 20's than Whites (5).

High level of exposure to cumulative stress is associated with the disturbance of the hypothalamo-pituitary-adrenal (HPA) axis (1). Among Blacks, research has shown an association between cumulative stress and cortisol levels (1). Thus, exposure to high levels of chron-

ic stress may have lasting effects on physiological stress response among Blacks (6). Despite of this information, our knowledge is limited on factors that shape their profile of stress markers.

Major Black-White differences have been shown in the HPA axis function (7), which is related to differential exposure to stress (1, 6). Compared to Whites, Blacks have a weaker HPA axis response to the stress test (7) as average cortisol level of Whites is 27% higher than those of Blacks (7). Chong et al. (7) suggested that Black-White differences in cortisol and ACTH responses to the stress tests are above and beyond the effect of socioeconomic status and

sex. Despite taking into account social and psychological factors, 36% of difference in cortisol response between Blacks and Whites remain significant (7) suggesting that stressors may play a role.

Research has suggested that the protective effect of religious involvement may vary across populations (8-11), as Lincoln and colleagues showed that religiosity operates differently for Blacks and Whites (10). In comparison to Whites, Blacks are more likely to receive the health-related benefits of religion (12).

## 2. Objectives

Although research has suggested that religiosity may alter the function of HPA axis (through buffering the effect of stress), we do not fully know if high religiosity is associated with lower cortisol levels among Black youth or not. In this study we test the association between religiosity and daytime cortisol among Black youth, while demographics, socio-economics, and psychological factors were controlled. Our hypothesis is that high religious involvement at age 15 predicts lower morning cortisol level at age 21, net of the effects of socio-economics, anxiety, and depression.

## 3. Materials and Methods

### 3.1. Design

Our data came from the Flint adolescent study (FAS), a cohort study that started in 1994 and ended in 2012. The study protocol was approved by the University of Michigan institutional review board. All participants signed consent or assent forms before each interview.

### 3.2. Participants

Data for the current study came from wave 1(1994) and wave 6 (2000) of the study. Wave 1 included 850 Black, White, or bi-racial youth who were at high risk for substance use and school dropout (13, 14). Eligible students were ninth graders enrolled in one of four public high schools in Flint, Michigan, who had an 8<sup>th</sup> grade point average (GPA) of 3.0 or below upon entering high school. Participants were excluded if they were diagnosed by the school as having emotional or developmental impairments. Retention rates were 90% from waves 1 to 4 and 75% from waves 4 to 8. The current study is limited to Blacks who had follow up data from wave 1 (age 15) to wave 6 in their adulthood (age 21), and also had cortisol data at wave 6. We only limited our study to Blacks because they composed 80% of the sample. Participants were randomly selected from eligible students at four local public high schools.

The current analysis only included Black youth who provided saliva samples in wave 6. Youth who consented to saliva sampling were not different from the overall wave 6 sample for socio-economic factors.

### 3.3. Procedure

Data were collected during structured face-to-face interviews conducted either at school or at alternative community locations. This study followed students who remained in school, as well as those who dropped out of school. Each interview lasted about 1 hour on average.

#### 3.3.1. Covariates

Baseline age and family socio-economic status (number of parents who were employed, and living in an intact family) were used as control variables.

#### 3.3.2. Religion Involvement

The current study measured frequency of participation in religious activities by asking participants to list five religious activities and report frequency of their behavior. Item responses included hardly ever, occasionally, frequently, and most of the time. Scores ranged from 1 to 7 for not at all to more than once a week.

#### 3.3.3. Salivary Cortisol Measurement

Saliva samples were collected from a subset of samples (n = 201). This number was a proportion of all participants who were present in wave 6 (n = 573), provided consent to the procedure, and were eligible for saliva collection. Eligibility for saliva collection included not being pregnant, and not having eaten, drank or used tobacco in the hour prior to the collection. Participants provided saliva samples at the beginning of the interview. Samples were placed on ice prior to transportation and assay. We utilized salivary cortisol as it reflects the free portion of cortisol in plasma (15). We eliminated any samples that tested positive for hemoglobin. The saliva was collected at three points during one hour. All saliva collections were conducted after 11:00 a.m. to control for changes due to diurnal rhythm. Mean cortisol values were calculated (16).

Cortisol was specifically assessed by high sensitivity salivary cortisol enzyme immunoassay by Salimetrics, Inc (State College, PA). The saliva samples were thawed and centrifuged at 1,500 rpm for 15 minutes before assay. A standard enzyme immunoassay procedure was followed (17). The intra-and inter-assay coefficients of variations were 3.88 to 7.12% and 6.69 to 6.88%, respectively. The lower limit of sensitivity of this assay is .007 µg/DL (14).

#### 3.3.4. Symptoms of Anxiety

Symptoms of anxiety were measured by the Brief Symptom Inventory (18). Six items assessed the frequency of feeling uncomfortable due to symptoms of anxiety during the past week. Response options were on a Likert scale that ranged from 1 (not at all uncomfortable) to 5 (extremely uncomfortable). Items were averaged to form a scale. This scale has been shown to have high internal consistency and test-retest reliability (19, 20). (Cronbach's alpha = 0.78)

### 3.3.5. Symptoms of Depression

Depressive symptoms were measured by six items from the Brief Symptom Inventory (18). These items assess the frequency of feeling uncomfortable during the past seven days due to symptoms of depression such as feeling hopeless about the future, and having no interest in things. Response options on the Likert scale ranged from 1 (not at all uncomfortable) to 5 (extremely uncomfortable). These six items were averaged to form the final scale. This scale has high internal consistency and test-retest reliability and is valid to use with adolescents (19, 20). Cronbach's alpha was .79 for the current sample at wave 1.

### 3.3.6. Data Analysis

We used SPSS 20 (IBM Corp) for data analysis. Descriptive statistics of age, religiosity, and cortisol were provided using mean and standard deviations (SD). To study bivariate associations between frequency of participation in religious activities and covariates, and also cortisol level, we used Pearson's correlation test. In the first step, we fitted multiple linear regressions to test if frequency of participation in religious activities at baseline (wave 1) predicts cortisol level at follow up (wave 6), net of covariates including sex, age, number of employed parents, living in an intact family, and symptoms of anxiety and depression at baseline. Then we ran similar models specific to males and females. Standardized beta (correlation coefficient), standard errors, and 95% confidence interval (CI) were reported. P values less than 0.05 were considered significant.

## 4. Results

### 4.1. Descriptive Statistics

This study included 201 Black youth, from which, 109 were male and 118 were female. The age of the participants at baseline ranged from 14 to 17 years, with a mean of 14.5 and a standard deviation of 1 year. Mean age of the participants at follow up was 21, with a range from 20 to 23. Mean (SD) and range of symptoms of anxiety and depression, and religious involvement at baseline are presented in Table 1. In addition, cortisol level at the end of follow up is also presented.

### 4.2. Bivariate Associations

Table 2 indicates that baseline frequency of participation in religious activities (wave 1) was significantly and negatively correlated with cortisol level at wave 6. This association could be found only among men, but not women. Frequency of participation in religious activities was not associated with age, symptoms of anxiety, and symptoms of depression, however, it was associated with parent employment among all, and males.

### 4.3. Multivariable Analysis

Our regression model in the pooled sample suggested an association between baseline participation in religious activities (wave 1) and cortisol level at wave 6, net of all control variables. This association could be found for male, but not female Black youth (Table 3).

**Table 1.** Descriptive Statistics of Study Variables Among All, Male, and Female Black Youth

Variables	All		Males		Females	
	Min - Max	Mean $\pm$ SD	Min - Max	Mean $\pm$ SD	Min - Max	Mean $\pm$ SD
Age (1994)	13.87 - 16.82	14.85 $\pm$ 0.68	13.87 - 16.82	14.92 $\pm$ 0.71	13.9 - 16.81	14.79 $\pm$ 0.65
Anxiety symptoms (1994)	1.00 - 4.33	1.57 $\pm$ 0.59	1.00 - 2.83	1.44 $\pm$ 0.41	1.00 - 4.33	1.70 $\pm$ 0.69
Depressive symptoms (1994)	1.00 - 4.33	1.69 $\pm$ 0.74	1.00 - 3.67	1.52 $\pm$ 0.59	1.00 - 4.33	1.85 $\pm$ 0.82
Frequency of participation in religious activities (1994)	1.00 - 4.00	3.35 $\pm$ 0.86	1.00 - 4.00	3.34 $\pm$ 0.84	1.00 - 4.00	3.36 $\pm$ 0.89
Cortisol (2000)	0.00 - 1.15	0.24 $\pm$ 0.19	0.00 - 1.15	0.26 $\pm$ 0.18	0.03 - 1.03	0.23 $\pm$ 0.19

**Table 2.** Correlation Matrix Between Study Variables Among All, Male, and Female Black Youth

Variables	1	2	3	4	5	6	7
<b>All</b>							
1. Age (1994)	1	0.14	0.07	0.09	-0.09	-0.03	-0.01
2. Frequency of participation in religious activities (1994)		1	0.12	0.12	0.23 <sup>a</sup>	0.03	-0.29 <sup>b</sup>
3. Anxiety symptoms (1994)			1	0.73 <sup>b</sup>	-0.04	-0.02	-0.05
4. Depressive symptoms (1994)				1	-0.032	-0.06	-0.07
5. Parental employment (1994)					1	0.10	0.05
6. Intact family (1994)						1	0.08
7. Cortisol (2000)							1
<b>Men</b>							
1. Age (1994)	1	0.14	-0.02	-0.01	-0.09	-0.02	0.01
2. Frequency of participation in religious activities (1994)		1	0.03	0.00	0.32 <sup>a</sup>	-0.07	-0.38 <sup>b</sup>
3. Anxiety symptoms (1994)			1	0.69 <sup>b</sup>	-0.03	-0.05	-0.07
4. Depressive symptoms (1994)				1	-0.10	-0.05	0.00
5. Parental employment (1994)					1	0.13	0.06
6. Intact family (1994)						1	0.07
7. Cortisol (2000)							1
<b>Women</b>							
1. Age (1994)	1	0.14	0.17	0.22 <sup>a</sup>	-0.11	-0.08	-0.03
2. Frequency of participation in religious activities (1994)		1	0.19	0.22	0.14	0.16	-0.20
3. Anxiety symptoms (1994)			1	0.73 <sup>b</sup>	-0.03	0.07	-0.02
4. Depressive symptoms (1994)				1	0.04	0.01	-0.09
5. Parental employment (1994)					1	0.06	0.03
6. Intact family (1994)						1	0.07
7. Cortisol (2000)							1

<sup>a</sup>p < 0.05.

<sup>b</sup>p < 0.01.

**Table 3.** Summary of Regression Models Among All, Male, and Female Black Youth<sup>a</sup>

Variables	All		Males		Females	
	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI
<b>Age (1994)</b>	-0.010 (0.028)	-0.059 - 0.053	-0.043 (0.040)	-0.093 - 0.066	0.022 (0.041)	-0.076 - 0.089
<b>Parental employment (1994)</b>	0.001 (0.037)	-0.073 - 0.074	0.004 (0.052)	-0.103 - 0.106	0.023 (0.054)	-0.099 - 0.118
<b>Intact family (1994)</b>	0.048 (0.039)	-0.057 - 0.097	-0.072 (0.051)	-0.131 - 0.072	0.166 (0.061)	-0.049 - 0.198
<b>Frequency of participation in religious activities (1994)</b>	-0.283 (0.021) <sup>b</sup>	-0.107 - -0.022	-0.368 (0.031) <sup>b</sup>	-0.148 - -0.024	-0.229 (0.031)	-0.113 - 0.011
<b>Female (1994)</b>	-0.047 (0.036)	-0.090 - 0.053	-	-	-	-

<sup>a</sup>Abbreviations: B: standardized regression coefficient, CI: confidence interval, SE: standard error.

<sup>b</sup>p < 0.01.

## 5. Discussion

We found a longitudinal association between frequency of participation in religious activities and baseline morning cortisol levels. Based on our findings, frequency of participation in religious activities is negatively associated with cortisol among male but not female Black youth.

According to the authors' knowledge, our report is the first longitudinal evidence on the link between religiosity and cortisol level. Neuro-endocrinology and neuro-immune mechanisms for the effect of religiosity on health have been reviewed elsewhere (21). Religiosity and spirituality have been associated with reductions in mean urinary cortisol (22) and elevated levels of immune cell counts (23), however, in cross-sectional studies.

Lower cortisol level of individuals who are more religious may or may not be explained by the effect of religion on perceived stress. Although salivary cortisol is linked to perceived stress (24, 25), there are studies suggesting that role of religion on cortisol may not be due to perceived stress (26). For instance, a study measured religiosity and spirituality using the Duke University religion index (DUREL) and the index of core spiritual experiences (INSPIRIT), perceived stress using the perceived stress scale (PSS), and diurnal salivary cortisol profiles. The study revealed significant associations of non-organizational religiosity and intrinsic religiosity with the diurnal cortisol rhythm. Individuals reporting high religiosity had rhythmic cortisol profiles characterized by high morning and low evening levels, while cortisol rhythms of those reporting low religiosity was flattened. The association between intrinsic religiosity and cortisol rhythm persisted after controlling for social support and perceived stress (26).

There are several studies that have explored the link between meditation and cortisol level. Sudsuang and colleagues (27) documented change in stress hormone levels (specifically cortisol) following participation in meditation programs among college students. Their results showed that meditation may lower stress hormone (specifically cortisol) among young individuals. Another research team also compared the change in cortisol levels between a group of young adults practicing transcendental meditation for 3 - 4 months, a group of long-time (3 - 5 years) practitioners of transcendental meditation, and a control group. Although the level of cortisol did not show a significant decline among controls, meditation practices were followed by a decline in cortisol level (28).

In a cross-sectional study, Walton and colleges (29) showed lower levels of cortisol, aldosterone and norepinephrine among individuals who had practiced transcendental meditation for a long time, compared to controls. Koenig et al. documented a significant association between frequency of church attendance and lower levels of interleukin-6 (a marker of inflammation), even if they could not replicate the cross-section finding longitudinally (30). Another study found that the meditation practitioners had no diurnal rhythm for adrenocortico-

tropic hormone or for  $\beta$ -endorphin, as compared to the control group (31). However, most of these studies have mostly enrolled White samples, and have rarely tested sex differences.

Blacks and Whites may have different daytime cortisol levels. When socioeconomic differences are taken into consideration, for instance, Blacks have a slower rate of decline in cortisol throughout the day (32). In other words, Blacks have higher cortisol levels during the end of the day than Whites (32). This means a slower rate of decline of cortisol during the day among Blacks compared to Whites (33).

Our findings suggest that religious behaviors may be relevant to the HPA function among male Black youth. This may or may not be the case for Whites, as Blacks and Whites differently use religion to cope with stress (11). Distribution of religious involvement and behaviors vary across different ethnic groups. Different ethnic groups have different religious beliefs, traditions, and practices (8, 34). Religious attitudes, values, activities, programs, and organization differ across denominations and ethnicities, thus the health effects of religiosity are not the same across race and ethnic groups (8, 35, 36). The nature of religious activity and participation varies by ethnicity (37), and the structure and mission of most congregations are based on ethnicity (38). Blacks and Whites may also have different social network compositions (34, 39) and social transactions (40, 41) inside church.

Our study suggested that religiosity may be associated with modified cortisol levels among male but not female Black youth. Men are generally less religious than women (42). The effect of religiosity on health may also vary based on sex (43, 44). In line with our findings, results of a study suggested that men obtain more mental health benefits from religious involvement than women (44). There are, however, studies with contrasting results. For instance, in a study, frequent church attendance was associated with a reduced prevalence of depression in women but increased prevalence in men (43).

Future research is needed on Black-White differences in the effect of religiosity on stress response pattern. Compared to Whites, Blacks may have a flatter decline in cortisol over the day (45). That is, compared to Whites, Blacks' rates of cortisol decrease throughout the day are slower (45). The slower rate of decline in cortisol throughout the day is an abnormality frequently reported among Blacks when compared to the lower frequency reported among Whites (32). Possibly due to chronic exposure, cortisol levels during the day are also different between Blacks and Whites (7). It has been shown that compared to Whites, Blacks have lower levels of cortisol immediately after waking up (45). Also going along with this finding, when comparing highly educated Whites to Blacks and lower educated Whites, cortisol levels upon waking are higher for highly educated Whites (46).



Cortisol and the HPA axis may be involved in the protective effects of religiosity against risk of hypertension, heart disease, and several other undesired outcomes. As high day time cortisol and also flat cortisol diurnal changes increase health risks (32), current findings on the lower cortisol level of individuals who were more religious may have implications for health disparities. Research has consistently linked religiosity to lower risk of hypertension (47), heart disease (48), and stroke (49). Religious practices are known to be linked to lower blood pressure, better lipid profiles, better immune function, and lower all-cause mortality (50). Our findings may help better understand the protective role of religion against cardiovascular disease (51) and other cardiovascular outcomes (52). Religious involvement may be associated with health benefits, possibly through effect of religious involvement on lowering baseline level of cortisol among more spiritual and religious individuals. Although religious involvement may also cause stress due to religious struggle (53, 54), it is more likely to be associated with comfort and peace (55). The current study increases our understanding about the complex associations between sex (56), behavioral and mental health factors (57) and altered cortisol level (58) which is an important risk factor for development of obesity and metabolic disorders (59-61).

Future research should also focus on individuals who benefit most from religious involvement.

The current study has a few limitations. Attrition of the participants from wave 1 to wave 6 was high, and the exact numbers of participants excluded from cortisol measurement for each reason is not known. The study did not use a validated measure of religion involvement. Participants were not selected at random, so the results are not generalizable to the Black youth in the U.S. Finally, we only measured morning cortisol in the morning, and measurement of cortisol in three consecutive days could enhance accuracy of our measurement. Finally, we only measured symptoms of anxiety and depression, but not clinical diagnosis of anxiety and depression based on DSM (62).

Our study suggests a mechanistic explanation for the protective effect of religious involvement on physical and mental health of male Black youth. Previously, behavioral (63) and social mechanisms (64) have been proposed to explain the effect of religion involvement on the physical and mental health of individuals. Further research should test whether altered HPA function explains at least some of the protective effect of religious involvement on health.

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## Footnotes

**Authors' Contributions:**The original idea of this analysis was developed by Shervin Assari. Shervin Assari also analyzed the data and drafted the manuscript. Maryam Moghani Lankarani contributed to drafting and revision of the manuscript. Cleopatra Howard Caldwell and Marc Zimmerman designed the main cohort, acquired the data, and contributed to all drafts of this manuscript. All authors confirmed the final version of the manuscript.

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