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Race Differences in Hemodynamics and Cardiovascular Reactivity to Mental Stress

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ABSTRACT COVER PAGE

Race Differences in Hemodynamics and Cardiovascular Reactivity to Mental Stress

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An abstract of
A thesis submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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in Clinical Research
2016

ABSTRACT

Race Differences in Hemodynamics and Cardiovascular Reactivity to Mental Stress

By Kobina A. Wilmot

Introduction: Increased hemodynamic responses to psychological stress have been associated with risk of hypertension and other adverse cardiovascular outcomes. African Americans (AA) have more hypertension and worse cardiovascular outcomes than other ethnic groups. Heightened hemodynamic responses to stress may play a role. Our hypothesis was that AA would have significantly increased hemodynamic reactivity to a standardized mental stress as compared to Non-African Americans (NAA).

Methods: We evaluated 693 patients (209 AA) with confirmed coronary heart disease (CHD), who underwent a standardized mental stress challenge. Heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were obtained during a resting period, a speaking task, and a recovery period. The rate-pressure product (RPP) was calculated as SBP x HR. Hemodynamic reactivity with mental stress was evaluated as the difference in RPP at rest and during mental stress. Depressive symptoms were measured with the Beck Depression Inventory-II (BDI-II).

Results: As compared to NAA, AA patients were younger, had lower education and income, and higher prevalence of diabetes, obesity, hypertension, current smoking, and more depressive symptoms. AA patients had higher SBP and DBP during all three periods than NAA. However, hemodynamic reactivity with stress was significantly lower in AA than NAA (RPP reactivity 3108 vs 3591, p= 0.02), however after controlling for cardiovascular risk factors the association was attenuated and no longer significant (RPP reactivity 3423.69 vs 3541.78, p=0.6). There was a significant negative association between norepinephrine reactivity AA race after controlling for baseline norepinephrine, demographic factors, and cardiovascular history factors. The association was attenuated and lost statistical significance after addition of psychosocial factors.

Conclusions: AA patients with CHD, compared with NAA, have persistently elevated blood pressure throughout mental stress but tend to have lower hemodynamic and neuroendocrine reactivity to stress. Cardiovascular disease history factors explain much of the difference of the in stress responses. Whether blunted cardiovascular reactivity to stress is related to worse outcomes in AA needs further study.

DISSERTATION COVER PAGE

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INTRODUCTION

Despite significant inroads in reductions in coronary heart disease (CHD) mortality over past 3-4 decades, disparities in CHD death rates persist between races. African American (AA) populations experience much higher CHD mortality as compared to other racial groups. Understanding pathways for these disparities is important. Cardiovascular responses to mental stress may be one possible pathway to explain increased CHD risk among AA. Previous literature has shown that exaggerated hemodynamic responses to psychological stress are associated with increased risk of hypertension and other adverse cardiovascular outcomes. However, there is emerging evidence that blunted cardiovascular reactivity to stress is also related to adverse health outcomes, possibly as a marker of reduced physiological capacity due to autonomic dysfunction from prolonged stress exposure. AA have higher levels of chronic stress from socioeconomic deprivation and discrimination and have more hypertension and worse cardiovascular outcomes than Non-African Americans (NAA). Abnormal (heightened or blunted) hemodynamic responses to stress could contribute to cardiovascular disease risk among AA. However, this has not been previously investigated. The overall objective of the proposed project was to examine hemodynamic reactivity differences between AA and NAA. Other objectives were to examine psychosocial and physiological correlates of hemodynamic responses to mental stress as possible explanations for racial differences in responses to stress.

BACKGROUND

There is growing recognition of the importance of psychological stress and emotional factors as common and potentially modifiable risk factors for coronary heart disease (CHD) incidence and mortality. Psychological stress appears to contribute to CHD at several stages of the disease process, from triggering acute coronary events to influencing CHD risk factors, to affecting the development of atherosclerosis, to impairing recovery, prognosis and quality of life of patients who have survived an acute coronary syndrome (1). The biological response to stress

involves the coordinated activity of the hypothalamic-pituitary- adrenal (HPA) axis, the sympathetic nervous system, and the immune system. Acute activation of these systems results in an increase in blood pressure and heart rate and metabolic changes aimed at mobilizing energy and preparing the individual for adequate coping with stressors. Chronic stress exposure, however, may result in maladaptive perturbations with adverse effects on hemodynamics, metabolism, inflammation and immune function (2).

The relationship between cardiovascular outcomes and cardiovascular reactivity to acute mental stress has been well studied in the psychosomatic and cardiovascular literature. Exaggerated cardiovascular reactivity to psychological stress is associated with poor future cardiovascular risk status and health outcomes, including increased risk of hypertension along with increased atherosclerosis (increased coronary calcification and carotid intima media thickness), and left ventricular mass (3). However, there is emerging evidence that blunted cardiovascular reactivity to stress is also maladaptive. Blunted cardiovascular reactivity has been implicated in tobacco, alcohol and substance dependence, obesity, depression and poor self-reported health, all predictors of poor cardiovascular health (4). Blunted cardiovascular reactivity may be a marker of reduced physiological capacity to respond to stress due to systems "exhaustion" or adaptation in face of severe, protracted, or chronic stress exposure.

African Americans (AA) have higher rates of hypertension and cardiovascular mortality than other ethnic groups. Despite declining cardiovascular death rates over the past several decades, significant disparities in CHD mortality rates exist and have actually widened (5). This disparity is largest among younger individuals less than 65 years of age, with AA having among the highest proportions of premature coronary heart disease death (6). AA are thought to have higher levels of chronic stress exposure due to socioeconomic deprivation (neighborhood instability and economic insecurity) and perceived discrimination, raising the question of whether AA's hemodynamic responses to daily stress may be contributory to their higher CHD mortality

risk (7). Abnormal (heightened or blunted) cardiovascular responses to stress could contribute to cardiovascular disease risk among AA. However, this question has not been previously investigated. Our hypothesis was that AA with stable CHD have significantly increased hemodynamic (blood pressure and heart rate) and neuroendocrine (catecholamine levels) responses to a standardized mental stress test as compared to NAA, and that social and psychosocial stressors in daily life play a role in these differing hemodynamic responses.

METHODS

Between July 2009 and July 2014, the Mental Stress Ischemia Mechanisms and Prognosis Study (MIPS) enrolled 695 patients with a diagnosis of stable CHD from Emory University-affiliated hospitals and clinics, Grady Memorial Hospital [GMH]), and the Atlanta Veterans Administration Medical Center. As previously described (8), presence of CHD was determined by 1) abnormal coronary angiography demonstrating atherosclerosis with at least luminal irregularities, 2) previous percutaneous or surgical coronary revascularization, 3) ascertained myocardial infarction, or 4) positive nuclear scan or exercise stress test. Patients were excluded if they were pregnant, had end stage renal disease, unstable psychiatric conditions or other severe medical problems, or if they were hospitalized in the previous week for unstable angina, decompensated heart failure, or myocardial infarction.

Mental Stress Protocol

All patients were tested in the morning after an overnight fast. Antianginal medications (beta-blockers, calcium-channel blockers, and long-acting nitrates) were withheld for 24 to 48 hours before stress testing, depending on the half-life of these medications. Patients underwent mental and physical stress testing on two separate days up to one week apart. Baseline vital signs were measured in a quiet, dimly lit, temperature-controlled room during a 30-minute period of rest. The mental stress test consisted of a standardized public-speaking task using an established protocol (9). Briefly, participants were asked to imagine a difficult interpersonal scenario:

complaining to the staff of a nursing home about a close relative who had been mistreated. They were given 2 minutes to prepare their speech, and 3 minutes to deliver it in front of a small audience wearing white coats. They were told that their speech would be videotaped and evaluated later for content, quality, and duration. Subjective stress levels were evaluated by means of a visual analog scale (ranging from 0%, signifying no stress, to 100%, signifying extreme stress) before and after the speech task. Participants were monitored for 10 minutes after the completion of the mental stress task.

Measurements

Hemodynamic and neuroendocrine measures. Systolic (SBP) and diastolic (DBP) blood pressure and heart rate (HR) were recorded at 5-minute intervals during the resting and recovery phase, and at 1-minute intervals during the mental stress task by the use of an automatic oscillometric device. Blood samples from an indwelling catheter were obtained for the measurement of norephinephrine and epinephrine before (0 minutes), and during mental stress testing (1 minute). Catecholamine levels were analyzed using a high sensitive 2-CAT plasma immunoassay kit according the instructions provided by the manufacturer (Labor Diagnostika Nord GmbH, from Rocky Mountain Diagnostics, Inc., Colorado). Samples were run in duplicate, and both epinephrine and norepinephrine assays were run from the same sample aliquot simultaneously. Standards and controls were used to monitor intra assay and inter-plate variability. 80% of patients had complete catecholamine values before and after stress.

Psychosocial and behavioral factors and other variables. A battery of psychosocial assessments was administered, including the Beck Depression Inventory(BDI)-II (10), a standardized scale providing a continuous measure of depressive symptoms; the Post-traumatic Stress Disorder (PTSD) Checklist (PCL), a standardized self-report rating scale for PTSD comprising 17 items that correspond to the key symptoms of PTSD (11); the Cook Medley Hostility Scale (CMHS) (12), which assesses propensity to experience hostility and/or anger; and

the Multidimensional Scale of Perceived Social Support (MSPSS), a 12-item scale that assesses support from 3 sources: spouse, family, and friends (13), Furthermore, we administered the Duke Activity Status Index (DASI) (14), a 12-item questionnaire designed to measure functional capacity in cardiac patients. Height and weight were measured and BMI was calculated. Sociodemographic characteristics, cardiovascular risk factors, medical history and current medications were assessed by using standardized questionnaires and chart reviews. The research protocol was approved by the institutional review board of Emory University, and all participants provided informed consent.

Statistical Analysis

First, we averaged SBP, DBP and HR measurements across each of the four protocol periods (rest, preparation, speaking task, and recovery). The rate-pressure product (RPP) was calculated according to the formula: RPP = SBP x HR, and averaged across the same periods. Hemodynamic reactivity was defined as the difference in average SBP, DBP, HR, and RPP during the speaking task, and their corresponding average values during rest. Similarly, neuroendocrine reactivity was defined as the difference between the mean epinephrine and norepinephrine levels during the speaking task and their corresponding average values during rest. Hemodynamic and neuroendocrine reactivity were compared between AA and NAA patients using t tests and regression models. Multivariable linear regression analyses adjusted for demographic factors (age, sex), cardiovascular history factors (abnormal angiogram, percutaneous transluminal coronary angioplasty, coronary artery bypass surgery, myocardial infarction, abnormal nuclear stress test), cardiovascular disease risk factors (diabetes, heart failure, current smoking, beta-blocker use, ace inhibitor use, cerebral vascular disease, DASI, and BMI), psychosocial factors (BDI score, antidepressant use, PTSD Checklist score, MSPSS score, CMHS score), and socioeconomic factors (high school education or lower and income below

20K). Variable selection was completed using simple correlation and single variable classifier methods.

RESULTS

Patient Characteristics

Compared with NAA, AA patients were younger, more often female, and with lower levels of education and income (Table 1). They also had lower levels of physical functional capacity and more comorbidities and CHD risk factors including diabetes mellitus, heart failure, cerebral vascular disease, peripheral vascular disease, current smoking, and a higher BMI. Similar proportions of AA and NAA had a previously abnormal nuclear test or angiogram, and history of myocardial infarction, percutaneous intervention, and coronary artery bypass graft (Table 1).

Compared with NAA, AA patients showed a more adverse psychosocial risk profile. They exhibited a higher level of current depressive symptoms evidenced in a higher BDI score; however, were less likely to be taking an anti-depressant medication. Additionally, AA scored higher for PTSD symptoms and hostility, and lower for social support (Table 2).

Hemodynamic and neuroendocrine responses to acute mental stress

Compared with NAA, AA patients had significantly higher SBP and DBP during all four stress protocol periods, and higher RPP during baseline and recovery periods (Table 3 and Figure 1). There were no significant differences in cardiovascular reactivity, although AA tended to have lower SBP and HR reactivity (Table 3). AA had higher pre-stress norepinephrine levels, but lower post-stress epinephrine levels (Table 4).

In bivariate analysis, RPP reactivity correlated positively with norepinephrine and epinephrine change, and negatively with psychosocial factors: increasing depressive symptoms, PTSD symptoms, and hostility correlated with lower RPP reactivity, as did lower social support,

lower income and education. In general, catecholamine levels showed similar associations (Table 5).

In a series of multivariable linear regression models, RPP reactivity was significantly lower in AA compared with NAA after adjusting for baseline RPP, demographic factors (age, sex), and cardiovascular history factors (abnormal angiogram, percutaneous transluminal coronary angioplasty, coronary artery bypass surgery, myocardial infarction, abnormal nuclear stress test) (Table 6). However, the association was attenuated and no longer significant once the model was adjusted for cardiovascular disease risk factors (diabetes, heart failure, current smoking, beta-blocker use, ace inhibitor use, cerebral vascular disease, DASI, and BMI) (Table 6). In the final model, baseline RPP, BMI, anti-depressant use, and CMHS score were significantly associated with a lower RPP response to mental stress. There were no significant interactions between AA race and socioeconomic and psychosocial factors.

Following a similar multivariable linear regression modeling strategy there was a significant, negative association between norepinephrine reactivity and AA race after controlling for baseline norepinephrine, demographic factors, and cardiovascular history factors. However, the association lost statistical significance after addition of psychosocial factors (BDI score, Antidepressant use, PTSD Checklist score, MSPSS score, CMHS score) and was significantly attenuated after controlling for socioeconomic factors (High School Education or lower, income below 20K) (Table 7). There was no significant association between epinephrine reactivity and AA race both in unadjusted and adjusted analysis (Table 8).

DISCUSSION

Contrary to our hypothesis, we found that AA with stable CHD tend to have lower, rather than higher, hemodynamic and neuroendocrine reactivity to a standardized mental stress test compared with NAA. AA patients in our study showed a higher burden of medical comorbidities

and psychosocial factors than NAA, and higher levels of SBP and DBP before, during and after mental stress. In multivariable analysis, adjustment for medical factors and comorbidities attenuated the association. Norepinephrine reactivity in general showed similar trends, but there was no association between race and epinephrine changes pre-post stress.

Although several decades of research have focused on exaggerated responses to stress as deleterious for health outcomes such as cardiovascular disease (3), in the past decade it has become clearer that blunted reactivity is also a poor prognostic sign and is related to psychosocial symptomatology (4, 15, 16). What is not clear is whether blunted hemodynamic reactivity represents an alternative pathophysiological pathway for adverse health or is in itself the result of poor health, perhaps due to prolonged physiologic systems exhaustion through chronic or repeated stress (4).

The vast majority of studies of racial differences in cardiovascular responses to stress have involved younger patients in an attempt to predict the risk of hypertension, cardiovascular disease, or cardiovascular end-organ damage (17-19). While there is limited prior data on race differences in hemodynamic and neuroendocrine responses to a standardized mental stress task, a large body of literature has investigated race differences in cardiovascular reactivity towards stressful stimuli such as discrimination, racism, and hostility. Racism has been of interest given evidence suggesting that individuals who perceive more discrimination have increased risk of hypertension (20), with night time ambulatory blood pressures being most strongly associated with discrimination (21). Although there is some conflicting evidence (22), most studies employing acute stressful responses to racist events have demonstrated increases in blood pressure reactivity to these stimuli (23). Hostility is a personality trait often related to responses to racial stress, which has been associated with incidence of CHD events in healthy populations and worse outcomes and poor prognosis in CHD populations (24). Higher hostility has been noted in African American populations (25) which is consistent with our study. Interestingly, although

most previous studies described a higher cardiovascular reactivity in individuals with higher hostility scores (24, 26), we found that higher hostility, as measured with the CMHS scale, was associated with lower hemodynamic and neuroendocrine reactivity to stress. Our study is consistent with a growing body of evidence linking psychosocial factors, obesity, and poor health with lower stress reactivity (27).

Additionally, norepinephrine reactivity to mental stress, demonstrated negative associations with AA race, which maintained significance until controlling for psychosocial factors. This suppressed or reduced response of catecholamines supports blunted reactivity, which has been previously described mainly in psychosocial disorders or obesity. Koo-Leob et. al reported that women with bulimia nervosa as compared to controls who completed acute mental stressors had blunted systolic blood pressures, HR, and epinephrine responses (28), which was replicated in women with eating disorder tendencies (29). De Rooji et. al in the Dutch Famine Birth Cohort Study also demonstrated that individuals with obesity, depression, anxiety, and poor self-reported health possessed diminished cortisol stress reactivity (30). Relating race to neuroendocrine responses, there is some data suggesting self-perceived discrimination is associated with alterations of cortisol secretion leading to flatter diurnal slopes (31).

There are several strengths of our study. Firstly, this is one of the largest studies addressing race differences in cardiovascular reactivity in a population with known CHD, with excellent representation of AA, who were over a quarter of the cohort. Also, the study population was well characterized in terms of demographic, socioeconomic, medical and psychosocial factors. Possible limitations include a heterogeneous sample in terms of CHD severity, although in our regression models we controlled for cardiovascular history. Furthermore, the mental stress test scenario may not have been sensitive to cause stress among African American participants. It is possible that a situation involving perceived racism may have produced a larger response to stress. Finally, outcome events were not available for analysis, thus we were not able to

determine whether the race differences we found in hemodynamic responses have prognostic significance.

CONCLUSIONS

Our study sought to evaluate if a difference in cardiovascular reactivity existed based on race in patients with known CHD. Although AA had elevated systolic and diastolic blood pressure before, during and after the mental stress test, contrary to our hypothesis they tended to have lower hemodynamic and neuroendocrine reactivity to stress. Medical history especially BMI explained much of racial difference in hemodynamic response. Psychosocial factors such as hostility and antidepressant use, in addition to baseline cardiovascular reactivity, were important predictors of RPP reactivity in our final model. Future studies should assess standardized mental stressors in AA that may tap into more culturally appropriate triggers of stress such as discrimination and deprivation. Further evaluation of the impact of blunted stress reactivity in CHD populations on adverse cardiac outcomes is needed.

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Table 1: Baseline demographic, medical and cardiovascular history data in African Americans (AA) and Non-African Americans (NAA)

	AA (n=209) Mean or % (SE)	NAA (n=484) Mean or % (SE)	P-value
Demographic and lifestyle factors			
Age, years	59.6 (0.4)	64.4 (0.4)	<.0001
Age <60, years	50.2	28.9	<.0001
Male sex	60.3	77.9	<.0001
Married	45.0	71.3	<.0001
Education , total years	13.9 (0.2)	15.4 (0.2)	<.0001
High school education or less	40.8	21.5	<.0001
Income below $20,000	30.6	9.8	<.0001
Medical and cardiovascular history			
Hypertension	74.6	67.6	0.0627
Dyslipidemia	81.3	81.6	0.9325
Diabetes	38.3	29.8	0.0276
Heart failure	22.9	11.3	0.0002
Heart Failure, <40 EF	13.4	8.3	0.0371
Statin use, %	84.1	85.9	0.5257
Beta blocker use	83.1	71.2	0.001
ACE inhibitor use	48.8	44.3	0.2783
Current smoking	18.2	9.4	0.0011
Peripheral vascular disease	12.3	5.6	0.0041
Family History of CHD	31.3	25.9	0.1745
Body Mass Index, kg/m^2	30.7 (0.4)	29.2 (0.2)	0.001
Cerebrovascular Disease	16.2	8.5	0.0043
DASI score	36.2 (1.1)	42.7 (0.6)	<.0001
Abnormal Nuclear test	13.4	12.3	0.69
Abnormal Angiogram	60.9	66.3	0.20
Percutaneous intervention	52.4	53.5	0.78
CABG	29.3	35.6	0.11
Myocardial Infarction	36.3	30.4	0.15

EF= Ejection Fraction; CABG= Coronary Artery Bypass Graft; DASI = Duke Activity Status Index

Table 2: Baseline psychosocial characteristics in African Americans (AA) and Non-African Americans (NAA)

Baseline characteristics	AA (n=175)	NAA (n=449)	P-value
	Mean or % (SE)	Mean or % (SE)	
BDI Score	10.2 (0.7)	7.7 (0.4)	0.0012
Anti-depressant use	15.9	27.5	0.0011
PCL score	29.0 (0.8)	25.9 (0.5)	0.002
MSPSS Score (social support)	64.7 (1.2)	68.2 (0.6)	0.0093
CMHS Score (hostility)	18.1 (0.6)	15.1 (0.3)	<.0001

BDI = Beck Depression Inventory; PCL = Post Traumatic Stress Disorder Checklist; MSPSS = Multidimensional Scale of Perceived Social Support; CMHS = Cook Medley Hostility Scale MS

Table 3: Baseline differences in hemodynamics before, during, and after stress in African Americans (AA) and Non-African Americans (NAA)

Variables	African Americans (n=209)			Non-African American (n=484)			P-value (AA vs. NAA)
	Mean	% change	SE	Mean	% change	SE	
Baseline							
SBP	140		1.5	132		0.8	<0.001
DBP	82		0.8	76		0.5	<0.001
HR	63		0.8	63		0.5	0.77
RPP	8794		149.2	8378		85.7	0.02
Mental stress, prep							
SBP	157	+11	1.59	152	+15	0.95	0.02
DBP	90	+11	0.9	85	+10	0.51	<0.001
HR	71	+11	0.9	73	+14	0.69	0.23
RPP	11136	+24	177.5	11092	+31	140.0	0.86
Mental stress, speech							
SBP	164	+5	1.7	159	+5	1.0	0.01
SBP_max	173		1.8	167		1.1	0.01
DBP	95	+4	1.0	90	+17	0.6	<0.001
DBP_max	102		1.0	96		0.6	<0.001
HR	73	+3	0.8	75	+4	0.7	0.12
HR_max	76		0.9	78		0.7	0.07
RPP	12099	+8	194.9	12048	+9	149.3	0.84
RPP_max	12936		207.6	12949		162.6	0.97
Recovery							
SBP	145	-12	1.7	137	-14	0.8	<0.001
DBP	84	-12	0.9	78	-13	0.5	<0.001
HR	65	-11	0.9	64	-15	0.5	0.73
RPP	9389	-23	161.7	8837	-27	90.3	0.003
Cardiovascular Reactivity							
SBP Reactivity	25		1.29	27		0.7	0.18
DBP Reactivity	13		0.6	14		0.5	0.74
HR Reactivity	9		0.6	12		0.5	0.06
RPP Reactivity	3028		157.0	3665		110.5	0.08

SBP= systolic blood pressure, DBP = diastolic blood pressure, HR=heart rate, RPP= rate pressure product, _max = maximum value for variable(s), _min = minimum value for variable(s), % = percent

Table 4: Differences in Neuroendocrine Reactivity to Stress between African Americans (AA) and Non-African Americans (NAA)			
Variables	African Americans	Non-African Americans	P-value (AA vs. NAA)
	Mean (SE)	Mean (SE)	
Catecholamine Reactivity*			
Epinephrine, pre-stress (pg/ml)	29.2 (4.9)	49.3 (6.3)	0.08
Epinephrine, post-stress (pg/ml)	46.0 (6.1)	70.9 (6.3)	0.03
Epinephrine reactivity (change)**	17.1 (3.4)	22.6 (3.3)	0.38
Norepinephrine, pre-stress (pg/ml)	616.9 (34.4)	527.7 (19.8)	0.03
Norepinephrine, post-stress (pg/ml)	550.2 (34.2)	552.0 (41.3)	0.98
Norepinephrine reactivity (change)**	-70.4 (23.2)	31.9 (31.0)	0.07

*Catecholamine sample size: N=488, **Change = post-stress value – pre-stress value

Table 5: Spearman correlations of RPP reactivity, norepinephrine change, and epinephrine change with socioeconomic and psychosocial factors.

	Correlation coff.	P-value
Rate Pressure Product Reactivity		
Norepinephrine change	0.19	<0.0001
Epinephrine change	0.36	<0.0001
Income < $20K	-0.16	<0.0001
High School education and lower	-0.13	0.0002
BDI score	-0.15	<0.0001
PTSD score	-0.14	0.0004
MSPSS score	0.14	0.0002
CMHS score	-0.23	<0.0001
Norepinephrine change		
Epinephrine change	0.36	<0.0001
Income <20K	-0.07	0.10
High School education and lower	-0.07	0.13
BDI score	-0.09	0.05
PTSD score	-0.07	0.14
MSPSS score	0.03	0.54
CMHS score	-0.08	0.06
Epinephrine change		
Income <20K	-0.18	<0.0001
High School education and lower	-0.09	0.05
BDI score	-0.14	0.0017
PTSD score	-0.14	0.0012
MSPSS score	0.04	0.34
CMHS score	-0.16	0.0003

BDI= Beck Depression Inventory, PTSD= Post-Traumatic Stress Disorder, MSPSS = Multidimensional Scale of Perceived Social Support, CMHS = Cook Medley Hostility Scale

Table 6: Multiple linear regression models with RPP reactivity as dependent variable and race (AA vs. NAA) as main predictor			
	Absolute Difference, NAA vs. AA (mmHg * beats/min) (Standard error)	**95% CI**	**p-value**
Model 1: Adjusting for baseline RPP and demographic[1] factors.	361 (207)	-45 – 768	0.08
Model 2: Adjusting for baseline RPP, demographic[1], and cardiovascular history[2] factors	482 (214)	62 – 902	0.02
Model 3: Previous factors, medical history, and cardiovascular disease risk[3] factors	118 (222)	-317.18 - 554	0.60
Model 4: Previous factors and psychosocial[4] factors	140 (223)	-299 - 578	0.53
Model 5: Previous factors and SES[5] factors	78 (226)	-366 - 522	0.73

[1]Age, Sex
[2]Abnormal Angiogram, Percutaneous transluminal coronary angioplasty, Coronary artery bypass surgery, Myocardial Infarction, Abnormal Nuclear Stress Test
[3]Diabetes, Heart failure, current smoking, Beta-Blocker use, ACE Inhibitor use, Cerebral Vascular disease, DASI, BMI
[4]BDI score, Antidepressant use, PTSD Checklist score, MSPSS score, CMHS score
[5]High School Education or lower, income below 20K

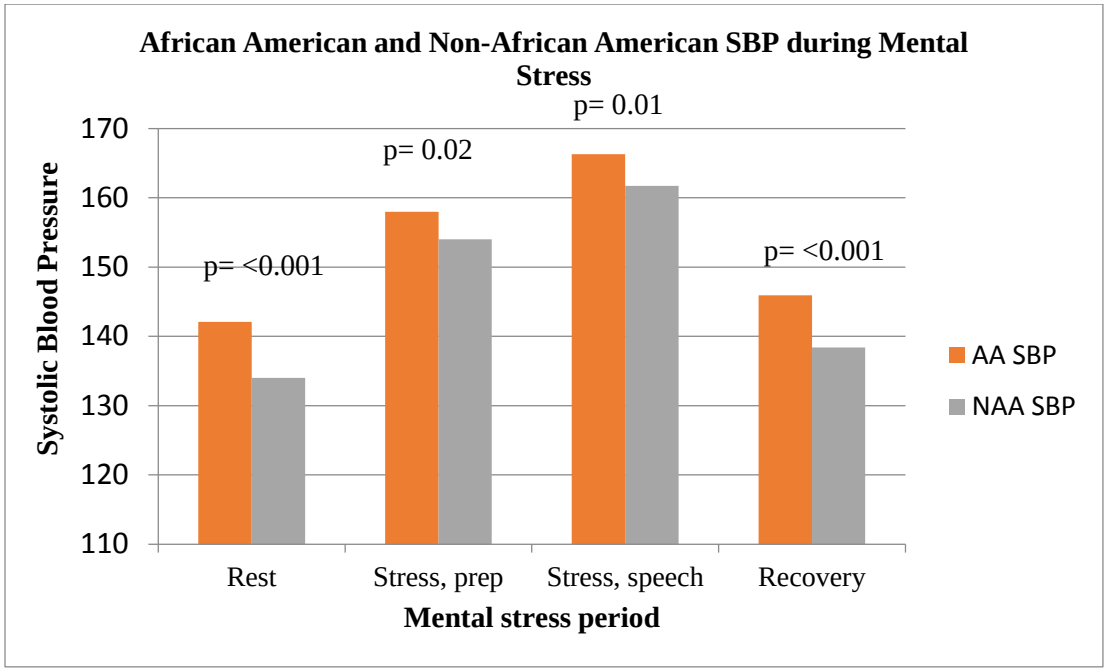
Table 7: Multiple linear regression models with change in Norepinephrine as dependent variable and race (AA vs. NAA) as main predictor			
	Absolute Difference, NAA vs. AA (pg/ml) (Standard error)	**95% CI**	**p-value**
Model 1: Adjusting for baseline RPP and demographic[1] factors.	-82 (48)	-177 - 13	0.03
Model 2: Adjusting for baseline RPP, demographic[1], and cardiovascular history[2] factors	-106 (49)	-203 - 9	0.02
Model 3: Previous factors, medical history, and cardiovascular disease risk[3] factors	-102 (53)	-205 - 2	0.05
Model 4: Previous factors and psychosocial[4] factors	-102 (55)	-209 - 5	0.06
Model 5: Previous factors and SES[5] factors	-89 (55)	-196 - 18	0.1

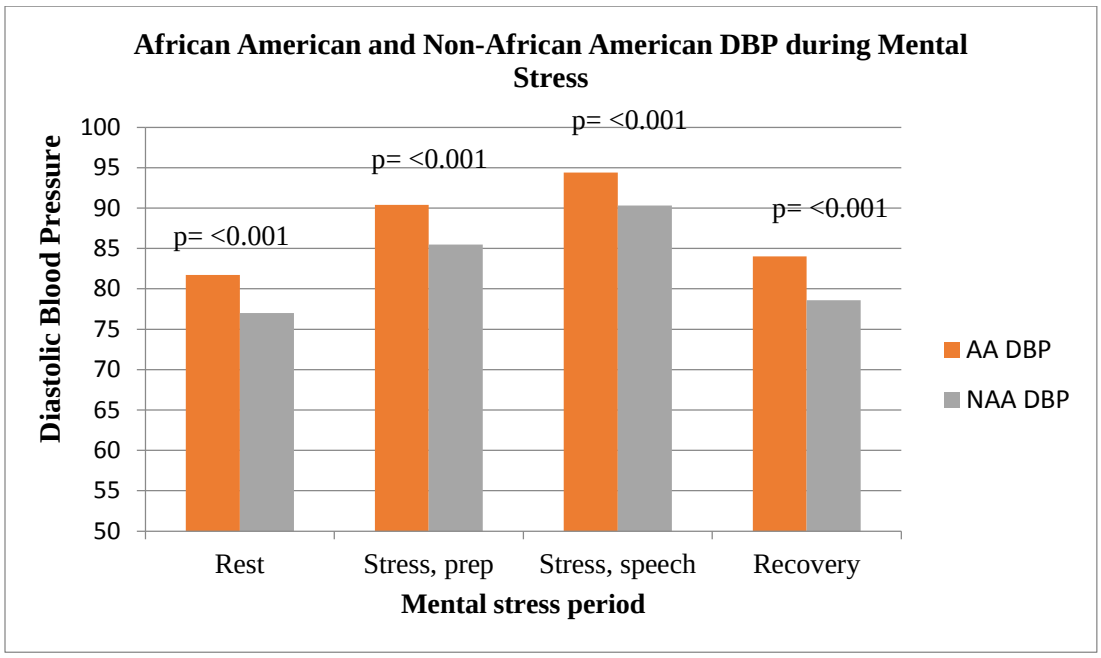
[1]Age, Sex
[2]Abnormal Angiogram, Percutaneous transluminal coronary angioplasty, Coronary artery bypass surgery, Myocardial Infarction, Abnormal Nuclear Stress Test
[3]Diabetes, Heart failure, current smoking, Beta-Blocker use, ACE Inhibitor use, Cerebral Vascular disease, DASI, BMI
[4]BDI score, Antidepressant use, PTSD Checklist score, MSPSS score, CMHS score
[5]High School Education or lower, income below 20K

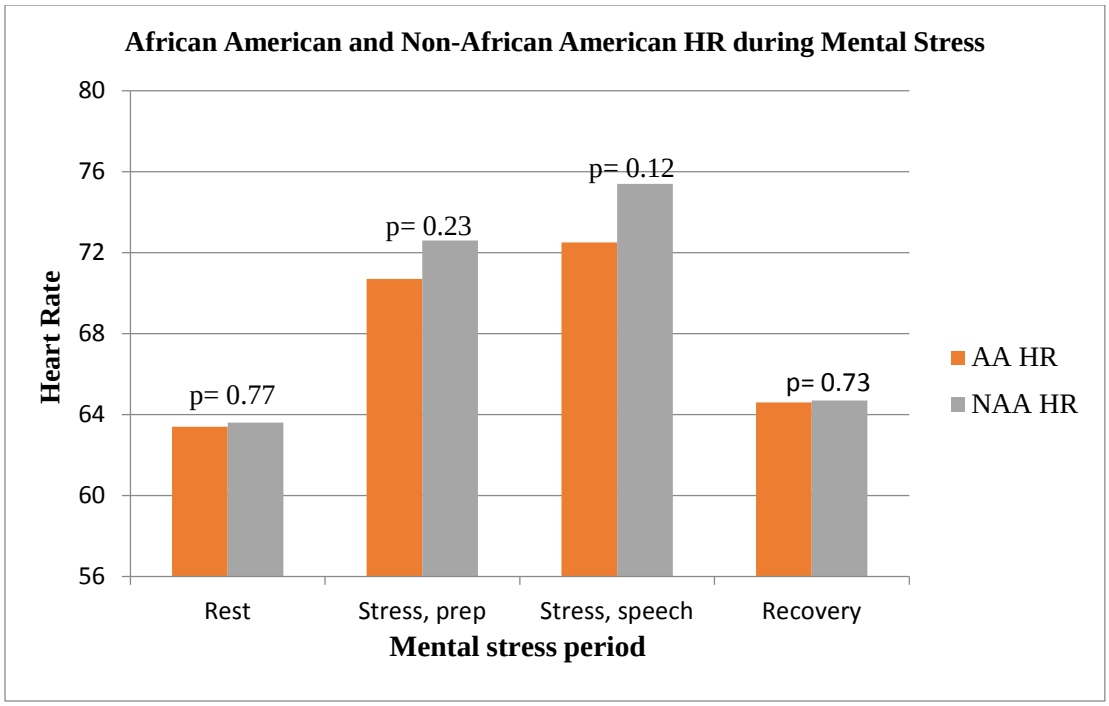
Table 8: Multiple linear regression models with change in epinephrine as dependent variable and race (AA vs. NAA) as main predictor			
	Absolute Difference, NAA vs. AA (pg/ml) (Standard error)	**95% CI**	**p-value**
Model 1: Adjusting for baseline RPP and demographic[1] factors.	-5 (4)	-12 - 3	0.19
Model 2: Adjusting for baseline RPP, demographic[1], and cardiovascular history[2] factors	-6 (4)	-203 - 9	0.19
Model 3: Previous factors, medical history, and cardiovascular disease risk[3] factors	-4 (5)	-12 – 5	0.39
Model 4: Previous factors and psychosocial[4] factors	-5 (5)	-14 - 4	0.26
Model 5: Previous factors and SES[5] factors	-3 (5)	-12 - 6	0.5

[1]Age, Sex
[2]Abnormal Angiogram, Percutaneous transluminal coronary angioplasty, Coronary artery bypass surgery, Myocardial Infarction, Abnormal Nuclear Stress Test
[3]Diabetes, Heart failure, current smoking, Beta-Blocker use, ACE Inhibitor use, Cerebral Vascular disease, DASI, BMI
[4]BDI score, Antidepressant use, PTSD Checklist score, MSPSS score, CMHS score
[5]High School Education or lower, income below 20K

Figure 1: Differences in Cardiovascular Reactivity to Stress between African Americans (AA) and Non-African Americans (NAA)






African American and Non-African American HR during Mental Stress
Heart Rate
80
76
72
68
64
60
56
p= 0.77
p= 0.23
p= 0.12
p= 0.73
Rest
Stress, prep
Stress, speech
Recovery
Mental stress period
AA HR
NAA HR