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**EXAMINING THE EFFECT OF RACE ON THE RELATIONSHIP BETWEEN  
POSTTRAUMATIC STRESS DISORDER AND METABOLIC SYNDROME IN  
WOMEN**

A thesis submitted in partial fulfillment of the requirements for the degree of Master of  
Science at Virginia Commonwealth University

By: LEIA A. HARPER  
Master of Divinity, Duke University, May 2009  
Bachelor of Arts in Religion, Clark Atlanta University, May 2005  
Bachelor of Science in Mathematics, Clark Atlanta University, May 2005

Director: Scott Vrana, Ph.D.  
Professor of Psychology  
Department of Psychology

Virginia Commonwealth University  
Richmond, Virginia  
May 2014

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## **Abstract**

### **EXAMINING THE EFFECT OF RACE ON THE RELATIONSHIP BETWEEN POSTTRAUMATIC STRESS DISORDER AND METABOLIC SYNDROME IN WOMEN**

By: Leia A. Harper, MDiv

A thesis submitted in partial fulfillment of the requirements for the degree of Master of  
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Virginia Commonwealth University, 2014

Major Director: Scott Vrana, Ph.D.  
Professor of Psychology  
Department of Psychology

Posttraumatic stress disorder (PTSD) is a psychiatric condition affecting approximately 8% of the adult U.S. population with rates twice as high in women than men. Increasingly, evidence has suggested a close relationship between PTSD and increased risk of metabolic diseases. However, the literature on PTSD and metabolic disease risk factors has been limited by the lack of investigation of the potential influence of race on this relation. The current study examined the possible effect of race on the relation between PTSD and metabolic risk. Data for this study were provided from sample of that included 50 African American women and 39 Caucasian women, 56.2% and 43.8% respectively. Results support the importance of race in the relationship between PTSD and metabolic disease risk factors. Future research would benefit from analysis of

cultural factors to explain how race might influence the course of metabolic disease risk and development in women with PTSD.



## Examining the Effect of Race on the Relationship Between Posttraumatic Stress Disorder and Metabolic Syndrome in Women

Posttraumatic stress disorder (PTSD) is a psychiatric condition that can develop after an individual is confronted with a traumatic event involving actual or threatened death or injury. In order to receive a diagnosis of PTSD, the individual's response must involve intense fear, helplessness, or horror (American Psychiatric Association. Task Force on DSM-IV. & American Psychiatric Association., 2000). The essential characteristics of PTSD include a cluster of symptoms lasting for at least a month causing significant distress and/or impairment. These essential features include re-experiencing, or intrusive recollections of the traumatic event, efforts to avoid anything associated with the event, numbing of emotions, and hyperarousal, which is often manifested by difficulty sleeping and/or concentrating together with increased irritability (Institute of Medicine (U.S.). Subcommittee on Posttraumatic Stress Disorder of the Committee on Gulf War and Health: Physiologic, 2006).

The overall lifetime prevalence of PTSD is 8% in the U.S. adult population (American Psychiatric Association. Task Force on DSM-IV. & American Psychiatric Association., 2000). Research has shown that women suffer from PTSD more frequently and experience PTSD symptomology more intensely than men (N. Breslau & Davis, 1992; Davidson, Hughes, Blazer, & George, 1991; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Tolin & Foa, 2006). Further, studies have also shown that the rate of PTSD is twice as high in women as in men (N.; Breslau, 2001; N. Breslau et al., 1998; Kessler et al., 1995) with estimates of 10% in women compared to 5% in men (Kessler et al., 1995). Women are also twice as likely to develop PTSD following a traumatic event and

are more likely to develop chronic symptoms of PTSD (N. Breslau & Davis, 1992; N. Breslau, Davis, Andreski, Peterson, & Schultz, 1997; Calhoun, Wiley, Dennis, & Beckham, 2009).

Increased rates of mood, anxiety, and substance use disorders are often comorbid with PTSD. Data from the National Comorbidity Survey indicated that 79% of women with a history of PTSD had at least one additional psychiatric disorder and 49% report a history of at least one major depressive episode (Kessler, Chiu, Demler, Merikangas, & Walters, 2005). Research has also shown that women with a PTSD diagnosis are four times more likely to develop major depressive disorder (MDD) as women who do not have PTSD (Brady, Killeen, Brewerton, & Lucerini, 2000). MDD is one of the leading causes of disease and disability worldwide, affecting 16.9% of the U.S. population (Bromet et al., 2011). Like PTSD, MDD is twice as likely to be diagnosed in women as in men, and women have a 70% greater chance of experiencing depression during their lifetime than men (Kessler, Berglund, et al., 2005).

In addition to gendered differentials, research has also shown that symptoms of anxiety and depression present differently across racial groups. A study using data from the National Epidemiologic Survey on Alcohol and Related Conditions found that in a sample of 34,653 adults the lifetime prevalence of PTSD in African Americans (8.7%) was significantly higher than what was found in both Caucasian (7.4%), and the general population (7.3%) (Roberts, Gilman, Breslau, Breslau, & Koenen, 2011). Contrary to PTSD, research has indicated that the lifetime prevalence of MDD is higher in Caucasians (17.9%) than in both African Americans (10.4%) and the general population (16.2%) (Kessler et al., 2003). However, research has also shown that African Americans

have higher rates of chronic episodes of depression (56.5%) compared to Caucasians (38.6%) (Williams et al., 2007). In addition, relative to Caucasians, when African Americans are diagnosed with MDD it usually goes untreated and is more severe and disabling (J. Breslau, Kendler, Su, Gaxiola-Aguilar, & Kessler, 2005).

In addition to race and gender differences in risk of poor mental health outcomes, race and gender also are related to cardiovascular disease risk. One in three female adults in the U.S. have some form of cardiovascular disease (CVD). Mortality rates for women are much higher in cardiac related diseases than the next five causes of death combined. The risk for prevalence and mortality in CVD increases significantly in ethnic minority populations, particularly African Americans. Nearly half of African American women have some form of CVD, compared to about one-third of Caucasian women (Roger et al., 2012).

Metabolic syndrome (MetS) is a cluster of metabolic risk factors that has long been a representative factor in the identification of CVD risk, the development of type II diabetes, and the increased risk of stroke. The metabolic risk factors that make up metabolic syndrome are abdominal obesity, elevated fasting plasma glucose levels, HDL cholesterol levels, triglyceride levels, and systolic or diastolic blood pressure levels, and a person is identified as having metabolic syndrome if they have three or more of these risk factors over a defined level. The management of MetS is an important component in addressing the global epidemics of CVD and diabetes mellitus. Compared to individuals without MetS, research has shown that individuals with MetS have a 2-fold increase in CVD risk (Gami et al., 2007; Mottillo et al., 2010), and a 5-fold increase in diabetes risk (Stern, Williams, Gonzalez-Villalpando, Hunt, & Haffner, 2004). Further, health care

cost increase by 24% for each additional metabolic risk factor present, making MetS a critical component in addressing the rising cost of healthcare (Boudreau et al., 2009).

As with cardiovascular disease, the prevalence of metabolic syndrome varies by race and gender. Data from the National Health and Nutrition Examination Survey (2007-2008) revealed that, in men, metabolic syndrome was more prevalent in Caucasian men (37.2%) than in African American men (25.3%), while data from women indicated that metabolic syndrome was more prevalent in African American women (38.5%), compared to Caucasian women (31.5%) (Ervin, 2009). Also, the prevalence of MetS is 53% higher among African American women than among African American men (Roger et al., 2012), further demonstrating the disparate burden of MetS among African American women.

Increasingly, evidence has suggested a close relationship between psychopathology and physical health (Eaton, Armenian, Gallo, Pratt, & Ford, 1996; Katon & Ciechanowski, 2002; Schnurr & Green, 2004). Research has shown that PTSD has been linked to several negative health outcomes related to metabolic abnormalities such as higher rates of obesity (David, Woodward, Esquenazi, & Mellman, 2004; Dedert, Becker, et al., 2010), higher lipid levels (Karlovic, Buljan, Martinac, & Marcinko, 2004; Karlovic, Martinac, Buljan, & Zoricic, 2004), as well as increased risk of hypertension (Kibler, Joshi, & Ma, 2009), myocardial infarction (Kubzansky, Koenen, Spiro, Vokonas, & Sparrow, 2007), and cardiovascular mortality (Boscarino, 2008; Dedert, Calhoun, Watkins, Sherwood, & Beckham, 2010). Additionally, there may be gender and race differences in the association between physical and mental health. For example, the Third National Health and Nutrition Examination Survey, which included 3,186 men and

3,003 women, found that the prevalence of MetS was elevated in women with a history of depression, while men with a history of depression were not significantly more likely to have MetS (Kinder, Carnethon, Palaniappan, King, & Fortmann, 2004).

The literature has cited a number of mechanisms underlying the health disparities found in both gender and race, citing family history, socioeconomic status, dietary habits, sedentary lifestyle, and substance misuse (Roger et al., 2012). Yet, little research has considered the implications of psychiatric conditions in relation to adverse health in women or in minority populations. Considering the disparities found in both health and trauma exposure, African American women who experience symptomology related to PTSD and comorbid MDD are of particular interest in the current study. African American women are at the intersection of heightened prevalence across categories of race and gender, and there is extensive literature linking these psychiatric conditions to multiple adverse health outcomes.

As a possible explanation of the increased prevalence of risk factors for cardiovascular morbidity and mortality in African American women, this study hypothesizes that the higher incidence and prevalence of metabolic risk factors are due, at least in part, to higher rates of trauma exposure and the subsequent development of PTSD and MDD. Thus, the current project aims to investigate the association of psychiatric diagnoses with metabolic risk factors and metabolic syndrome among a sample of Caucasian and African American women.

## **Review of the Literature**

There is a growing body of literature documenting the relationship between PTSD and metabolic risk factors. Research has demonstrated that various psychosocial domains, including socioeconomic status, race, gender and occupation, can often moderate these relationships. Yet research examining the compounded effects of these demographic domains is relatively scarce. In order to further investigate the implications of racial status on the relationship between PTSD and MetS in women, the literature will be surveyed and reported with particular attention given to research focusing on racial and/or gender differences.

### **Posttraumatic stress disorder.**

*Gender effects in posttraumatic stress disorder.* In 1980, the DSM-III was published, and with it, the first official definition of PTSD. The categorization of trauma symptoms into the DSM had been prompted by the high prevalence of Vietnam veterans, primarily male, seeking treatment for distinct post-trauma symptoms (Figley, 1985). Interestingly, subsequent research has suggested not only that PTSD is more prevalent among women than men (N. Breslau & Davis, 1992; N. Breslau et al., 1998), but that women are at greater risk than men of developing PTSD following trauma exposure (N. Breslau, Davis, Andreski, et al., 1997; N. Breslau, Davis, Peterson, & Schultz, 1997).

Tolin & Foa, 2006 conducted a meta-analysis reviewing sex-specific risk of potentially traumatic events and PTSD. This review included published literature dated from the introduction of PTSD in 1980 through July 2005. By identifying articles that investigated the prevalence of potentially traumatic events and PTSD among male and female participants, Tolin & Foa sought to answer what they identified as four key

questions. 1) Are women and girls more likely than men and boys to meet diagnostic criteria for PTSD? 2) Are women and girls more likely than men and boys to experience a traumatic event? 3) Do male and female participants differ in terms of the type of traumatic experience? 4) Do sex differences in PTSD remain when controlling for the type of traumatic event? The literature search yielded 290 articles with data to address these questions. They found that 1) women and girls were more likely than men and boys to meet criteria for PTSD following a traumatic event, 2) adult male participants were significantly more likely to report a traumatic experience than were adult females, and 3) the trend of males reporting more traumatic events appears to only be true for certain events (i.e. accidents, nonsexual assault, witnessing an assault, combat, natural disasters, and serious illness or injury). The fourth and final of the tested hypotheses saw mixed results. Findings suggest that though women have higher levels of PTSD prevalence and severity, gender differences in traumatic event frequency was moderated in part by the methods employed during the study. When the occurrence of the traumatic event was assessed over a discrete time period (e.g., the past year) rather than the individual's lifetime, there were no significant gender differences. The researchers deduced that this lack of consistency could have been due to the limited number of traumatic events that may have occurred during that period.

***Race effects in posttraumatic stress disorder.*** Research examining race differences in trauma exposure and the development of PTSD is extremely limited. The National Comorbidity Survey Replication (NCS-R) is a nationally representative survey conducted using the World Mental Health version of the Composite International Diagnostic Interview. Using data from this survey Breslau et al. (2006) examined the

variation in race of lifetime risk and prevalence of DSM-IV disorders. Findings from this study indicated a 7.1% lifetime prevalence of PTSD in African Americans, compared to 6.8% in Caucasian, a small and not statistically significant difference between the two (J. Breslau et al., 2006).

In 2009 Himle and colleagues combined data from the NCS-R and the National Survey of American Life (NSAL) in a study estimating the prevalence, ages of onset, severity, and associated disability of anxiety disorders among African Americans, Caribbean Blacks, and Caucasians. The researchers found that Caucasians had elevated odds of all 12-month anxiety disorders except PTSD, and that the lifetime prevalence of PTSD was greater in African Americans (9.1%) and Black Caribbeans (8.4%) than in Caucasians (6.8%) (Himle, Baser, Taylor, Campbell, & Jackson, 2009).

Another study used data from the 2004-2005 wave of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) to identify the sources of race/ethnic differences in PTSD. The NESARC uses a multi-stage sampling design yielding a representative sample of the civilian, non-institutionalized U.S. population over the age of 18 years. Using a sample of 34,653 adults, the researchers found that the lifetime prevalence of PTSD in African Americans (8.7%) was significantly higher than what was found in both Caucasian (7.4%), and the general population (7.3%) (Roberts et al., 2011).

**Metabolic syndrome.** There is growing evidence linking trauma exposure and diminished physical health, particularly cardiovascular related diseases. MetS is a cluster of metabolic risk factors that has been shown to be a significant predictor of CVD and diabetes. Though many different definitions have been proposed for MetS, in 2009 the



International Diabetes Federation, the National Heart, Lung, and Blood Institute, the American Heart Association, the World Heart Federation, the International Atherosclerosis Society and the International Association for the Study of Obesity initiated a task force in order to standardize a definition (Alberti et al., 2009). As such, a diagnosis of MetS is given when three or more of the following five risk factors are present:

- Fasting plasma glucose greater than or equal to 100 mg/dL or undergoing drug treatment for elevated glucose.
- HDL cholesterol less than 40 mg/dL in men or less than 50 mg/dL in women or undergoing drug treatment for reduced HDL cholesterol.
- Triglycerides greater than or equal to 150 mg/dL or undergoing drug treatment for elevated triglycerides.
- Abdominal obesity, or a waist circumference greater than or equal to 102 cm for men or greater than or equal to 88 cm for women (in the United States).
- Blood pressure greater than or equal to 130 mm Hg systolic or greater than or equal to 85 mm Hg diastolic or undergoing drug treatment for hypertension or antihypertensive drug treatment in a patient with a history of hypertension (Roger et al., 2012).

Thus, throughout this thesis, I will use the term metabolic risk factor when referring to one or more of the five risk factors listed above, and metabolic syndrome when I am referring to the presence of three or more of the five metabolic risk factors. Additionally, due to the varying methods used in assessing glucose metabolism, it is important to note differences in these terms as well. Insulin is a hormone produced in the pancreas that

helps regulate the way the body metabolizes food. As the digestive tract breaks down carbohydrates into glucose, the pancreas releases insulin into the blood the bloodstream. With the help of insulin, cells throughout the body absorb glucose and use it for energy. Insulin resistance is a condition in which the body produces insulin but does not use it effectively. Over time, insulin resistance can lead to diabetes as the pancreas fails to keep up with the body's increased demand for insulin. The lack of sufficient levels of insulin leads to excess glucose in the bloodstream, which, in turn, results in diabetes and/or other adverse health conditions. Fasting glucose testing, or glucose tolerance testing are methods used to assess how well the body metabolizes glucose. Fasting insulin tests assess the amount of insulin in the bloodstream. High levels of insulin are indicative of insulin resistance; in which case the pancreas is overproducing in order to maintain healthy blood glucose levels. These methods will be further discussed later within this paper.

***Gender and race effects in metabolic risk factors.*** As of 2008, approximately 35% of women over the age of 20 years old have some form of CVD with the risk for prevalence and mortality in CVD increasing significantly in ethnic minority populations (Roger et al., 2012). In 2008, the death rates from CVD were 200.5 per 100,000 for non-Hispanic white females and 277.4 per 100,000 for non-Hispanic black females. Since 1984, the number of CVD deaths for females have exceeded those of males, with females representing 51.7% of deaths from CVD (Roger et al., 2012). Yet, surprisingly, women are vastly underrepresented in research, comprising only 24% of most heart-related studies (Johnson, Karvonen, Phelps, Nader, & Sanborn, 2003), with even fewer exploring the implications of race.

African Americans, and particularly African American women, bear a disproportionate physical burden from metabolic related conditions. As a group, African Americans have diabetes at a rate that is more than three times that of Caucasians and have a 40% higher prevalence rate of heart disease (*Mental Health: Culture, Race, and Ethnicity: A Supplement to Mental Health: A Report of the Surgeon General*, 2001). The prevalence of hypertension in African Americans is 41.4% compared to 28.1% in Caucasians, and is highest (44.0%) among African American women (Roger et al., 2012). Nearly half of African American women have some form of CVD, compared to about one-third of Caucasian women (Roger et al., 2012), and while the prevalence of CVD is higher in white men (37.4%) than in white women (33.8%), African American women have a higher prevalence of CVD (47.3%) than that of African American men (44.8%) (Roger et al., 2012). Additionally, the prevalence of diagnosed diabetes is 1.4 times as frequent in African Americans as in Caucasians with the risk of diabetes being 77% higher among African Americans. African American women are especially affected. The age-adjusted incidence of diabetes diagnosis is 15% for African American women, compared to 10.9% for African men and 7.0% and 6.9% for Caucasian men and women, respectively (Lipton, Liao, Cao, Cooper, & McGee, 1993).

The identification of metabolic syndrome represents either the presence of or an increased long-term risk for developing chronic cardiovascular and metabolic conditions. Just as there are gender and racial differentials in the prevalence of CVD, research has found similar disparities in the prevalence of MetS. The age-adjusted prevalence of MetS was 35.1% for men and 32.6% for women, 37.2% for Caucasians and 25.3% for African Americans. Among women, prevalence rates for MetS are 31.5% for Caucasian women

and 38.8% for African American women. What is interesting about the statistics for MetS are the ways in which the numbers are similar to those of CVD. Though Caucasians have an overall higher prevalence of MetS, Caucasian women have a lower rate than those of Caucasian men, while African American women have a higher prevalence than those of African American men; approximately 53% higher (Roger et al., 2012).

**Metabolic syndrome and posttraumatic stress disorder.** The initial evidence of the relationship between traumatic stress and MetS was drawn from research on CVD following traumatic stress. A longitudinal study investigated the relationship between exposures to wartime events, CVD and all-cause mortality in Lebanon following a 16-year civil war. The authors of this study reported a total of 416 deaths in a cohort of 1,567 men and women during the 10-year follow-up, with CVD accounting for 60% of the total (237 men and 179 women). Yet, mortalities from physical injuries sustained as a result of war were less than 2% (Sibai, Fletcher, & Armenian, 2001). Note that CVD related mortalities dwarfs those due to physical injuries sustained during the war. Kang, Bullman & Taylor investigated the association between PTSD and CVD in World War II prisoners of war (POWs). In this study, the researchers found that compared to non-POWs and POWs without PTSD, POWs with PTSD had an increased likelihood of hypertension and chronic heart disorders (Kang, Bullman, & Taylor, 2006).

Heppner et. al, 2009 analyzed clinical data from 253 male and female veterans in order to examine the association between PTSD, PTSD symptom severity and MetS. PTSD diagnosis and symptom severity was measured using the Clinician Administered PTSD Scale (CAPS). MDD and substance use disorders (SUD) were assessed using a structured diagnostic interview. The researchers in this study used clinical cut-offs

defined by the World Health Organization and the National Cholesterol Education Program for MetS status. The overall prevalence of MetS in this sample was 39.9%. Among individuals with comorbid PTSD and MDD, 46.2% met criteria for MetS compared to 34.3% in those with PTSD only and 28.8% with MDD only. Heppner and colleagues also found that the CAPS total score was a significant predictor of MetS such that an individual's risk for MetS increased one percentage point for each point obtained on the CAPS. Results from this study indicate that PTSD is a significant predictor of MetS, and, that as PTSD symptom severity increases, the likelihood of meeting criteria for MetS also increases (Heppner et al., 2009).

Similarly, Violanti et al. (2006) conducted a study in which a sample of male and female police officers were administered the Impact of Events Scale, which is a scale that measures PTSD symptomology. The investigators found that the officers with more severe PTSD symptoms had a significantly higher prevalence of MetS (50%) than those with subclinical symptoms (15.1%) (Violanti et al., 2006). A study using a sample of Croatian combat veterans found that the prevalence of metabolic syndrome was related to the severity of PTSD. Veterans with severe symptomology had a 66.7% prevalence rate of MetS compared to only 23.3% in veterans with subclinical symptomology (Babic et al., 2007). Jakovljevi et al. examined the prevalence of MetS in a sample of Croatian war veterans with PTSD. The investigators found that 31.9% of the veterans with PTSD met criteria for MetS, compared to only 8.9% of the age matched controls (Jakovljevic, Saric, Nad, Topic, & Vuksan-Cusa, 2006).

One study examined whether PTSD was a risk factor for the development of MetS among an impoverished urban population (Weiss et al., 2011). The researchers

recruited 245 low-socioeconomic-status participants in which 18.8% met criteria for current PTSD and 33.2% met criteria for MetS. The researchers found that a current diagnosis of PTSD was significantly associated with the presence of MetS. Also, after controlling for demographics, smoking history, antipsychotic use, depression and exercise, current PTSD remained the only significant predictor of MetS (Weiss et al., 2011).

Another important construct in considering the relationship between PTSD and MetS is hostility, a construct known to be symptomatic of PTSD. Vitaliano and colleagues examined the relationship of psychosocial factors, including hostility, with fasting insulin and glucose levels. Using the State-Trait Anger Scale to assess hostility, the authors of this study found that participants with high anger/hostility scores had significantly higher blood glucose levels than those who were low on these factors. Additionally, hostility was associated with insulin and glucose levels even after controlling for obesity, cholesterol, and cardiovascular disease (Vitaliano, Scanlan, Krenz, & Fujimoto, 1996).

In 2000, Niaura and colleagues examined the associations between hostility and metabolic disease risk factors in 1081 men. Hostility was measured using the Cook-Medley Hostility Scale (Ho), which was derived from the Minnesota Multiphasic Personality Inventory. The researchers found that the total Ho score was positively associated with waist to hip ratio, BMI, fasting insulin levels, blood pressure and triglyceride levels (Niaura et al., 2000).

Another study examined the relationship between cynical hostility and the incidence of diabetes and MetS in a sample of women. Using the cynicism subscale of

the Cook-Medley Hostility Questionnaire to assess cynical hostility, the researchers found that women with high cynical hostility scores had higher BMI. Also, the incident of diabetes was 36% higher among women with high cynical hostility scores. Another interesting finding to note in this study was the association of hostility and race. Cynical hostility scores were associated with race such that African American women had higher levels compared to Caucasian women (Wylie-Rosett et al., 2010).

**Women, race, metabolic disease risk, and psychopathology.** The association of poorer physical health with psychiatric symptomology is greater in African Americans than in Caucasians, particularly disorders related to glucose metabolism. Cooper & Waldstein (2004) conducted a study to examine if hostility influences racial disparities in cardiovascular disease. The sample included 66 adults aged 18 -26 years old and examined the following metabolic risk factors: systolic and diastolic blood pressure, cardiac index (i.e. cardiac output adjusted for body size), total peripheral resistance (i.e. the overall resistance to blood flow in the blood vessels), insulin levels, triglyceride levels and percent body fat. The researchers included total peripheral resistance and cardiac index because these are hallmarks of hypertension (Lund-Johansen, 1994). The researchers found that hostility scores were higher among African Americans than Caucasians, and that while African Americans had significantly higher HDL cholesterol, Caucasians had higher triglyceride levels. Hostility was positively associated with systolic and diastolic blood pressure, insulin levels and triglyceride levels among African Americans. Conversely, hostility was negatively associated with total peripheral resistance and percent body fat among Caucasian participants. Overall, the results suggested that hostility potentiated metabolic risk in African Americans and diminished

risk among Caucasians (Cooper & Waldstein, 2004).

Georgiades and colleagues conducted a study to determine whether the relationship of hostility to fasting glucose was moderated by sex and race. A total of 565 men and women were assessed using the Cook-Medley hostility scale. Results showed a moderating effect of race and sex on the association of hostility to fasting glucose but not for insulin. There was a positive association between hostility and fasting glucose in African American women only. This association remained significant after controlling for age and body mass index (Georgiades et al., 2009).

In 2004, Everson-Rose et al. published findings from a study examining the relationship between depressive symptoms, insulin resistance and risk of diabetes in a multiracial community sample of middle-aged women. Participants were from the Study of Women's Health Across the Nation (SWAN), an ongoing longitudinal study of menopausal transition. Depression was assessed using the 20-item Center for Epidemiological Studies Depression Scale (CES-D); insulin resistance was calculated by using a computer algorithm known as the revised homeostasis model assessment of insulin resistance (HOMA-IR) model via blood draw following a 12-hour fast; and the incidence of diabetes was obtained via self-report and fasting glucose levels. The researchers found that diabetes was 66% more likely to develop in depressed women than in without depression. Depressed women, also, had significantly greater fasting glucose levels than those without depression, even after adjusting for age, race, education and medication use. Additionally, Everson-Rose and colleagues found that while depression was associated with higher fasting glucose level and incident diabetes, African-American women with depression experienced an increased risk of diabetes independent of central



adiposity and obesity. These findings suggest that there may be additional mechanisms that contribute to the excess risk of diabetes experienced by African-American women. The current project hypothesizes that trauma exposure and subsequent psychiatric symptomology may account, at least in part, for these differences.

The association of poorer physical health with psychiatric symptomology is greater in women than in men. In 2006, Edward Suarez conducted a study examining sex differences in the relation of depressive symptomatology, hostility and anger expression to glucose metabolism. Suarez used the Beck Depression Inventory to measure depressive symptoms, the Cook Medley Hostility Scale to assess hostility, and the Spielberger Anger Expression scale to assess anger. Suarez found that the severity of depressive symptoms, higher levels of hostility, and a propensity to express anger were all significantly associated with higher levels of fasting insulin and glucose levels in women, but not in men. Also, these associations remained significant independent of BMI, age, triglyceride levels, alcohol consumptions and educational status (Suarez, 2006).

Another study to examine different relationships between psychopathology and metabolic risk explored the effect of race on metabolic disease risk factors in women with and without PTSD (Dedert, Harper, Calhoun, Dennis, & Beckham, 2012). The current project seeks to replicate and extend this research, and as such, will provide a more detailed analysis of this study. Data for were provided by a sample of 134 women. The sample had a mean age of 40.4 ( $SD = 12.9$ ). In that study, the researchers testEd for demographic differences by PTSD, MDD, substance use disorder (SUD), and race (African American vs. Caucasian) using general linear models for continuous variables

and Chi-square tests for categorical variables.

The study found that participants with current MDD had a higher mean age and lower SES, but no between-group difference in race. Participants with a lifetime substance use disorder (SUD) had a lower SES, but no significant differences in age or race. A greater number of Axis I disorders was generally associated with lower SES, but there was no significant relationship of Axis I disorders with age or race. Individuals with PTSD had higher BMI, larger abdominal obesity, and higher systolic blood pressure. Examination of associations between race and metabolic disease risk factors revealed that African American participants had larger abdominal obesity, and lower triglycerides.

Results from general linear models examining associations of race and psychiatric disorders revealed a race by PTSD interaction in BMI, such that Caucasians without PTSD had a lower BMI than Caucasians with PTSD. Caucasians without PTSD also had a lower BMI than racial minorities regardless of PTSD diagnosis. Similarly, there was an interaction of PTSD and race on obesity, such that Caucasians without PTSD had lower rates of obesity and lower abdominal obesity than each of the other groups. Also, there was an interaction for triglycerides, such that Caucasians with PTSD had higher triglycerides than each of the other groups.

Models testing the association of MDD and race with disease risk factors revealed that MDD was associated with elevations in BMI, obesity rate, waist-hip ratio, LDL level, and triglyceride level. In contrast to models with PTSD, the models with MDD resulted in no interactions of MDD with race. A history of SUD was associated with higher systolic blood pressure, but no other health risk measures. There were no interactions of SUD history with race in models of metabolic risk measures. The number

of total axis I disorders was associated with an increased rate of obesity, larger waist-hip ratio, higher LDL levels, and higher triglyceride levels.

Findings from this study indicate that race plays a significant role in the association of PTSD with metabolic risk factors, particularly as only systolic blood pressure did not also have a significant interaction between PTSD and race where all other metabolic factors did. However, contrary to what was expected, PTSD did not have as great of an effect on metabolic risk factors in African American women as what was found in Caucasian women. This was found to be true in abdominal obesity, BMI, obesity rates, and triglycerides. There was no significant increase in rates of obesity, triglyceride levels, waist to hip ratio, or systolic blood pressure in African American women with PTSD.

**Statement of the problem.** While evidence has shown that gender and race are critical aspects in metabolic disease risk factors as well as PTSD symptomology, the effect of these variables has received little empirical attention in assessing the relationship between PTSD and MetS. The current project seeks to replicate and extend a previous study that examined metabolic risk in women with and without PTSD (Dedert et al., 2012). Dedert et al., found that while PTSD did not have a significant effect on certain metabolic risk factors in African Americans, it was associated with a notable worsening of metabolic risk in Caucasians. While these patterns were noted in abdominal obesity, BMI, obesity rates, and triglycerides, a limitation of this study was the absence of fasting glucose data. This absence in the Dedert and colleagues study is of particular interest because of previous data indicating that African Americans have a strong relationship between insulin resistance and metabolic risk (Gaillard, Schuster, & Osei,

2009, 2010; Gu, Cowie, & Harris, 1998; Meis, Schuster, Gaillard, & Osei, 2006; Zeno et al., 2010). As such, fasting glucose and insulin resistance would be an important component to evaluate and include when assessing MetS in African Americans. Also, African American women tend to have higher fasting glucose levels, and higher rates of and mortality from diabetes (Roger et al., 2012). Additionally, studies have shown a significant positive association between hostility, a personality construct that commonly co-occurs with PTSD (Beckham, Calhoun, Glenn, & Barefoot, 2002; Beckham, Vrana, et al., 2002), and fasting glucose among African American women (Georgiades et al., 2009; Surwit et al., 2009; Surwit et al., 2002). This relationship is important to note as research has also shown that anger and hostility are common symptoms experienced by individuals following trauma exposure.

The current project will use data from a study whose goal was to evaluate the relationships between hostility, PTSD and biomarkers of CVD and diabetes in a younger population. Participants were between the ages of 19 and 39. Using this data set, the current project seeks to examine the effect of race on MetS in women with and without PTSD. Given that the current project will replicate the work of Dedert et al. (2012), it is hypothesized the current project will also replicate the findings from that study as well.

***Hypothesis 1.*** Compared to Caucasian women, African American women will have larger values on all five metabolic risk factors, and will be more likely to meet criteria for metabolic syndrome.

***Hypothesis 2.*** Compared to Caucasian women, African American women will display higher rates of PTSD.

***Hypothesis 3.*** PTSD will be associated with larger values on all five metabolic

risk factors and increased likelihood of MetS.

**Hypothesis 4.** This hypothesis examines whether the relationship between psychiatric symptoms and metabolic risk factors is different for African American and Caucasian women. It is predicted that, consistent with previous data (Dedert et al., 2012), Caucasian women will show a stronger association between PTSD symptoms and triglycerides and waist circumference than will African American women. On the other hand African American women will show a stronger association between PTSD and insulin resistance than will Caucasian women. Based on the results of Dedert et al. (2012), no racial differences are expected in the association between PTSD and the other two metabolic risk factors (HDL cholesterol and blood pressure).

## **Method**

### **Participants**

Data for this study is provided from an investigation of hostility, PTSD, biomarkers of CVD and type II diabetes in a trauma-exposed sample of men and women between the ages of 19 and 39. There were a total of 206 study participants, with women representing 47.1% ( $N = 97$ ). The sample consisted of 50 African American women and 39 Caucasian women, 56.2% and 43.8% respectively. The average age was 29.91 ( $SD = 5.67$ ). All participants endorsed having experienced at least one traumatic event and 16% reported veteran status. Additional participant demographics appear in Table 1.

Table 1.

*Means and standard deviations for independent variables*

	PTSD		No PTSD	
	African American	Caucasian	African American	Caucasian
<i>N</i>	27	12	23	27
Age	33.00 (4.32)	30.92 (5.49)	27.09 (6.27)	28.78 (5.05)
Education	12.19 (2.60)	13.42 (1.68)	13.76 (2.91)	15.81 (2.35)
%Employed	61.54	58.33	31.82	70.37
%Married	18.52	25.00	.45	29.63
Hollings	52.37 (13.99)	52.18 (15.53)	52.96 (13.03)	45.63 (14.93)
Cook-Medley	15.99 (5.44)	13.42 (5.07)	11.12 (5.44)	7.22 (3.76)
DTS	70.89 (31.69)	80.50 (28.70)	23.22 (26.95)	10.78 (19.92)
BDI	19.09 (11.64)	21.73 (10.37)	7.57 (7.61)	3.88 (4.50)

**Note.** Values enclosed in parentheses indicate standard deviations

**Recruitment.** Participants were recruited from among outpatients at the Durham Veterans Affairs Medical Center and Duke University Primary Health Care and PTSD Clinics, and also from the community. Participants were made aware of the study through their health care providers or through IRB approved flyers and brochures advertising a study on stress and health posted in the medical centers. Upon contacting the lab in order to learn more about the study protocol, subjects were asked screening questions regarding age, medical history (specifically, HIV positive status, AIDS, diabetes, heart disease, cancer, epilepsy, kidney disease, pregnancy, and hypertension) and psychiatric history (specifically, history of organic mental disorder, schizophrenia, current manic syndrome,

and current substance abuse/dependence). Individuals who met DSM-IV criteria for organic mental disorder, schizophrenia, bipolar I mixed state or bipolar II; or current substance abuse/dependence were excluded. Since depression is independently associated with CVD, individuals with co-morbid lifetime or current major depressive disorder (along with PTSD) were included as one of the group comparisons so the effect of this co-morbidity in the presence of PTSD can be specifically examined. Those who met criteria for lifetime substance abuse/dependence were also included. Individuals that were pregnant and those with AIDS or who reported a positive HIV status, or who had an uncontrolled medical conditions (e.g., kidney or liver failure), were not eligible. The medical records of veterans enrolled at the Durham VA Medical Center were reviewed to determine eligibility.

### **Procedure**

Participants came in to the lab for two sessions of questionnaires and diagnostic assessments. Study personnel collected data on racial/ethnicity, income, years of education, age, and job status. Waist circumference was measured in centimeters. Waist circumference was measured once for each participant, so no reliability data were calculated for these measurements. Study participants were compensated a total of \$150 for two sessions of questionnaires and diagnostic assessment.

Fasting lipids, insulin and glucose levels were determined from blood specimens. Prior to blood draws for lipid assessment, all participants reported fasting for 12 hours. Lipid assessment consisted of determination of high-density lipoprotein (HDL), low density lipoprotein (LDL), and plasma triglycerides. Insulin resistance and fasting glucose data were collected using the HOMA-IR, a commonly used surrogate for insulin

resistance (Bonora et al., 2000). HOMA-IR is calculated as a product of the fasting glucose (mg/dL) with lower values indicating a higher degree of insulin sensitivity.

Blood pressure was measured while participants were seated, according to AHA guidelines, using a Datascope Accutorr Plus blood pressure monitor.

Participants were identified as meeting criteria for MetS by having three or more of the following five risk factors:

- Fasting plasma glucose greater than or equal to 100 mg/dL or undergoing drug treatment for elevated glucose.
- HDL cholesterol less than 40 mg/dL in men or less than 50 mg/dL in women or undergoing drug treatment for reduced HDL cholesterol.
- Triglycerides greater than or equal to 150 mg/dL or undergoing drug treatment for elevated triglycerides.
- Abdominal obesity, or a waist circumference greater than or equal to 102 cm for men or greater than or equal to 88 cm for women (in the United States).
- Blood pressure greater than or equal to 130 mm Hg systolic or greater than or equal to 85 mm Hg diastolic or undergoing drug treatment for hypertension or antihypertensive drug treatment in a patient with a history of hypertension.

The Clinician Administered PTSD Scale (CAPS) was administered to determine PTSD diagnostic status (Blake et al., 1995). The CAPS is a 30-item structured interview that corresponds to the DSM-IV criteria for PTSD and is considered the gold standard in PTSD assessment. Symptoms are counted as present if it has a frequency of 1 or more (scale 0 = "none of the time" to 4 = "most or all of the time") and an intensity of 2 or more (scale 0 = "none" to 4 = "extreme"). A PTSD diagnosis is made if there is at least 1



"B" symptom (re-experiencing), 3 "C" symptoms (avoidance), and 2 "D" symptoms (hyperarousal) as well as meeting the other diagnostic criteria such symptom duration and functional impairment (Blake et al., 1995; Weathers, Keane, & Davidson, 2001; Weathers, Ruscio, & Keane, 1999) Current diagnoses are determined using a one-month time frame.

## **Materials**

The Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1997) was used to diagnose other possible Axis I disorders, including substance use disorders and MDD. To assure inter-rater reliability, study personnel independently coded the same five charts. Kappa scores were calculated. In the case that kappa was less than .70, the study raters coded five more medical records and the lead investigator, Dr. Jean Beckham, reassessed reliability. Once kappa was greater than or equal to .70, on-going inter-rater reliability throughout the record extraction was assured by choosing one chart at random every four months for the research assistants to code.

The Davidson Trauma Scale (DTS) was used to measure PTSD symptom severity. The DTS is a 17-item self-report measure that assesses the DSM-IV symptoms of PTSD. Items are rated on 5-point frequency (0 = "not at all" to 4 = "every day") and severity scales (0 = "not at all distressing" to 4 = "extremely distressing"). Participants were asked to identify the trauma that is most disturbing to them and to rate, in the past week, how much trouble they have had with each symptom. The DTS yields a frequency score (ranging from 0 to 68), severity score (ranging from 0 to 68), and total score (ranging from 0 to 136). It can be used to make a preliminary determination about whether the symptoms meet DSM criteria for PTSD. Scores can also be calculated for

each of the 3 PTSD symptom clusters (re-experiencing, avoidance, and hyperarousal) (Davidson et al., 1997). For the purposes of this study, DTS severity scores will be used to measure symptom severity. The DTS has demonstrated high test-retest and split-half reliability, excellent internal consistency, concurrent validity, and discriminant validity (Davidson et al., 1997). The DTS has demonstrated excellent reliability and validity in clinical and research settings (Weathers, Keane, & Davidson, 2001; Weathers, Ruscio, & Keane, 1999; Zanarini et al., 2000).

The Beck Depression Inventory-II (BDI-II) was used to measure depression symptom severity. The BDI-II is a 21-item scale designed to measure severity of depressive symptoms over a two-week period, and has demonstrated excellent test-retest reliability, high internal consistency and high convergent validity (Beck, Guth, Steer, & Ball, 1997; Beck, Steer, Ball, & Ranieri, 1996; Osman, Kopper, Barrios, Osman, & Wade, 1997).

Given the high co-morbidity of PTSD and depression (Breslau, Davis, Peterson, & Schultz, 1997; Kessler, Chiu, Demler, Merikangas, & Walters, 2005), a latent variable was created in order to adequately capture trauma-related psychiatric symptomology. This latent variable, which will be referred to as PTSD symptoms, was created using the BDI to capture associated depressive symptoms and the DTS for trauma-related symptoms.

Participants listed their current medications and provided demographic information, including socioeconomic status based on the Hollingshead Index (Hollingshead & Redlich, 1958). The Hollingshead Index of Socioeconomic Status is a survey designed to measure social status of an individual based on four domains: marital

status, retired/employed status, educational attainment, and occupational prestige. Education is rated on a 7-point scale in which 7=graduate/professional training, 6=standard college or university graduation, 5=partial college, at least one year of specialized training, 4= high school graduate, 3=partial high school, 10th or 11th grade, 2= junior high school, including 9th grade, 1= less than 7th grade, 0=not applicable or unknown. Occupational is then rated on a 9-point scale where 9=higher executive, proprietor of large businesses, major professional, 8=administrators, lesser professionals, proprietor of medium-sized business, 7=smaller business owners, farm owners, managers, minor professionals, 6=technicians, semi-professionals, small business owners (business valued at \$50,000-70,000), 5=clerical and sales workers, small farm and business owners (business valued at \$25,000-50,000), 4=smaller business owners (<\$25,000), skilled manual laborers, craftsmen, tenant farmers, 3=machine operators and semi-skilled workers, 2=unskilled workers, 1=farm laborers, menial service workers, students, housewives, (dependent on welfare, no regular occupation), 0=not applicable or unknown. An SES score is then calculated using the following formula: (Occupation score x 7) + (Education score x 4) (Hollingshead & Redlich, 1958). When SES is used as a covariate in the analysis of psychiatric variables unique differences are difficult to detect due to the significant correlation between SES and psychiatric diagnosis (Miller & Chapman, 2001). For this reason, SES will only be examined as a possible mediator in the analysis of the data.

The 27-item form of the Cook-Medley Hostility Scale was used to assess hostility. There are three subscales in this instrument including cynicism, hostile affect, and aggressive responding. The Cook-Medley scale has shown high test-test reliability

and a number of studies have supported its construct validity as a measure of hostility (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989).

### **Data Analysis**

In order to evaluate the association of PTSD with metabolic risk factors, the sample was split into two groups: 1) participants with PTSD, and 2) participants without PTSD, according to diagnostic scores from the CAPS. Because analysis of a PTSD group with psychiatric comorbidities removed would not be representative of PTSD, all participants with a diagnosis of PTSD were included in the analysis (Dedert et al., 2012).

Data was analyzed using SPSS. Power analysis illustrated that with three predictors (psychiatric diagnosis, psychiatric symptoms, and race) in the model, an  $n = 89$  participants were sufficient to detect a small effect at .80 (80%). Prior to analysis, psychiatric symptoms and diagnosis, race, and all metabolic variables were examined through various SPSS programs for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis. The variables were examined separately for the 89 participants. There was one missing value for HDL cholesterol and two missing data points for waist circumference. The triplicated measures for blood pressure were missing seven values total (one missing data point for first draw, and three each for the second and third draws). Missing variables were calculated using an expectation maximization (EM) algorithm in SPSS. There were two univariate outliers that made the fasting glucose variable severely skewed (3.436) and kurtotic (20.581). A square root transformation was used on this variable in order to improve the normality, linearity, and homoscedasticity of the residuals.

## Results

### Hypothesis 1

The first hypothesis was to evaluate racial differences in metabolic risk factors and the likelihood of meeting criteria for MetS. A multivariate analysis of variance (MANOVA) was performed on six dependent variables: fasting glucose, triglycerides, diastolic and systolic blood pressure, waist circumference and HDL cholesterol. Race was entered as the independent variable. Means for each of these variables by race can be found in Table 2.

Table 2.

*Means and standard deviations for dependent variables by race.*

	African American	Caucasian
<b>Fasting Glucose</b>	83.66 mg/dL (12.72)	84.13 mg/dL (10.64)
<b>HDL Cholesterol</b>	54.20 mg/dL (16.36)	57.56 mg/dL (15.86)
<b>Triglycerides</b>	76.74 mg/dL (40.24)	92.51 mg/dL (41.54)
<b>Waist Circumference**</b>	95.12 cm (20.80)	82.28 cm (13.95)
<b>Blood Pressure</b>		
<b>Systolic**</b>	124.94 mm Hg (13.85)	112.72 mm Hg (11.16)
<b>Diastolic**</b>	76.81 mm Hg (9.87)	67.85 mm Hg (6.46)
<b>% Meeting MetS criteria</b>	22%	7.7%

*Note.* Values enclosed in parentheses indicate Standard Deviations. \*\*  $p < .001$

Using Pillai's trace, there was a significant effect of race on the overall model,  $V = 0.36$ ,  $F(6, 82) = 7.67$ ,  $p < .001$ . Separate univariate ANOVAs on the outcome variables revealed that, compared to Caucasians, African Americans had significantly greater waist circumference,  $F(1, 87) = 10.98$ ,  $p < .001$  (Figure 1), diastolic blood pressure (mm Hg),  $F(1, 87) = 24.07$ ,  $p < .001$ , and systolic blood pressure (mm Hg),  $F(1, 87) = 20.16$ ,  $p < .001$  (Figure 2). There were non-significant effects for HDL cholesterol levels,  $F(1, 87) =$

0.96,  $p = .331$ , triglycerides,  $F(1, 87) = 3.27$ ,  $p = .074$ , and fasting glucose,  $F(1, 87) = 0.06$ ,  $p = 0.81$ . As can be seen in Table 1, Caucasians exhibited higher means than African Americans on these three variables.

Race disparities in health are multidimensional and can often reflect multiple dimensions of social inequality. Socioeconomic status (SES) is one aspect of many that combine to affect disparate numbers in disease prevalence in ethnic minorities (Farmer & Ferraro, 2005; Franks, Muennig, Lubetkin, & Jia, 2006; Williams, Mohammed, Leavell, & Collins, 2010). For this reason, a regression analysis was performed in order to assess whether SES was a mediator of the relations between those metabolic risk factors significantly related to race. SES was not related to waist circumference,  $\beta = .164$ ,  $t(85) = 1.20$ ,  $p = .23$ , diastolic blood pressure,  $\beta = -.009$ ,  $t(85) = -.142$ ,  $p = .89$ , or systolic blood pressure,  $\beta = .045$ ,  $t(85) = .468$ ,  $p = .64$ . As such, there were no potential mediating effects of SES on the relation between race and these metabolic variables.

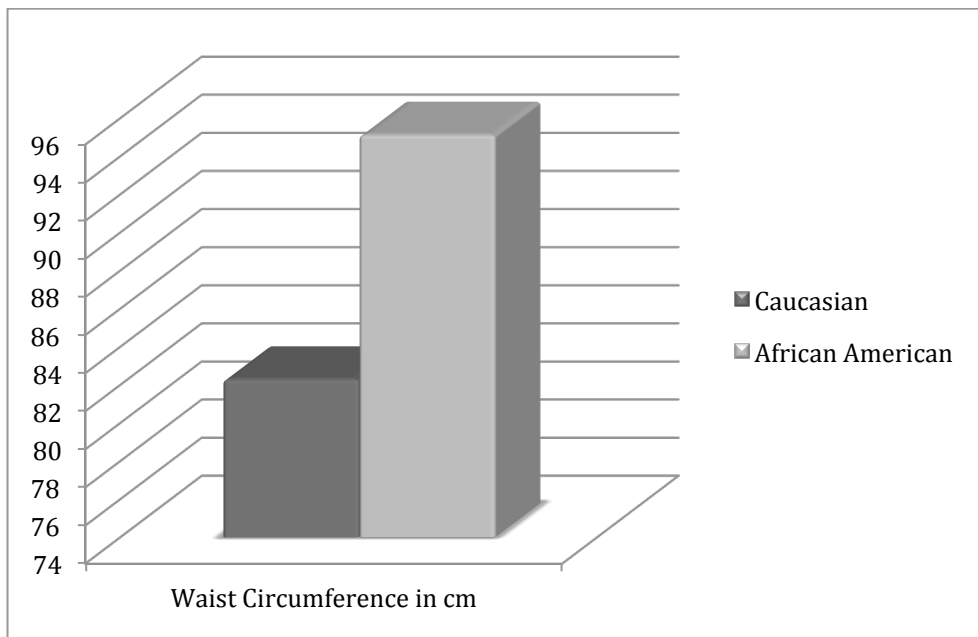


Figure 1. Waist circumference means by race.

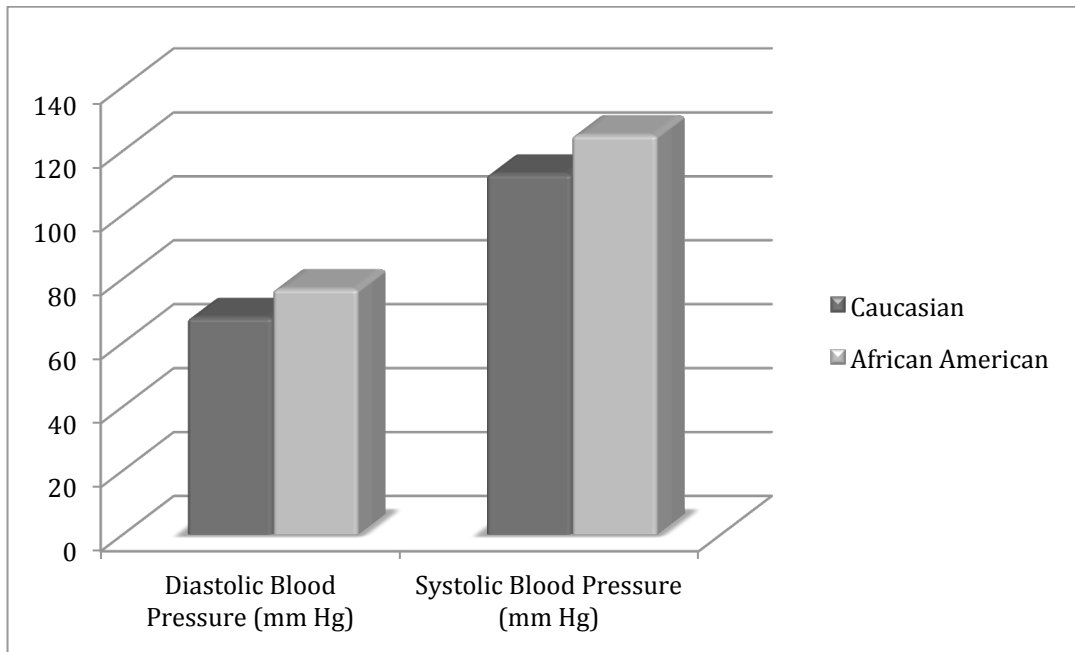


Figure 2. Diastolic and systolic blood pressure means by race.

A chi-square test of independence was performed to examine the relation between race and MetS. African American women were more likely to meet criteria for MetS compared to Caucasian women,  $\chi^2(1) = 3.38$ ,  $p = 0.033$ , with twenty-two percent of African American women meeting criteria for MetS compared to 7.7% of Caucasian women (Figure 3).

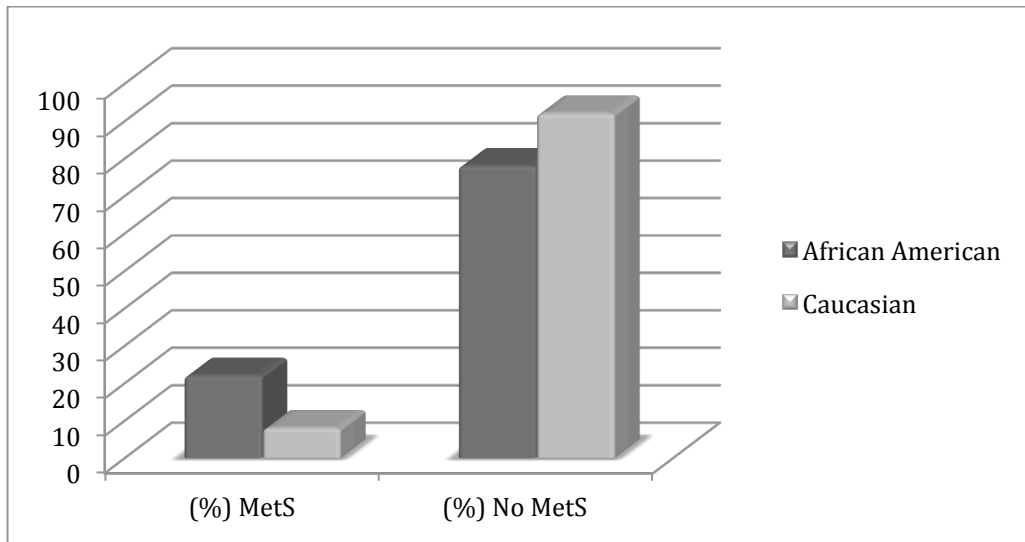


Figure 3. Percentage likelihood of metabolic syndrome by race.

## Hypothesis 2

The second hypothesis was to evaluate racial differences in PTSD diagnosis. Based on diagnoses made from the CAPS, participants were divided into two groups: those with PTSD and those without PTSD. A chi-square test of independence revealed a significant association between race and the presence of PTSD,  $\chi^2(1) = 4.80, p = 0.014$ . African American women were more likely to have PTSD than Caucasian women, 54% and 31% respectively (Figure 4).



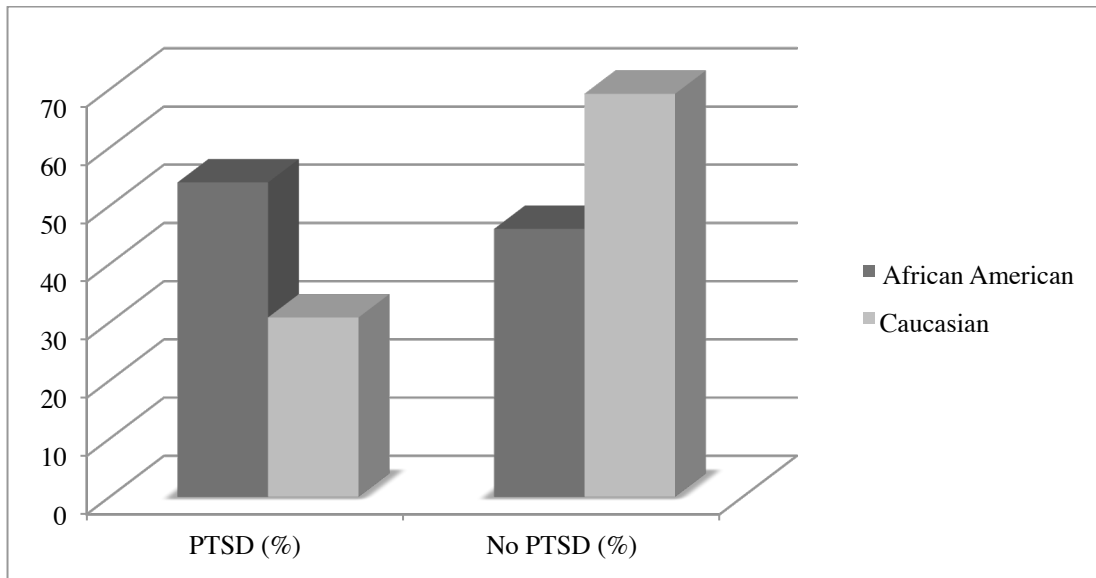


Figure 4. Percentage likelihood of posttraumatic stress disorder by race.

### Hypothesis 3

In order to examine whether PTSD is associated with larger values on metabolic factors, a multivariate analysis of variance (MANOVA) was performed on six dependent variables: fasting glucose, triglycerides, diastolic and systolic blood pressure, waist circumference, and HDL cholesterol, with PTSD diagnosis as the independent variable.

Table 3.

*Means and standard deviations for dependent variable by PTSD.*

	PTSD	No PTSD
<b>Fasting Glucose</b>	84.20 mg/dL (13.42)	83.60 mg/dL (9.93)
<b>HDL Cholesterol*</b>	51.54 mg/dL (13.15)	58.89 mg/dL (17.60)
<b>Triglycerides</b>	81.95.74 mg/dL (43.59)	84.98 mg/dL (30.89)
<b>Waist Circumference*</b>	94.42 cm (20.33)	85.65 cm (17.38)
<b>Blood Pressure</b>		
<b>Systolic</b>	120.42 mm Hg (13.15)	118.93 mm Hg (14.84)
<b>Diastolic</b>	74.78 mm Hg (10.14)	71.41 mm Hg (9.00)
<b>% Meeting MetS criteria</b>	20%	12%

Note. Values enclosed in parentheses indicate Standard Deviations. \*  $p < .05$

Using Pillai's trace, there was a significant effect of PTSD on the overall model,  $V = 0.17$ ,  $F(6, 82) = 2.78$ ,  $p = .017$ . Separate univariate ANOVAs on the outcome variables revealed significant effects on waist circumference,  $F(1, 87) = 4.81$ ,  $p = .031$  (Figure 5), such that women with PTSD had larger values than women without PTSD, as well as significant effects on HDL cholesterol,  $F(1, 87) = 4.74$ ,  $p = .032$ , such that women with PTSD had significantly lower values than women without PTSD (Table 2). There were no significant effects for diastolic blood pressure,  $F(1, 87) = 2.75$ ,  $p = .101$ , systolic blood pressure,  $F(1, 87) = 0.244$ ,  $p = .623$ , triglycerides,  $F(1, 87) = .117$ ,  $p = .734$ , or fasting glucose,  $F(1, 87) = .023$ ,  $p = .879$ .

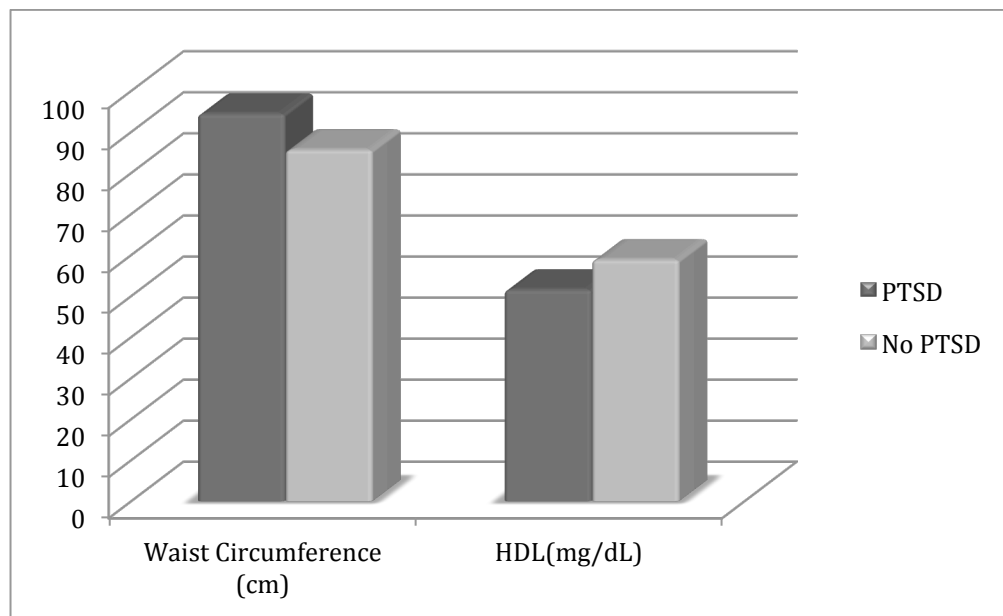


Figure 5. Waist circumference and HDL means by likelihood of PTSD

A chi-square test of independence was performed to examine the relation between PTSD and MetS. There was no statistically significant association between PTSD and the likelihood of MetS,  $\chi^2(1) = 1.198$ ,  $p = 0.274$ . Women with PTSD were not more likely to meet criteria for MetS, with the percentage of likelihood being 20% and 12%, respectively.

#### Hypothesis 4

A series of sequential regressions were performed to examine whether the relationship between psychiatric symptoms and metabolic risk factors is different for African American women and Caucasian women. Prior to analyses, race was coded as a dichotomous variable (Caucasian = 0, African American = 1, the independent variable (PTSD symptoms) was centered and product terms were created from these two variables (Baron & Kenny, 1986). The following are the results from the regression analyses for each of the metabolic risk factors.

**Waist circumference.** PTSD symptoms positively predicted waist circumference,  $\beta = .309$ ,  $t(85) = 2.14$ ,  $p = .036$ , where greater PTSD symptoms were associated with higher waist circumference. Race was also significantly related to waist circumference,  $\beta = .289$ ,  $t(85) = 2.88$ ,  $p = .005$ , such that African Americans had higher values. However, the association between PTSD symptoms and waist circumference was not moderated by race,  $\beta = -.090$ ,  $t(85) = -.631$ ,  $p = .530$  (see Figure 6).

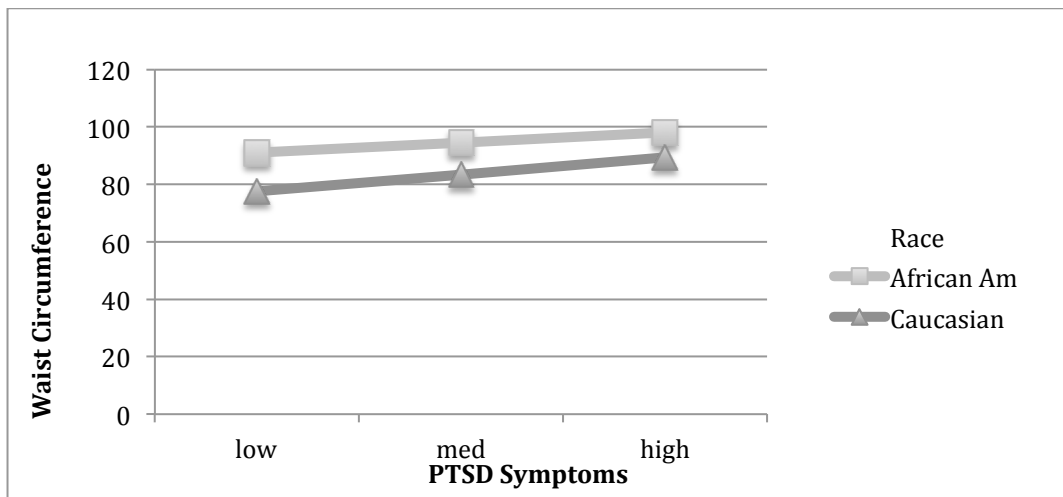


Figure 6. Waist circumference main effects of PTSD by race

Note. Low, medium, and high PTSD symptoms are represented by -1 SD, mean, and +1 SD, respectively

**Blood pressure.** PTSD symptoms were not significantly related to systolic blood pressure,  $\beta = .078$ ,  $t(85) = .551$ ,  $p = .583$ , or diastolic blood pressure,  $\beta = .096$ ,  $t(85) = .687$ ,  $p = .494$ . Race was significantly related to systolic blood pressure,  $\beta = .441$ ,  $t(85) = 4.49$ ,  $p < .001$ , and diastolic blood pressure,  $\beta = .467$ ,  $t(85) = 4.82$ ,  $p < .001$ . Race did not moderate the effect between PTSD symptoms and systolic blood pressure  $\beta = -.191$ ,  $t(85) = -1.37$ ,  $p = .175$ , or diastolic blood pressure,  $\beta = -.168$ ,  $t(85) = -1.22$ ,  $p = .225$ .

**Fasting glucose.** Neither PTSD symptoms,  $\beta = .120$ ,  $t(85) = .764$ ,  $p = .447$ , nor race,  $\beta = -.026$ ,  $t(85) = -.235$ ,  $p = .815$ , were significantly related to fasting glucose levels. Race did not moderate between PTSD symptoms and fasting glucose,  $\beta = -.193$ ,  $t(85) = -1.24$ ,  $p = .218$ .

**HDL cholesterol.** More PTSD symptoms were related to lower HDL cholesterol levels,  $\beta = -.394$ ,  $t(85) = -2.60$ ,  $p = .011$ . Race was not significantly related to HDL cholesterol levels,  $\beta = -.074$ ,  $t(85) = -.706$ ,  $p = .482$ . However, the association between PTSD symptoms and HDL cholesterol was moderated by race,  $\beta = .372$ ,  $t(85) = 2.48$ ,  $p = .015$ . Specifically, there is a negative relation between HDL levels and PTSD symptoms for Caucasian women, while this was not the case for African American women.

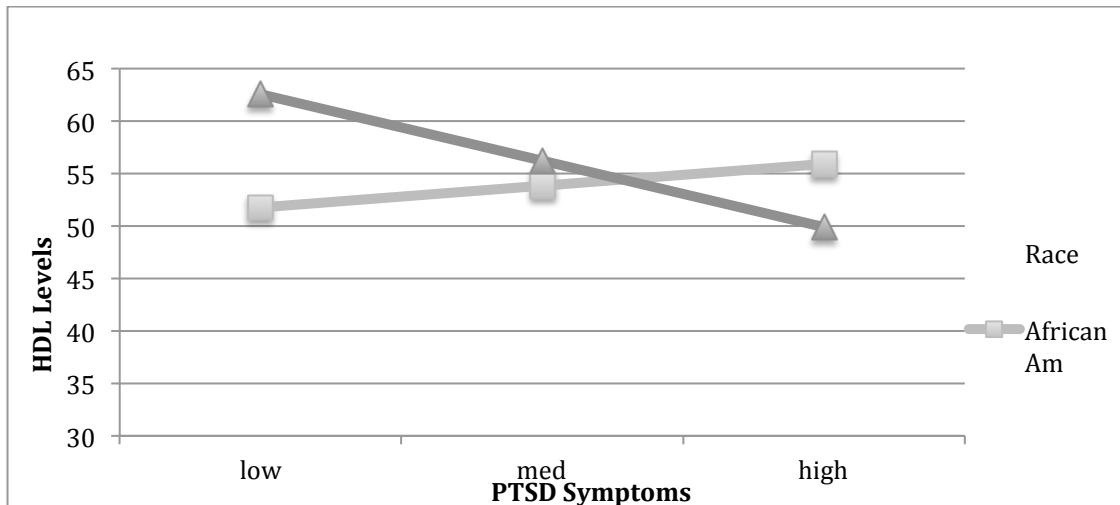


Figure 7. HDL interaction of posttraumatic stress disorder by race.

**Triglycerides.** Neither PTSD symptoms,  $\beta = -.091$ ,  $t(85) = -.586$ ,  $p = .560$ , nor race,  $\beta = -.190$ ,  $t(85) = -1.765$ ,  $p = .081$ , were significantly related to triglyceride levels. Also, race did not moderate the relationship between PTSD symptoms and triglyceride levels,  $\beta = .146$ ,  $t(85) = .949$ ,  $p = .345$ .

**Metabolic syndrome.** A sequential logistic regression analysis was performed to assess the likelihood of meeting criteria for MetS, based on PTSD symptoms and race. A test of the full model against the constant only model was not significant,  $\chi^2(2) = 3.62$ ,  $p = 0.164$ , Nagelkerke  $R^2 = .07$ , indicating that taken together, PTSD symptoms and race did not reliably distinguish the likelihood of meeting criteria for MetS.

**Further exploratory analyses.** In addition to the hypothesis-driven analyses, the possibility of hostility as a mediator of the relation between race and metabolic risk was assessed. A direct logistic regression analysis was conducted with MetS entered as the dependent variable and scores from the Cook Medley Hostility scale as the independent predictor. The model was not statistically significant,  $\chi^2(1, N = 89) = .202$ ,  $p = 0.653$ , as hostility was not found to be a predictor of the likelihood of meeting criteria for MetS.

In order to assess the possible effect of hostility on the relation between race and metabolic risk factors a one-way analysis of variance was first conducted to examine if there were differences in means. The ANOVA indicated that there was a significant effect of race on hostility,  $F(1, 88) = 15.17, p < .001$ , such that African Americans ( $M = 13.74, SD = 5.92$ ) had significantly higher hostility scores than Caucasians ( $M = 9.13, SD = 5.05$ ).

Earlier analysis revealed racial differences for waist circumference, diastolic and systolic blood pressure. For this reason, a regression analysis was performed to assess whether hostility mediated the relation between race and these metabolic risk factors. While hostility was found to be a significant predictor of waist circumference,  $\beta = .229, t(86) = 2.20, p = .031$ , hostility did not mediate the relation between race and waist circumference,  $\beta = .118, t(86) = 1.08, p = .285$ . Regression analysis determined that hostility was not related to diastolic blood pressure,  $\beta = .190, t(87) = 1.81, p = .074$ , or systolic blood pressure,  $\beta = .109, t(87) = 1.02, p = .310$ .

### **Discussion**

Previous research has shown that gender and race are critical aspects in metabolic disease risk factors as well as PTSD symptomology. However, the effect of these variables has received little empirical attention in assessing the possible relationship between PTSD and MetS. The purpose of the current study was to investigate the effect of race on the relation between PTSD diagnosis/symptomology and the presence of metabolic risk factors/MetS diagnosis. This investigation found that race plays a significant role in both the mental and physical health of women, and furthers the understanding of the important relation between race, PTSD and metabolic disease risk.

### **Hypothesis 1: Race and Metabolic Disease Risk**

The first hypothesis examined the racial variability in metabolic risk factors and the likelihood of meeting criteria for MetS. Results from this study were consistent with previous literature in finding that African American women had larger values for waist circumference (Go et al., 2014; McDowell, Fryar, & Ogden, 2009), and diastolic and systolic blood pressure, and were more likely to meet criteria for MetS than Caucasian women (Go et al., 2014). Yet, contrary to what was hypothesized, there were no notable differences found for fasting glucose, triglyceride, and HDL levels.

There is an overwhelming amount of literature indicating that African Americans typically have higher fasting glucose levels and are at a significantly greater risk of developing diabetes than Caucasians (Gregg, Gu, Cheng, Narayan, & Cowie, 2007; Gu, Cowie, & Harris, 1998; Hu et al., 2001; McEwen et al., 2006; Saydah et al., 2004). The age of the current sample ( $M = 29.9$ ,  $SD = 5.67$ ) may contribute to the non-significant findings in fasting glucose levels. According to the National Diabetes Fact sheet statistics, diabetes is associated with older age with typical onset  $\geq 45$  y/o. Also, it is estimated that there are only 3.7% individuals aged 20-44 with diagnosed and undiagnosed diabetes, compared to 13.7% aged 45-64, and 26.9% older than 65. Given that the current sample is both younger than 45 y/o and would fall within the smallest percentage prevalence, this could explain, at least in part, why there were no detectable differences in fasting glucose levels in the current sample. Future research could examine the etiological pathways that cause racial disparities in diabetes, specifically if there are additional mediating factors present that contribute to a greater disparity in African Americans as they age.

In looking deeper into the pattern of results for cholesterol lipids, the literature suggest that, while African American women maintain an increased risk of mortality from heart disease, they typically have a more favorable lipid profile than Caucasian women (Ervin, 2009; Go et al., 2014; Koval, Setji, Reyes, & Brown, 2010; Kurella, Lo, & Chertow, 2005). Findings from the current study add to the existing literature documenting racial differences in this area. In screening participants for a clinical trial, researchers from another study noticed a potential racial disparity in women who responded to the advertisement (McIntosh et al., 2013). The researchers designed a nested observational study in order to assess differences in metabolic risk factors in African American women and Caucasian women. The researchers found only 7% of African American women, compared to 41% of Caucasian women, had triglyceride levels that met MetS criteria (McIntosh et al., 2013).

Another study sought to examine racial differences in lipid levels among a sample of African American and Caucasian premenopausal (18-36 y/o) women (Lamon-Fava et al., 2005). The authors found that compared to Caucasian women, African American women had significantly higher BMI and waist-to-hip ratios, and significantly lower triglyceride levels. Similarly, a study examining racial differences in physiological patterns among women found that African American women had lower mean triglyceride levels, higher blood pressure levels, and lower fasting glucose levels (Ladson et al., 2011). Due to these racial differences in blood lipids, some researchers have suggested that the current criteria for MetS may result in an underestimation of cardiovascular risk in African Americans (Appel et al., 2006; McIntosh et al., 2013) and have led others to suggest establishing different metabolic criteria depending on race (Appel et al., 2006;



Haffner et al., 1999; Zeno et al., 2010).

## **Hypothesis 2: Race and PTSD**

The second hypothesis examined racial variability in PTSD diagnosis. While the gender disparity in PTSD is well documented in the literature, little is known about the effect of race, and even less is known about the compounded effect of race and gender. Consistent with previous literature (Himle, Baser, Taylor, Campbell, & Jackson, 2009, Roberts, Gilman, Breslau, Breslau, & Koenen, 2011), the current study found that African American women had higher rates of PTSD than Caucasian women.

Roberts et al. (2011) conducted a study examining the differences in exposure to traumatic events and the development of posttraumatic stress disorder. The authors found that the lifetime prevalence of PTSD was highest among African Americans (Roberts, Gilman, Breslau, Breslau, & Koenen, 2011). Similarly, a study using data from the National Epidemiologic Survey on Alcohol and Related Conditions found that the lifetime prevalence of PTSD in African Americans (8.7%) was significantly higher than both the general population (7.3%) and Caucasians (7.4%).

Another study examined race as a possible risk factor for PTSD in a group of 1,581 women (Seng, Kohn-Wood, McPherson, & Sperlich, 2011). The authors of this study found that African American women had higher rates of lifetime PTSD (24%) and fourfold higher rates of current PTSD (13.4%) when compared to non-African Americans (Seng et al., 2011). Findings from the current study add to the existing literature by further documenting a racial difference in women, as little attention has been given to this population.

### **Hypothesis 3: PTSD and Metabolic Disease Risk**

The third hypothesis examined whether PTSD diagnosis was associated with larger values on the metabolic risk factors and an increased likelihood of meeting criteria for MetS. Women with PTSD had higher waist circumferences and lower HDL cholesterol levels. While the relation between PTSD and waist circumference was consistent with previous research and the findings from Dedert et al., 2010, the relation between PTSD and HDL was a unique finding in this study in that this was not detected in the previous Dedert et al. study. Yet the findings from the current study are consistent with the literature indicating that PTSD was related to lower HDL levels (Kagan, Leskin, Haas, Wilkins, & Foy, 1999; Karlovic, Buljan, Martinac, & Marcinko, 2004; Solter, Thaller, Karlovic, & Crnkovic, 2002).

There were no significant differences in blood pressure, fasting glucose or triglycerides levels. There was also no increased risk in the likelihood of meeting criteria for MetS in women with PTSD. Though these findings may appear to be inconsistent with research evidencing exaggerated cardiovascular risk in individuals with PTSD, research focusing specifically on blood pressure and PTSD has been mixed, with some demonstrating elevated basal blood pressure in participants with PTSD (Cohen et al., 1997; Gerardi, Keane, Cahoon, & Klauminzer, 1994; Muraoka, Carlson, & Chemtob, 1998) and others finding no difference (McFall, Veith, & Murburg, 1992; Orr, Meyerhoff, Edwards, & Pitman, 1998; Shalev, Bleich, & Ursano, 1990).

The findings in the current study may be due to the age of the sample. Because hypertension, diabetes, and hypertriglyceridemia are age-related chronic illnesses, having a relatively younger sample may account for the non-significant findings in the current

sample. Women aged 20-34 account for only 6.8% of individuals with high blood pressure, and less than 1% of those with hypertriglyceridemia. Also, studies showing a significant relation between PTSD and cardiovascular risk typically use samples with higher mean age than the one used in the current study. For example, the mean age in a meta-analysis comparing adults with and without PTSD on psychophysiological variables was 41.6 (Pole, 2007). This meta-analysis included 122 studies. Again, as the metabolic risk factors assessed in the current study are age-related chronic conditions, participants in the current study may have not yet developed significant medical problems in this area.

Another explanation for the inconsistent findings related to blood pressure may be differences in the duration of PTSD symptoms. As numerous studies show that, relative to individuals without PTSD, those with PTSD show exaggerated cardiovascular responses to trauma cues, particularly heart rate variability (Cohen et al., 1997; Griffin, 2008; Vrana, Hughes, Dennis, Calhoun, & Beckham, 2009), this repeated autonomic reactivity may result in structural and/or functional changes in the cardiovascular system over time, ultimately leading to an increase in blood pressure (Buckley & Kaloupek, 2001). Again, this may explain why there are significant effects for PTSD and cardiovascular risk factors in older individuals, and why these effects were not present in the current study.

#### **Hypothesis 4: PTSD symptoms, Race and Metabolic Disease Risk**

The fourth hypothesis examined whether the relation between PTSD symptoms and metabolic risk factors was different for African American women than for Caucasian women. Contrary to what was expected, there were no differences found in the relation between PTSD symptoms and blood pressure, fasting glucose, triglycerides or MetS.

While PTSD symptoms and race were both positively related to waist circumference, these variables were related to PTSD independent of each other. In other words, waist circumference increased as PTSD symptomology increased in both African American and Caucasian women.

However, women with PTSD also had significantly lower levels of HDL cholesterol. While race was not independently related to HDL levels, Caucasian women with PTSD had significantly lower HDL levels when compared to Caucasian women without PTSD. This effect was not present in African American women. As mentioned earlier, research has shown that African Americans typically have a more favorable lipid profile than Caucasian women. As such, given that African Americans have a higher prevalence and mortality for cardiovascular related diseases, these findings again beg the question of whether lipid variables are reliable indicators of possible metabolic abnormalities in African Americans and if race specific criteria should be used to assess CVD risk.

### **Limitations**

Within the current study, the term “African American” was used broadly to represent individuals of African descent. As African Americans are not a monolithic group and, as such, have varied cultural identities and social experiences, future studies should consider the cultural implications of the African diaspora and its possible impact on both physical and mental health outcomes.

Similarly, there is increasing literature that suggests a relation between perceived discrimination in minority groups and both physical and mental health outcomes (Bostwick, Boyd, Hughes, West, & McCabe, 2014; Haywood et al., 2014; Unger,

Schwartz, Huh, Soto, & Baezconde-Garbanati, 2014). While the current study showed significant racial differences in both physical and mental health variables, future studies should consider the potential effects of perceived discrimination and minority related stress specifically as it relates to disparities, both by gender and racial category.

Another limitation of the current study is the age of the sample. The metabolic risk factors examined in this study are those that are present in chronic illnesses that develop over time. For example, the median age of first acute myocardial infarction (heart attack) is 65 years old in men and 56 years old in women. While the median age of the current sample ( $M = 29.9$ ) is significantly younger than the age of onset for most cardiovascular diseases, differences by age in the current sample could have had an effect on the results. The median age of individuals with PTSD ( $M = 32.4$ ) was significantly higher than that of those without PTSD ( $M = 28.0$ ). Given that individuals with a psychiatric diagnosis are more likely to use substances like tobacco and alcohol (Beckham et al., 1997; Bremner, Southwick, Darnell, & Charney, 1996; Epstein, Saunders, Kilpatrick, & Resnick, 1998; Lasser et al., 2000), and are also more likely to have more sedentary lifestyles (Goodwin, 2003; Ramsay & Farmer, 1988), the difference in years and the deleterious effects of PTSD on decisions related to physical health could have had an effect on the differences found in metabolic health by PTSD diagnosis. Future research should include variables that measure the frequency of substance use and physical activity.

### **Conclusion**

African American women are at the intersection of heightened prevalence across categories of race and gender. As identified in the literature, African American women

bear a disproportionate physical burden from metabolic-related conditions and are at higher risk of psychiatric morbidity. Findings from the current study are not only consistent with research suggesting disparate rates of PTSD and MetS in African American women, but also suggest that these disparities are evident in younger populations.

There has been little empirical attention given to the possible effects of race on the relation between psychiatric and physical health. The current study sought to shed light on the possible effect of race on the relation between PTSD and metabolic health. The significant findings between race and the metabolic components of MetS warrant further research to help elucidate the mechanisms involved in development of the MetS and the trajectories leading to cardiovascular disease. Future studies should include longitudinal data. Time-trend analysis would allow for observations of psychiatric and metabolic data and their relation over time. As metabolic risk factors develop into chronic conditions over time, each measure would have its own psychophysiological underpinning that may be informative about possible racial differences in the pathophysiology of PTSD.

Finally, future research on the influence of race on the relation between psychiatric symptomology and metabolic health would benefit from the consideration of cultural variables that may potentially provide direction in the etiology of disease pathways. Diagnosis can be challenging as manifestations of mental disorders vary with gender, race, and culture. Further research is needed to develop appropriate treatments and prevention efforts to reduce the burden of metabolic disease risk, particularly in high-risk populations.

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## List of References

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## Appendix A

### Correlation Matrix of Study Variables

	Latent Variable	Age	SES	Diastolic Blood Pressure	Systolic Blood Pressure	Waist Circumference	HDL	Triglyceride	Fasting Glucose
Latent Variable	1								
Age	.288**	1							
SES	.170	.023	1						
Diastolic Blood Pressure	.059	.166	.071	1					
Systolic Blood Pressure	.020	.167	.125	.870**	1				
Waist Circumference	.296**	.423**	.180	.361**	.418**	1			
HDL	-.138	-.353**	-.163	-.220*	-.258**	-.305**	1		
Triglyceride	-.020	.190	-.073	.135	.166	.242*	-.228*	1	
Fasting Glucose	-.018	.196	.052	.272*	.178	.178	-.169	.164	1

\* $p < .05$ ; \*\* $p < .001$

## Appendix B

### Summary of Index Traumas

<b>Trauma Category</b>	<b>Frequency (%)</b>
<b>Combat</b>	8.6
<b>Physical/Sexual Assault</b>	
<b>Child</b>	19.8
<b>Adult</b>	18.5
<b>Accident/MVA/Fire</b>	6.2
<b>Domestic Violence</b>	7.4
<b>Death of Someone</b>	17.3
<b>Witness/Experience</b>	
<b>Violence</b>	
<b>Child</b>	4.9
<b>Adult</b>	11.1
<b>Natural Disaster</b>	1.2
<b>Other</b>	4.9

## Vita

Leia Adelle Harper was born on September 16, 1980 in Jackson, Mississippi. She graduated from Clark Atlanta University in 2005 with a Bachelor of Science degree in mathematics and Bachelor of Arts degree in religion. In 2009, she received a Master of Divinity degree from Duke University. She entered the Psychology Ph.D program at Virginia Commonwealth University in August of 2011, and completed her Masters of Science in May of 2015.