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THE RELATIONSHIP BETWEEN MATERNAL ALLOSTATIC LOAD AND DEMOGRAPHIC CHARACTERISTICS WITHIN DIFFERENT ETHNIC POPULATIONS AND DIFFERENT FEDERAL-LEVEL POVERTY GROUPS

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Abstract

Background: The purpose of this study is to investigate the relationship between maternal allostatic load, a measure of the cumulative toll of chronic stress, and demographic characteristics within different ethnic populations and different federal-level poverty groups, which provides some foundational research prior to investigating the association of maternal allostatic load with the outcome of a subsequent pregnancy.

Methods: This study is a part of a large study conducted by the Community and Child Health Network (CCHN). The CCHN allostatic load data set includes 10 objective biomarkers taken at the T2M visit (six months postpartum) and the T3M visit (12 months postpartum) for the mothers. The linear mixed-effects model was used to analyze the differences of all maternal allostatic load variables between the T2M visit and the T3M visit. Next, principal component analysis was applied to summarize the variability across maternal allostatic load variables in different ethnicity and poverty level groups and to do variable reduction. Finally, regression analysis was invoked to determine the relationship between maternal allostatic load variables and demographic variables within different ethnicity and poverty level groups.

Results: From the linear mixed-effects regression analysis, there were significant differences on total cholesterol between the T2M visit and the T3M visit in poor Hispanic group (Difference=-9.9, SE=4.6, p=0.03), in the rich White group (Difference=-8.5, SE=3.7, p=0.02), and in the middle White group (Difference=-29.9, SE=7.2, p<0.0001). Principal component analysis identified two principal components of the biomarkers of maternal allostatic load. The first principal component was total cholesterol and the second principal component can be explained as a weighted average of systolic blood pressure and diastolic blood pressure. The comparisons of each allostatic load variable between different groups by ethnicity and poverty level at the T3M visit showed the only difference of mid-arm circumference between the middle Africa-American group and the middle White group after performing Hochberg step-down procedure (Difference=8.6, 95% Confidence Limits: 3.8-13.3, p=0.0004). The group wise comparisons of overall allostatic load variables at the T3M visit showed no statistical significance.

Conclusions: There were no differences on most allostatic load biomarkers among 18 to 40 years old women within different ethnicity and poverty level groups while accounting for education, recruitment location, and age as covariables.

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Introduction

Differential exposure to stressors may explain a portion of health disparities. Allostatic load is a construct theorized to quantify stress-induced biological risk. Differences in allostatic load may reflect the accumulation of physiological changes induced by differences in exposure to stressors and thus provide a mechanistic link to understanding and studying health disparities.[1]The concept of allostasis refers to the body's adaptation to stressors through sympathetic nervous system, in particular the hypothalamic-pituitary-adrenal (HPA) axis, and the immune system. [1] Repeated or prolonged activation of the hypothalamic-pituitary-adrenal axis leads to a loss of effectiveness and efficiency in stress hormone feedback mechanisms. [2] As a result, the cumulative dysregulation of biological systems with prolonged or poorly regulated allostatic responses leads to allostatic load.[3] It has been associated with declines in physical and neurocognitive function and increased risk for many diseases.[4,5] The specific measurement of allostatic load varies across research studies, but it has generally included levels of hormones secreted in response to stress (primary, direct mediators) and/or biomarkers that reflect the effects of these hormones on the body (secondary, indirect mediators).[6] Based on prior literature, 10 objective biomarkers were collected in the study conducted by the Community and Childhood Health Network (CCHN). These biomarkers included cardiovascular markers (systolic blood pressure, diastolic blood pressure, pulse, total cholesterol, HDL, body mass index), metabolic markers (waist to hip ratio, glycosylated hemoglobin, mid-arm circumferences), and inflammatory markers (C-reactive protein).

Many factors of the preconception period may influence pregnancy outcomes and child health. Racial-ethnic disparities in birth outcomes are the consequences of not only differential exposures to protective and risk factors during pregnancy, but also cumulative allostatic load over the life course.[7] Many maternal and childhood health problems, including asthma, overweight/obesity, diabetes, hypertension, and allergies, have been associated with stress-regulation processes over the life course.[8] Thus, maternal allostatic load has been an important factor in the Preconception Stress and Resiliency Pathways

(PSRP) model, which is a novel model to rethink the health disparities in pregnancy outcomes and early childhood development, to influence birth outcomes for future generations.

Numerous studies have displayed health disparities among different racial groups. Allostatic load burden partially explains the disparities, independent of socioeconomic status (SES) and health behaviors.[9] On the other hand, allostatic load is associated with SES, along with education and age.[3] The published literature demonstrates that allostatic load is elevated in those of low SES as compared to those of high SES.[1] The purpose of this study is to investigate the relationship between maternal allostatic load and demographic characteristics within different ethnic populations and different federal-level poverty groups, which provides some foundational research prior to investigating the association of maternal allostatic load with the outcome of a subsequent pregnancy.

Methods

This study is part of a large study, which is being conducted by the Community and Child Health Network (CCHN), a large community-based participatory research network in perinatal medicine. The goal of the research of CCHN was to examine how community-, family-, and individual- level stressors may influence and interact with biological factors to affect maternal and child health. CCHN examined the factors associated with maternal allostatic load (biological stress markers) and the effects of these factors on disparities in perinatal outcomes.

Study Subjects

As part of the research leading by NIH Community Child Health Network (CCHN), the study subjects included 4837 people in all, 3079 of them women in their postpartum period and 1758 spouses. Most participants were from predominantly lower socioeconomic levels, living in African American, Latina, or Caucasian communities in five regions of the United States, i.e. Baltimore, Chicago, Los Angeles, North Carolina, and Washington DC.

Data Structure

The demographic variables include age, ethnicity, foreign born status, federal poverty level, education and center. Ethnicity was identified as "African-American or Black", "White or Caucasian", and "Latina or Hispanic". With respect to federal poverty level, three poverty categories were derived based on the US Census Bureau, Weighted Average Poverty Thresholds 2009[10], which vary according to the size of the household without requiring information on the number of related children under 18 years: (1) <=100% federal poverty level (FPL) (indication income at or less than poverty threshold); (2) 101-200% FPL; (3) >200% FPL. According to the years of school completed and highest degree earned, education was divided in five groups, i.e. "Less than High School", "High School, GED, Certificate, Technical", "Some college but not 4-year degree", "4-year degree or higher", and "Other, no information". Among the five study centers there were three urban (Baltimore, Los Angeles, Washington, DC), one suburban (Chicago), and one rural (North Carolina).

The CCHN allostatic load data set includes measurements taken at the T2M visit (six months postpartum) and the T3M visit (12 months postpartum) for the mothers. The allostatic load variables are as follows: C-reactive protein, hemoglobin A1C, total cholesterol, HDL cholesterol, mid-arm circumference, systolic blood pressure, diastolic blood pressure, pulse, waist-to-hip ratio, body mass index.

Statistical Analyses

Descriptive statistics, adjusted means and standard deviations, were prepared for 10 allostatic load variables in different ethnicity and federal poverty level groups. The linear mixed-effects model was used to analyze the differences of all maternal allostatic load variables between T2M visit and T3M visit at five centers. Next, principal component analysis was applied to summarize the variability across maternal allostatic load variables in different ethnicity and poverty level groups and to do data reduction. Finally, regression analysis was invoked to determine the relationship between maternal allostatic load variables and demographic variables within different ethnicity and poverty level

groups. Each allostatic load variable was compared across different ethnicity and poverty level groups using univariate regression models and multivariate regression model was used to compare overall effect of all allostatic load variables within different ethnicity and poverty level groups. Findings were considered statistically significant for $p<0.05$. Reported p-values for comparisons of maternal allostatic load variables in different groups were adjusted via the Hochberg step-down procedure. Data were analyzed using the statistical program SAS version 9.4 (SAS Institute Inc, Cary, NC).

Results

Descriptive Statistics

The number and adjusted means with standard errors of each allostatic load variable by ethnicity and federal poverty level are shown in Table 1(see Appendix). Poor African-American and poor Hispanic demonstrate worse results than poor Whites.

Linear Mixed-effects Regression

The differences of allostatic load variables between 6 months postpartum (T2M visit) and 12 months postpartum (T3M visit) within different ethnicity and poverty level groups are shown in Table 2(see Appendix). For total cholesterol, there were significant differences between 6 months postpartum and 12 months postpartum in poor Hispanic group (Latina or Hispanic and <=100% FPL) (Difference=-9.9, SE=4.6, p=0.03), in rich White group (White or Caucasian and >=200% FPL) (Difference=-8.5, SE=3.7, p=0.02), and in middle White group (White or Caucasian and >100 to 200% FPL) (Difference=-29.9, SE=7.2, p<.0001). For systolic blood pressure, there was significant difference between 6 months postpartum and 12 months postpartum in middle Hispanic group (Latina or Hispanic and >100 to 200% FPL) (Difference=2.6, SE=1.1, p=0.02). For pulse, there was significant difference between 6 months postpartum and 12 months postpartum in rich Hispanic group (Latina or Hispanic and >200% FPL) (Difference=3.3, SE=1.6, p=0.049).

Principal Component Analysis

Within the 9 different groups by ethnicity and poverty level, the principal components and the cumulative proportions are shown in Table 3(see Appendix). The first two principal components explain 80.8%-87.0% of the total variability of the biomarkers through the 9 groups. The first principal component was total cholesterol for all the 9 groups. The second principal component can be explained as a weighted average of systolic blood pressure and diastolic blood pressure in poor AA group, middle AA group, rich AA group, poor White group, poor and middle Hispanic groups. In middle White group, rich White group and rich Hispanic group, the second principal component increases with only one value, decreasing HDL. Of all the groups the first principal component was total cholesterol and the second principal component was a weighted average of systolic blood pressure and diastolic blood pressure. The cumulative proportion of these two principal components was 82.1%.

Univariate Regression Analysis

At 12 months postpartum, the comparisons of each allostatic load variable between different groups by ethnicity and poverty level are shown in Table 4(see Appendix). Reported p-values were adjusted via Hochberg step-down procedure. Only the difference of mid-arm circumference between middle Africa-America group (African-American or Black and 101-200% FPL) and middle White group (White or Caucasian and 101-200% FPL) indicated statistical significance after performing Hochberg step-down procedure (Difference=8.6, 95% Confidence Limits: 3.8-13.3, p=0.0004).

Multivariate Regression Analysis

At 12 months postpartum, the group wise comparisons of overall allostatic load variables are shown in Table 5(see Appendix). After adjusting p-values using Hochberg step-down procedure, none of them showed statistical significance.

Discussion

Allostatic load measurements provide an effect way to explain differential social and environmental risks for chronic diseases accounting for ethnic and racial disparities. From the NHANES studies, the investigators found that there are racial disparities in allostatic load among young through middle-aged adults. Allostatic load was higher in Blacks than in Whites.[3] Maeve Wallace etc. also found that mean allostatic load score was higher among African American women compared to whites, which was consistent with previous literature.[11] Lower education, income gradients and social economic status were related to higher allostatic load across all ethnic groups. Foreign-born status had significant association with higher allostatic load due to the stressful influences of immigration.[3] Allostatic load has demonstrated great prediction in many health problems and it may prove to be a potential contributor to adverse birth outcomes. Based on the evidence of important influence of allostasis, CCHN investigated the role of maternal allostatic load in preconception period on pregnancy outcomes and child health. In this study we focus on the relationship between demographic characteristics (e.g. age, race, foreign-born status, federal poverty level, education, location) and allostatic load.

Most of the biomarkers of allostatic load indicated no significant difference between 6-month postpartum and 12-month postpartum. The differences mainly lied in comparing total cholesterol in poor Hispanic group, in rich White group, and in middle White group. High concentration of cholesterol is a common finding during pregnancy and during early postpartum period and total cholesterol usually drops around 4 weeks postpartum. There was, however, a strikingly more rapid fall of plasma cholesterol in those mothers who breast-fed their infants compared with that in those whom lactation was never established.[12, 13] Thus, the decreases in total cholesterol can be explained by the normal changes after delivery. In a conclusion, the biomarkers of allostatic load indicate no significant difference between 6-month postpartum and 12-month postpartum, which means allostatic load is relatively stable during the 6-month postpartum period.

Our hypothesis of this study is that there are differences of the allostatic load variables in different ethnicity and poverty groups, especially white vs. black and white vs. Hispanic. Contrary to our hypothesis, however, we didn't find the differences in most allostatic load vairables. Nor was there any difference of all the allostatic load biomarkers in any ethnicity and poverty groups. The reasons may be:

(1)Racial differences in allostatic load are caused by persistent experiences of racism, poverty, educational disadvantage, and perceived stress and anxiety.[14] In the model used to study the association between allostatic load and interaction of ethnicity and poverty was adjusted by education, recruitment location, age, etc. Among these adjusting factors, education is associated with poverty level and ethnicity and might be termed an intermediate variable. After adjusting education, the differences in allostatic load biomarkers may be deviated as they are supposed to.

(2)In an addition, racial/ethnic differences in allostatic load, according to the previous literature, exist in general population. The unique study population in this study may be one reason of failure to find any difference among the groups that considered both the race and the level of poverty. The women included in this study were in their postpartum period, most of whom were from lower socioeconomic levels. And the relatively young age in this population (mean=25.88, SD=5.78) may contribute to the reason. Geronimus et al.[14] reported little difference in allostatic load scores among women younger than age 35 but significant and increasing racial gaps thereafter up to age 64.

(3)Also, Hochberg step-down procedure is a more powerful procedure for multiple tests of significance than Bonferroni adjustment.[15] Before performing Hochberg procedure, more racial differences in allostatic load biomarkers were found.

An additional finding from this study is the result of principal component analysis, which was applied to produce an empirical summary of the total variance by principal components. The first principal component was strongly correlated with total cholesterol. The second principal component loaded on systolic blood pressure and diastolic blood pressure and can be described as "blood pressure". Allostatic load score can be constructed based on the contribution of each biomarker according to the principal

component analysis. Some association using unweighted allostatic load not identified as significant were found significant when using weighted allostatic load score.[16] Allostatic load score can be constructed based on the weighted contribution of the biomarkers in the future study.

There are limitations to the study. First, of the 10 physiological biomarkers of allostatic load, there are no measures of stress hormones (cortisol, catecholamines, or their antagonists) to present the primary, direct mediators. CCHN attempted to measure salivary cortisol, but experienced more than 60% missing data. Although the absence of stress hormones in a summary measure of allostatic load is arguably inadequate[5], further studies should examine alternative biomarkers of allostatic load, including stress hormones, to study the preconception allostatic load on birth outcomes. Second, education level may be a potential mediator of ethnic and poverty differences in allostatic load. Future research can investigate the racial differences of allostatic load with considering the education level as an intermediate variable.

Conclusions

Allostatic load is a measurement of the cumulative toll of chronic stress that may be useful in health disparities. In our research, we didn't find any differences on most allostatic load biomarkers among 18 to 40 years old women within different ethnicity and poverty level groups while accounting for education, recruitment location, and age as covariables.

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Appendix

Table 1. Descriptive statistics of allostatic load biomarkers in different ethnicity and poverty level groups (T3M visit)

Group	Variable	N	Adjusted Mean(SE)
AA <=100% FPL	HbA1c	457	5.6 (0.2)
AA >100 to 200% FPL	HbA1c	194	5.4 (0.2)
AA >200% FPL	HbA1c	183	5.3 (0.2)
White <=100% FPL	HbA1c	69	4.9 (0.6)
White >100 to 200% FPL	HbA1c	66	4.8 (0.3)
White >200% FPL	HbA1c	234	5.0 (0.2)
Hispanic <=100% FPL	HbA1c	167	5.5 (0.3)
Hispanic >100 to 200% FPL	HbA1c	188	5.3 (0.3)
Hispanic >200% FPL	HbA1c	57	5.3 (0.4)
AA <=100% FPL	CRP	452	6.2 (1.1)
AA >100 to 200% FPL	CRP	196	4.3 (1.2)
AA >200% FPL	CRP	181	4.4 (1.1)
White <=100% FPL	CRP	69	0.9 (2.7)
White >100 to 200% FPL	CRP	66	1.7 (1.5)
White >200% FPL	CRP	233	5.0 (0.9)
Hispanic <=100% FPL	CRP	167	5.5 (1.5)
Hispanic >100 to 200% FPL	CRP	188	4.1 (1.7)
Hispanic >200% FPL	CRP	58	2.7 (1.8)
AA <=100% FPL	Cholesterol	429	164.4 (10.4)
AA >100 to 200% FPL	Cholesterol	180	165.7 (11.4)
AA >200% FPL	Cholesterol	171	149.7 (11.1)
White <=100% FPL	Cholesterol	66	162.4 (24.6)
White >100 to 200% FPL	Cholesterol	64	157.3 (13.3)
White >200% FPL	Cholesterol	226	168.0 (8.2)
Hispanic <=100% FPL	Cholesterol	167	148.1 (14.0)
Hispanic >100 to 200% FPL	Cholesterol	188	153.8 (15.1)
Hispanic >200% FPL	Cholesterol	57	142.7 (16.6)
AA <=100% FPL	HDL	394	48.6 (3.7)
AA >100 to 200% FPL	HDL	175	52.0 (4.0)
AA >200% FPL	HDL	165	43.9 (3.7)
White <=100% FPL	HDL	61	46.6 (8.9)
White >100 to 200% FPL	HDL	55	42.2 (5.7)
White >200% FPL	HDL	214	42.0 (3.0)
Hispanic <=100% FPL	HDL	139	39.5 (5.1)
Hispanic >100 to 200% FPL	HDL	159	43.7 (5.7)
Hispanic >200% FPL	HDL	54	43.4 (5.9)
AA <=100% FPL	mac	436	30.5 (1.7)
AA >100 to 200% FPL	mac	186	33.5 (1.7)

AA >200% FPL	mac	164	27.9 (1.5)
White <=100% FPL	mac	69	25.6 (3.5)
White >100 to 200% FPL	mac	64	24.9 (1.7)
White >200% FPL	mac	230	29.7 (1.2)
Hispanic <=100% FPL	mac	149	32.6 (2.1)
Hispanic >100 to 200% FPL	mac	154	28.2 (2.2)
Hispanic >200% FPL	mac	55	26.0 (2.8)
AA <=100% FPL	sbp	458	113.3 (3.1)
AA >100 to 200% FPL	sbp	200	114.2 (3.2)
AA >200% FPL	sbp	184	106.7 (2.9)
White <=100% FPL	sbp	68	106.1 (7.2)
White >100 to 200% FPL	sbp	66	104.0 (3.5)
White >200% FPL	sbp	238	107.6 (2.3)
Hispanic <=100% FPL	sbp	165	110.2 (4.1)
Hispanic >100 to 200% FPL	sbp	189	104.4 (4.5)
Hispanic >200% FPL	sbp	61	104.8 (4.9)
AA <=100% FPL	dbp	458	75.3 (2.5)
AA >100 to 200% FPL	dbp	200	73.4 (2.7)
AA >200% FPL	dbp	184	68.9 (2.4)
White <=100% FPL	dbp	68	68.2 (6.0)
White >100 to 200% FPL	dbp	66	69.6 (2.9)
White >200% FPL	dbp	238	69.5 (1.9)
Hispanic <=100% FPL	dbp	165	71.8 (3.4)
Hispanic >100 to 200% FPL	dbp	189	66.4 (3.7)
Hispanic >200% FPL	dbp	61	73.0 (4.0)
AA <=100% FPL	pulse	458	75.5 (2.7)
AA >100 to 200% FPL	pulse	200	81.5 (2.8)
AA >200% FPL	pulse	184	75.9 (2.5)
White <=100% FPL	pulse	68	76.5 (6.3)
White >100 to 200% FPL	pulse	66	78.1 (3.1)
White >200% FPL	pulse	238	77.5 (2.0)
Hispanic <=100% FPL	pulse	165	76.8 (3.6)
Hispanic >100 to 200% FPL	pulse	189	75.3 (3.9)
Hispanic >200% FPL	pulse	61	77.5 (4.3)
AA <=100% FPL	wh_ratio	466	0.85 (0.02)
AA >100 to 200% FPL	wh_ratio	201	0.88 (0.02)
AA >200% FPL	wh_ratio	186	0.85 (0.02)
White <=100% FPL	wh_ratio	68	0.86 (0.05)
White >100 to 200% FPL	wh_ratio	65	0.91 (0.03)
White >200% FPL	wh_ratio	234	0.86 (0.02)
Hispanic <=100% FPL	wh_ratio	164	0.95 (0.03)
Hispanic >100 to 200% FPL	wh_ratio	183	0.88 (0.03)
Hispanic >200% FPL	wh_ratio	55	0.87 (0.03)

AA <=100% FPL	BMI	456	29.08 (2.02)
AA >100 to 200% FPL	BMI	195	29.34 (2.44)
AA >200% FPL	BMI	182	28.22 (1.99)
White <=100% FPL	BMI	66	22.86 (4.80)
White >100 to 200% FPL	BMI	65	25.69 (2.32)
White >200% FPL	BMI	240	27.97 (1.53)
Hispanic <=100% FPL	BMI	167	37.21 (2.74)
Hispanic >100 to 200% FPL	BMI	185	28.55 (2.96)
Hispanic >200% FPL	BMI	58	27.12 (3.27)

Abbreviations: AA= African-American or Black; White=White or Caucasian; Hispanic=Latina or Hispanic; FPL=Federal Poverty Level; HbA1c=hemoglobin A1C; CRP=C-reactive protein; Cholesterol=total cholesterol; HDL=high-density lipoprotein; mac=mid-arm circumference; sbp=systolic blood pressure; dbp=diastolic blood pressure; wh_ratio=waist-to-hip ratio; BMI=body mass index.

Table 2. Differences of allostatic load biomarkers between T2M visit and T3M visits in different ethnicity and poverty level groups

Group	Variable	Diff (SE)	P-value
AA <=100% FPL	HbA1c	0.06 (0.06)	0.32
AA >100 to 200% FPL	HbA1c	0.07 (0.08)	0.37
AA >200% FPL	HbA1c	-0.03 (0.12)	0.80
White <=100% FPL	HbA1c	0.08 (0.14)	0.59
White >100 to 200% FPL	HbA1c	0.04 (0.09)	0.64
White >200% FPL	HbA1c	0.02 (0.05)	0.62
Hispanic <=100% FPL	HbA1c	0.02 (0.08)	0.77
Hispanic >100 to 200% FPL	HbA1c	0.03 (0.07)	0.68
Hispanic >200% FPL	HbA1c	0.006 (0.16)	0.97
AA <=100% FPL	CRP	0.3 (0.3)	0.22
AA >100 to 200% FPL	CRP	0.5 (0.4)	0.20
AA >200% FPL	CRP	-0.5 (0.4)	0.27
White <=100% FPL	CRP	0.7 (0.7)	0.31
White >100 to 200% FPL	CRP	0.06 (0.78)	0.94
White >200% FPL	CRP	0.06 (0.33)	0.85
Hispanic <=100% FPL	CRP	0.5 (0.4)	0.25
Hispanic >100 to 200% FPL	CRP	0.7 (0.4)	0.09
Hispanic >200% FPL	CRP	-0.2 (0.7)	0.81
AA <=100% FPL	Cholesterol	-4.9 (2.6)	0.06
AA >100 to 200% FPL	Cholesterol	-4.9 (4.1)	0.24
AA >200% FPL	Cholesterol	-3.8 (4.7)	0.41
White <=100% FPL	Cholesterol	-7.2 (6.3)	0.26
White >100 to 200% FPL	Cholesterol	-29.9 (7.2)	<.0001
White >200% FPL	Cholesterol	-8.5 (3.7)	0.02
Hispanic <=100% FPL	Cholesterol	-9.9 (4.6)	0.03
Hispanic >100 to 200% FPL	Cholesterol	-1.6 (3.9)	0.68
Hispanic >200% FPL	Cholesterol	1.4 (8.3)	0.87
AA <=100% FPL	HDL	0.5 (1.0)	0.58
AA >100 to 200% FPL	HDL	2.4 (1.5)	0.12
AA >200% FPL	HDL	-0.4 (1.6)	0.81
White <=100% FPL	HDL	0.4 (2.1)	0.86
White >100 to 200% FPL	HDL	-2.4 (2.5)	0.34
White >200% FPL	HDL	-2.3 (1.5)	0.13
Hispanic <=100% FPL	HDL	-3.0 (1.6)	0.06
Hispanic >100 to 200% FPL	HDL	2.0 (1.5)	0.18
Hispanic >200% FPL	HDL	2.3 (3.2)	0.47
AA <=100% FPL	mac	-0.1 (0.4)	0.78
AA >100 to 200% FPL	mac	0.4 (0.6)	0.54
AA >200% FPL	mac	-0.1 (0.7)	0.85
White <=100% FPL	mac	0.03 (0.98)	0.98

White >100 to 200% FPL	mac	-1.4 (1.0)	0.14
White >200% FPL	mac	-0.6 (0.4)	0.20
Hispanic <=100% FPL	mac	-0.7 (0.5)	0.23
Hispanic >100 to 200% FPL	mac	-0.7 (0.5)	0.16
Hispanic >200% FPL	mac	-0.7 (1.0)	0.46
AA <=100% FPL	sbp	-0.8 (0.8)	0.34
AA >100 to 200% FPL	sbp	-0.8 (1.3)	0.52
AA >200% FPL	sbp	-0.2 (1.2)	0.89
White <=100% FPL	sbp	-0.04 (1.80)	0.98
White >100 to 200% FPL	sbp	-1.8 (1.9)	0.34
White >200% FPL	sbp	1.0 (1.0)	0.33
Hispanic <=100% FPL	sbp	1.6 (1.2)	0.18
Hispanic >100 to 200% FPL	sbp	2.6 (1.1)	0.02
Hispanic >200% FPL	sbp	2.5 (1.7)	0.14
AA <=100% FPL	dbp	-0.7 (0.7)	0.27
AA >100 to 200% FPL	dbp	-0.9 (1.1)	0.42
AA >200% FPL	dbp	-0.3 (1.0)	0.74
White <=100% FPL	dbp	-0.1 (1.6)	0.94
White >100 to 200% FPL	dbp	-2.9 (1.6)	0.07
White >200% FPL	dbp	-0.6 (0.8)	0.45
Hispanic <=100% FPL	dbp	-0.04 (1.0)	0.97
Hispanic >100 to 200% FPL	dbp	-0.4 (0.9)	0.66
Hispanic >200% FPL	dbp	0.5 (1.5)	0.73
AA <=100% FPL	pulse	-0.6 (0.7)	0.34
AA >100 to 200% FPL	pulse	1.1 (1.0)	0.27
AA >200% FPL	pulse	1.3 (1.1)	0.23
White <=100% FPL	pulse	0.5 (1.7)	0.78
White >100 to 200% FPL	pulse	0.3 (1.9)	0.85
White >200% FPL	pulse	1.4 (1.0)	0.16
Hispanic <=100% FPL	pulse	1.3 (1.1)	0.22
Hispanic >100 to 200% FPL	pulse	-0.06 (1.0)	0.95
Hispanic >200% FPL	pulse	3.3 (1.6)	0.049
AA <=100% FPL	wh_ratio	-0.007 (0.006)	0.22
AA >100 to 200% FPL	wh_ratio	0.003 (0.008)	0.73
AA >200% FPL	wh_ratio	-0.008 (0.009)	0.40
White <=100% FPL	wh_ratio	-0.008 (0.01)	0.54
White >100 to 200% FPL	wh_ratio	0.01 (0.01)	0.28
White >200% FPL	wh_ratio	-0.007 (0.007)	0.31
Hispanic <=100% FPL	wh_ratio	0.001 (0.007)	0.84
Hispanic >100 to 200% FPL	wh_ratio	0.002 (0.007)	0.80
Hispanic >200% FPL	wh_ratio	0.003 (0.01)	0.80
AA <=100% FPL	BMI	0.12 (0.57)	0.83
AA >100 to 200% FPL	BMI	0.45 (0.85)	0.59

AA >200% FPL	BMI	-0.29 (0.85)	0.73
White <=100% FPL	BMI	0.70 (1.43)	0.63
White >100 to 200% FPL	BMI	-1.67 (1.29)	0.20
White >200% FPL	BMI	-0.27 (0.55)	0.62
Hispanic <=100% FPL	BMI	-0.45 (0.71)	0.53
Hispanic >100 to 200% FPL	BMI	-0.003 (0.6)	1.00
Hispanic >200% FPL	BMI	0.0005 (1.18)	1.00

Abbreviations: AA= African-American or Black; White=White or Caucasian; Hispanic=Latina or Hispanic; FPL=Federal Poverty Level; Diff=differences; HbA1c=hemoglobin A1C; CRP=C-reactive protein; Cholesterol=total cholesterol; HDL=high-density lipoprotein; mac=mid-arm circumference; sbp=systolic blood pressure; dbp=diastolic blood pressure; wh_ratio=waist-to-hip ratio; BMI=body mass index.

Table 3. Principal components and cumulative proportions in different ethnicity and poverty level groups and in all groups

Group	Principal Component1	Principal Component2	Cumulative Proportion*
AA <=100% FPL	Cholesterol (0.995)	sbp (0.688)	0.812
		dbp (0.591)	
AA >100 to 200% FPL	Cholesterol (0.995)	sbp (0.718)	0.808
		dbp (0.619)	
AA >200% FPL	Cholesterol (0.994)	sbp (0.684)	0.834
		dbp (0.577)	
White <=100% FPL	Cholesterol (0.988)	sbp (0.627)	0.812
		dbp (0.580)	
White >100 to 200% FPL	Cholesterol (0.994)	HDL (-0.845)	0.844
White >200% FPL	Cholesterol (0.996)	HDL (-0.801)	0.832
Hispanic <=100% FPL	Cholesterol (0.997)	sbp (0.743)	0.846
		dbp (0.581)	
Hispanic >100 to 200% FPL	Cholesterol (0.992)	sbp (0.683)	0.836
		dbp (0.562)	
Hispanic >200% FPL	Cholesterol (0.997)	HDL (-0.895)	0.870
All Groups	Cholesterol (0.996)	sbp (0.659)	0.821
		dbp (0.583)	

*Cumulative proportion of variability explained by the first two Principal Components.

Abbreviations: AA= African-American or Black; White=White or Caucasian; Hispanic=Latina or Hispanic; FPL=Federal Poverty Level; Cholesterol=total cholesterol; HDL=high-density lipoprotein; sbp=systolic blood pressure; dbp=diastolic blood pressure.

Table 4. Groupwise comparisons (differences and 95% confidence limits) of allostatic load biomarkers (T3M visit)

Group Comparison*	Variable	Diff	95% CL	p-Value	Hochberg Significance
Poor AA vs poor White	HbA1c	0.6	(-0.5,1.8)	0.28	NS
Poor AA vs poor Hispanic	HbA1c	0.1	(-0.7,0.9)	0.81	NS
Poor White vs poor Hispanic	HbA1c	-0.6	(-1.8,0.7)	0.39	NS
Middle AA vs middle White	HbA1c	0.6	(-0.2,1.4)	0.12	NS
Middle AA vs middle Hispanic	HbA1c	0.1	(-0.7,0.9)	0.84	NS
Middle White vs middle Hispanic	HbA1c	-0.5	(-1.4,0.4)	0.26	NS
Rich AA vs rich White	HbA1c	0.3	(-0.3,0.9)	0.31	NS
Rich AA vs rich Hispanic	HbA1c	0.02	(-0.8,0.9)	0.96	NS
Rich White vs rich Hispanic	HbA1c	-0.3	(-1.1,0.5)	0.51	NS
Poor AA vs poor White	CRP	5.3	(-0.4,11.0)	0.07	NS
Poor AA vs poor Hispanic	CRP	0.7	(-3.0,4.5)	0.70	NS
Poor White vs poor Hispanic	CRP	-4.6	(-10.7,1.5)	0.14	NS
Middle AA vs middle White	CRP	2.7	(-1.0,6.3)	0.16	NS
Middle AA vs middle Hispanic	CRP	0.3	(-3.7,4.3)	0.90	NS
Middle White vs middle Hispanic	CRP	-2.4	(-6.7,1.9)	0.28	NS
Rich AA vs rich White	CRP	-0.6	(-3.3,2.1)	0.67	NS
Rich AA vs rich Hispanic	CRP	1.8	(-2.4,5.9)	0.40	NS
Rich White vs rich Hispanic	CRP	2.4	(-1.6,6.3)	0.24	NS
Poor AA vs poor White	Cholesterol	2.1	(-50.3,54.4)	0.94	NS
Poor AA vs poor Hispanic	Cholesterol	16.4	(-18.0,50.7)	0.35	NS
Poor White vs poor Hispanic	Cholesterol	14.3	(-41.2,69.8)	0.61	NS
Middle AA vs middle White	Cholesterol	8.5	(-26.0,42.9)	0.63	NS
Middle AA vs middle Hispanic	Cholesterol	11.9	(-25.3,49.1)	0.53	NS
Middle White vs middle Hispanic	Cholesterol	3.4	(-36.2,43.0)	0.86	NS
Rich AA vs rich White	Cholesterol	-18.4	(-45.5,8.7)	0.18	NS
Rich AA vs rich Hispanic	Cholesterol	6.9	(-32.3,46.2)	0.73	NS
Rich White vs rich Hispanic	Cholesterol	25.3	(-11.0,61.6)	0.17	NS
Poor AA vs poor White	HDL	2.0	(-16.9,20.9)	0.83	NS
Poor AA vs poor Hispanic	HDL	9.1	(-3.2,21.4)	0.15	NS
Poor White vs poor Hispanic	HDL	7.1	(-13.0,27.1)	0.49	NS
Middle AA vs middle White	HDL	9.8	(-4.0,23.5)	0.16	NS
Middle AA vs middle Hispanic	HDL	8.3	(-5.4,21.9)	0.24	NS
Middle White vs middle Hispanic	HDL	-1.5	(-17.4,14.4)	0.85	NS
Rich AA vs rich White	HDL	1.9	(-7.5,11.3)	0.69	NS
Rich AA vs rich Hispanic	HDL	0.6	(-13.1,14.3)	0.93	NS
Rich White vs rich Hispanic	HDL	-1.3	(-14.3,11.6)	0.84	NS
Poor AA vs poor White	mac	4.9	(-2.8,12.6)	0.21	NS
Poor AA vs poor Hispanic	mac	-2.1	(-7.4,3.2)	0.44	NS
Poor White vs poor Hispanic	mac	-7.0	(-15.0,1.0)	0.09	NS

Middle AA vs middle White	mac	8.6	(3.8,13.3)	0.0004	Significant
Middle AA vs middle Hispanic	mac	5.3	(-0.2,10.8)	0.06	NS
Middle White vs middle Hispanic	mac	-3.3	(-8.7,2.2)	0.24	NS
Rich AA vs rich White	mac	-1.7	(-5.5,2.0)	0.36	NS
Rich AA vs rich Hispanic	mac	1.9	(-4.2,8.1)	0.54	NS
Rich White vs rich Hispanic	mac	3.7	(-2.2,9.5)	0.22	NS
Poor AA vs poor White	sbp	7.2	(-8.2,22.6)	0.36	NS
Poor AA vs poor Hispanic	sbp	3.1	(-7.0,13.2)	0.54	NS
Poor White vs poor Hispanic	sbp	-4.1	(-20.5,12.3)	0.62	NS
Middle AA vs middle White	sbp	10.2	(0.9,19.5)	0.03	NS
Middle AA vs middle Hispanic	sbp	9.9	(-1.0,20.7)	0.07	NS
Middle White vs middle Hispanic	sbp	-0.3	(-11.5,10.8)	0.95	NS
Rich AA vs rich White	sbp	-0.9	(-8.1,6.4)	0.81	NS
Rich AA vs rich Hispanic	sbp	1.9	(-9.2,13.0)	0.74	NS
Rich White vs rich Hispanic	sbp	2.8	(-7.8,13.4)	0.61	NS
Poor AA vs poor White	dbp	7.2	(-5.5,19.9)	0.27	NS
Poor AA vs poor Hispanic	dbp	3.5	(-4.8,11.9)	0.40	NS
Poor White vs poor Hispanic	dbp	-3.6	(-17.1,9.9)	0.60	NS
Middle AA vs middle White	dbp	3.9	(-3.8,11.5)	0.33	NS
Middle AA vs middle Hispanic	dbp	7.1	(-1.8,16.0)	0.12	NS
Middle White vs middle Hispanic	dbp	3.2	(-6.0,12.4)	0.49	NS
Rich AA vs rich White	dbp	-0.7	(-6.7,5.3)	0.83	NS
Rich AA vs rich Hispanic	dbp	-4.1	(-13.3,5.1)	0.38	NS
Rich White vs rich Hispanic	dbp	-3.4	(-12.2,5.3)	0.44	NS
Poor AA vs poor White	pulse	-1.0	(-14.5,12.5)	0.89	NS
Poor AA vs poor Hispanic	pulse	-1.3	(-10.1,7.5)	0.77	NS
Poor White vs poor Hispanic	pulse	-0.3	(-14.6,14.0)	0.96	NS
Middle AA vs middle White	pulse	3.5	(-4.7,11.6)	0.41	NS
Middle AA vs middle Hispanic	pulse	6.2	(-3.3,15.7)	0.20	NS
Middle White vs middle Hispanic	pulse	2.7	(-7.0,12.5)	0.58	NS
Rich AA vs rich White	pulse	-1.6	(-7.9,4.8)	0.62	NS
Rich AA vs rich Hispanic	pulse	-1.6	(-11.3,8.2)	0.75	NS
Rich White vs rich Hispanic	pulse	0.01	(-9.3,9.3)	1.00	NS
Poor AA vs poor White	wh_ratio	-0.004	(-0.11,0.10)	0.94	NS
Poor AA vs poor Hispanic	wh_ratio	-0.09	(-0.16,-0.02)	0.01	NS
Poor White vs poor Hispanic	wh_ratio	-0.09	(-0.20,0.03)	0.14	NS
Middle AA vs middle White	wh_ratio	-0.03	(-0.10,0.04)	0.35	NS
Middle AA vs middle Hispanic	wh_ratio	-0.004	(-0.08,0.07)	0.92	NS
Middle White vs middle Hispanic	wh_ratio	0.03	(-0.05,0.11)	0.48	NS
Rich AA vs rich White	wh_ratio	-0.01	(-0.06,0.04)	0.70	NS
Rich AA vs rich Hispanic	wh_ratio	-0.02	(-0.10,0.06)	0.58	NS
Rich White vs rich Hispanic	wh_ratio	-0.01	(-0.09,0.06)	0.76	NS
Poor AA vs poor White	BMI	6.22	(-4.00,16.44)	0.23	NS

Poor AA vs poor Hispanic	BMI	-8.13	(-14.82,-1.45)	0.02	NS
Poor White vs poor Hispanic	BMI	-14.35	(-25.20,-3.50)	0.01	NS
Middle AA vs middle White	BMI	3.66	(-2.95,10.26)	0.28	NS
Middle AA vs middle Hispanic	BMI	0.79	(-6.74,8.32)	0.84	NS
Middle White vs middle Hispanic	BMI	-2.87	(-10.25,4.52)	0.45	NS
Rich AA vs rich White	BMI	0.25	(-4.68,5.18)	0.92	NS
Rich AA vs rich Hispanic	BMI	1.10	(-6.41,8.62)	0.77	NS
Rich White vs rich Hispanic	BMI	0.85	(-6.24,7.94)	0.81	NS

*Poor defined as <=100% federal poverty level (FPL) (indication income at or less than poverty threshold); middle defined as 101-200% FPL; rich defined as >200% FPL.

Abbreviations: AA= African-American or Black; White=White or Caucasian; Hispanic=Latina or Hispanic; Diff=differences; 95%CL=95% confidence limits; HbA1c=hemoglobin A1C; CRP=C-reactive protein; Cholesterol=total cholesterol; HDL=high-density lipoprotein; mac=mid-arm circumference; sbp=systolic blood pressure; dbp=diastolic blood pressure; wh_ratio=waist-to-hip ratio; BMI=body mass index; NS=not significant.

Table 5. P-values for multivariate regression analysis in different ethnicity and poverty level groups (T3M visit)

Comparison Groups*	**P-value**	**Hochberg Significance**
Middle White vs middle Hispanic	0.87	NS
Rich AA vs rich Hispanic	0.64	NS
Middle AA vs middle Hispanic	0.45	NS
Middle AA vs middle White	0.16	NS
Rich White vs rich Hispanic	0.12	NS
Poor White vs poor Hispanic	0.07	NS
Poor AA vs poor White	0.05	NS
Poor AA vs poor Hispanic	0.03	NS
Rich AA vs rich White	0.01	NS

*Poor defined as <=100% federal poverty level (FPL) (indication income at or less than poverty threshold); middle defined as 101-200% FPL; rich defined as >200% FPL.

Abbreviations: AA= African-American or Black; White=White or Caucasian; Hispanic=Latina or Hispanic; NS=not significant.