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Explaining racial and ethnic inequalities in postpartum allostatic load: Results from a multisite study of low to middle income woment

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ABSTRACT

Background: Racial and ethnic inequalities in women's health are widely documented, but not for the postpartum period, and few studies examine whether neighborhood, psychosocial, and biological factors explain these gaps in women's health.

Methods: Using prospective longitudinal data collected from 1766 low to middle income women between 2008 and 2012 by the Community Child Health Network (CCHN), we tested the extent to which adjustment for neighborhood, economic, psychological, and medical conditions following a birth explained differences between African American, Latina, and White women in an indicator of physiological dysregulation allostatic load (AL), at one year postpartum as measured by 10 biomarkers: Body Mass Index, Waist Hip Ratio, systolic and diastolic blood pressure, high sensitivity C-reactive protein, Hemoglobin A1c, high-density lipoprotein and cholesterol ratio, and diurnal cortisol.

Results: Mean postpartum AL scores were 4.65 for African American, 4.57 for Latina and 3.86 for White women. Unadjusted regression estimates for high AL for African American women (with White as the reference) were 0.80 (SD = 0.11) and 0.53 (SD = 0.15) for Latina women. Adjustment for household poverty, neighborhood, stress, and resilience variables resulted in a reduction of 36% of the excess risk in high AL for African Americans versus Whites and 42% of the excess risk for Latinas compared to Whites.

Conclusions: Racial and ethnic inequalities in AL were accounted for largely by household poverty with additional contributions by psychological, economic, neighbourhood and medical variables. There remained a significant inequality between African American, and Latina women as compared to Whites even after adjustment for this set of variables. Future research into health inequalities among women should include a fuller consideration of the social determinants of health including employment, housing and prepregnancy medical conditions.

1. . Introduction

Women's health during the childbearing years is important for reproductive success (Craft, 1997; Atrash, Jack, and Johnson, 2008) and according to life course theory, postpartum health status can promote or hinder healthy aging (Morton, Mustillo, and Feraro, 2014; Vasunilashorn & Martinson, 2013; Davis, Stange, and Horwitz, 2012; Perng et al., 2015; McClure, Mustillo, and Feraro, 2013). Women's health prior to and during pregnancy has been the focus of the large majority of maternal health scholarship, while postpartum health receives far less research attention than the period of pregnancy or pre-pregnancy (Meltzer-Brody & Stuebe, 2014; Fahey & Shenassa, 2013). Postpartum markers of health and well-being can help us predict women's future health (Davis et al., 2012; Karlamangla,

Singer, and Seeman, 2006; Wu et al., 2016), making the postpartum period a critically important phase in women's lives. Further, the well-known health inequalities by race, ethnicity, and socioeconomic position demonstrated for pregnancy seem to continue during the postpartum period for a variety of outcomes including utilization of health care (Glasheen et al., 2015; DiBari et al., 2014; Seplowitz et al., 2015), psychosocial well-being (Glasheen et al., 2015; Liu & Tronick, 2014; Phelan et al., 2015), and exposure to stressors such as discrimination (Rosenthal et al., 2015).

There is a growing interest in the impact of stress including cumulative adversity over the lifetime, and the physiological toll resulting from ongoing activation of stress responses at or around the time of childbearing (Phelan et al., 2015; Hobel, Goldstein, and Barrett, 2008; Dominguez et al., 2008; Gonzalez et al., 2009). In their highly influential theory, McEwen and colleagues defined allostatic load (AL) as the cumulative toll on multiple body systems of adaptation to stressful events and chronic stressful life conditions (McEwen, 1998; McEwen and Stellar, 1993). Indices of AL combine multi-systemic biomarkers (for example, blood pressure, serum cholesterol, body mass index, and C-reactive protein [CRP]) into a composite risk score. In initial studies of middle-aged and older populations (Singer & Ryff, 1999; Seeman et al., 1997), higher AL predicted greater morbidity and mortality (Karlamangla et al., 2006; Seeman et al., 2001, 2004; Gruenwald et al., 2006). Broader population studies (Mattei et al., 2010; Hwang et al., 2014) further established that AL is a mediator of disease risk in humans, and that it varies with socioeconomic position (SEP), race/ethnicity, and gender (Wu et al., 2016; Beckie, 2012; Geronimus et al., 2006). In addition, chronic life stress, including exposure to chronic and persistent discrimination, is linked to higher AL (Juster, McEwen, and Lupien, 2010; Brody et al., 2014). More recent studies of maternal populations establish the need to look further at AL during the childbearing years (Premji, 2014; Shannon, King, and Kennedy, 2007; Hux & Roberts, 2015; Morrison et al., 2013), in part because AL could enable us to detect risks for a mother and her child prior to or during pregnancy. For example, Wallace and Harville (2013), who studied a small set of biomarkers taken between 26 and 28 weeks gestation in 42 White and Black pregnant women, found that gestational age at birth decreased significantly with increasing AL adjusted for smoking and body mass (Wallace & Harville, 2013; Wallace et al., 2013a, 2013b).

Growing income inequalities in the United States are a defining issue of our time (Kondo et al., 2009). Hundreds of studies have demonstrated the adverse impact of increased economic inequalities and poverty on population health and mortality by documenting gaps by income or by race (Kondo et al., 2009; Aizer & Currie, 2014; Costa-Font & Hernández-Quevedo, 2012; Pickett & Wilkinson, 2015). Yet research into whether and how structural, social, and biological factors explain these growing health and social gaps is sparse. In the US, studies of health inequalities have heavily emphasized differences by race or ethnicity, with too little attention to the joint impact of both race/ethnicity and socioeconomics on health. Authors have argued that without such joint consideration (Braveman, 2008; Kawachi, Norman, and Robinson, 2008; Mechanic, 2008; Sparks, 2009; Williams & Jackson, 2005), we cannot identify the key drivers of inequalities (Kawachi et al., 2008).While some studies have suggested that genetic differences might explain health gaps between different races, such explanations for racial inequities have been long discounted (Braveman, 2008; Williams & Jackson, 2005; Kaufman et al., 2015; Gravlee, 2009). Finally, research that takes advantage of strong longitudinal designs and contextual data in the study of social and health inequalities is still too rare.

In 2003, using community-based participatory research methods (Jagosh et al., 2012), the Community Child Health Network (CCHN) established by the Eunice Kennedy Shriver National Institute of Child Health and Human Development began a multisite observational study to better understand multiple health and social determinants of AL

during the interconception period (Ramey et al., 2015). The concept of AL as wear-and-tear on body systems leading to premature weathering among people living in poverty, and the need to examine multiple levels (e.g. individual and neighbourhood) of both risk and resilience factors, were unifying concepts for our study and mutually endorsed by community and academic partners (Wu et al., 2016; Ramey et al., 2015). While community members affirmed the role of stress as a contributor to AL in high-risk populations, they also felt strongly that we needed to study sources of resilience. Furthermore, in the past two decades, many scholars have critiqued the overreliance on individual factors to explain health at the expense of assessing impacts from physical and social contexts (Borrell et al., 2014; Rajaratnam, Burke, and O'Campo, 2006; O'Campo et al., 1997; Ncube et al., 2016), therefore, our interest included neighborhoods and how they serve as a context contributing to inequalities (Nkansah-Amankra et al., 2010; O'Campo, 2003) which was strongly endorsed by our community partners. Moreover, we took advantage of the wide variability in neighborhood context offered by our multisite study which included urban and non-urban settings.

In this study, we extend the prior preliminary findings of the CCHN longitudinal study examining the patterns of AL by poverty group and race and ethnicity over the first year postpartum to determine whether levels of inequality are stable or dynamic during this period (Shalowitz et al., unpublished manuscript). Here we investigate whether neighborhood and individual economic, psychosocial, and health conditions at birth or 6 months postpartum explain the AL gaps by race/ethnicity at 12 months postpartum. Our hypothesis is that economic, stress, and resilience factors assessed at the individual level and neighborhood deprivation assessed at the community level would account for a substantial portion of race and ethnic inequalities in AL scores.

2. Methods

2.1. Study design

The CCHN study was conducted in three urban sites (Washington, DC; Baltimore, MD; Los Angeles County, CA), one suburban site (Lake County, IL), and one rural site (seven counties in eastern North Carolina) all of which had high documented maternal child health disparities(Ramey et al., 2015). Women were recruited and enrolled between 2008 and 2010 during postpartum hospital stays following childbirth, except in North Carolina where participants were recruited in clinics during pregnancy or postpartum. Mothers who met the following criteria were eligible to participate: (1) 18 to 40 years of age; (2) self-identification as White/Caucasian, Latina/Hispanic, and/or African American/Black; (3) ability to converse in English or Spanish; (4) anticipated residence in one of the target zip codes for at least 6 months; (5) 4 or fewer children; and (6) no plans to be surgically sterilized following the birth of the index child. We over-sampled mothers living in low income neighborhoods and preterm births. With the mother's permission, the baby's father (or father figure) was invited to participate in the study.

Community research staff trained in the study protocol conducted interviews in English or Spanish during in-person visits when index children were approximately 1 month (T1), 6 months (T2), 12 months (T3), and 24 months (T5) of age, and during a brief telephone interview at 18 months (T4). With very few exceptions, assessments were done in participants' homes. Interviewers were also trained to collect biological data during T2 and T3 study visits, including: 1) blood pressure; 2) height and weight for calculation of BMI; 3) waist and hip circumference measurements; 4) blood spots for C-reactive protein (CRP), hemoglobin A1c (HbA1c), high-density (HDL) and low-density lipoprotein (LDL) cholesterol assays; and 5) diurnal salivary cortisol measured upon waking, 30 min later, and before bedtime on two consecutive days.

2.2. Participants

The full CCHN cohort included 2510 mothers (54% African American, 24% Latina, and 22% non-Hispanic White) who completed the T1 interview between 2 and 16 weeks after delivery (Mean 11.02; SD = 13.44). We excluded 203 (8%) participants who were pregnant again at the time of T2 or T3 study visits, as they would alter estimates of postpartum biomarkers, and 541 (21%) who had insufficient data on biomarkers, leaving a final sample of 1766 mothers. The cohort also included 1436 fathers, but only maternal data are used in the present analyses.

2.3. Measures

2.3.1. Allostatic Load

We calculated AL based on the ten biomarkers in two ways (Shalowitz et al., unpublished manuscript). The first was the method used most commonly in the published literature following the method of McEwen and colleagues (McEwen, 1998; McEwen, 1993; Juster et al., 2010) which is to create binary variables for each biomarker indicating the top quartile and summing them across biomarkers for a score from 0 to 10 (Seeman et al., 1997; Morrison et al., 2013; Wallace & Harville, 2013; Wallace et al., 2013). The second involved specific clinical cut-offs for each marker, as described below. In preliminary analyses, we found no major differences by race, ethnicity, or poverty between the two scoring methods (Shalowitz et al., unpublished manuscript); therefore, to increase the clinical relevance of our work, we chose to proceed with the clinical cut-off approach. We calculated this clinical AL index by assigning one point for each of ten markers a person had above the following clinical cut-offs: Body Mass Index (BMI) of ≥ 30 kg/m^2; Waist Hip Ratio (WHR) of ≥ 0.85; systolic blood pressure (SBP) of ≥ 125 mmHg; diastolic blood pressure (DBP) of ≥ 80 mmHg: pulse of ≥ 100 beats per minute: HS-CRP of ≥ 3 mg/L: HbA1c of $\geq 5.4\%$; HDL of ≤ 40 mg/dL; total cholesterol/HDL ratio ≥ 5.9; and diurnal cortisol slope of ≥ -0.01. For this last measure there was no clinical cut off so we used the top quartile as the cut off. The range for this high AL index was 0–10.

2.3.2. Race/ethnicity

Participants self-reported their primary racial/ethnic identity upon enrollment. We included only mothers who self-reported being primarily African American, White, or Latina. While terminology used in the literature varies, in this paper we refer to African American/Black as African American (we had relatively few foreign born Black women enroll), and Hispanic/Latina women as Latina and non-Hispanic White/Caucasian as White.

2.3.3. Socioeconomic position (SEP)

We capture SEP via an indicator representing household income levels. During the one-month postpartum interview (T1) we asked participants about their pre-tax household income in the previous calendar year, which we recorded using pre-specified categories (e.g., $10–20,000 per year, $50–75,000 per year). In scoring for analyses, we assigned the midpoint value for the response category as each person's household income (e.g., $62,500 as the midpoint for $50–75,000). To account for differences in household size, we used an indicator of income that accounts for level of household income and household size. We calculated household income as a percentage of the federal poverty level based on household size using 2009 US Census data for US poverty thresholds (e.g., $21,954 is the poverty threshold for a family of four). As examples, the household income of $21,954 for a family of 4 is 100% of FPL and $32,000 for a family of 4 would be 145% of FPL, while $60,000 for a family of 4 is 273% of FPL. Our four category poverty group variable includes: < 200% federal poverty level

(FPL), 200–300% FPL, 300–400% FPL, and > 400% FPL. Our lowest income category, < 200%FPL represents families who are still struggling with financial strain and may be experiencing food insecurity, housing instability, precarious or no employment conditions compared to those with higher incomes. Even those with incomes of 400% FPL will be lower middle class as they are eligible for some types of income tax credits (e.g., Premium Tax Credit intended to assist families pay for the health care insurance premiums under the Affordable Care Act).

2.3.4. Stress

In these analyses, we utilized six stress measures pertaining mainly to chronic stress, and selected through a community-based participatory research approach (described in detail elsewhere (Dunkel Schetter et al., 2013)). These included measures of pregnancy stress (Misra, O'Campo, and Strobino, 2001), interpersonal violence (O'Campo, Caughy, and Nettles, 2010), everyday discrimination (Williams et al., 1997), life events and their impact (Parker Dominguez et al., 2005, 2008), financial strain (Cheng, Fowlers, and Walker, 2006), and chronic life stress in various domains (Tanner Stapleton et al., 2016). All Cronbach alpha coefficients for these stress measures were found to be acceptable to good, ranging from 0.68 to 0.92 in English and Spanish (Dunkel Schetter et al., 2013). For these analyses, we calculated a stress composite by assigning a score of "1" to participants who were in the top quartile of the sample distribution of a given variable, and a "0" to those who were in the bottom three quartiles. We then summed these six dichotomous variables to create a composite variable with a range from 0–6, with higher scores indicating higher composite stress. We chose this method to create our index over other approaches, such as Factor Analysis, as these variables are not intended to capture common shared variance among the measures but rather to capture a wide range of (potentially weakly correlated) aspects of stress.

2.3.5. Resilience resources

We conceptualized resilience for these analyses in terms of self-reported personal internal and external resources, using seven well-validated measures that assess sense of mastery (Pearlin & Schooler, 1978), self-esteem (Rosenberg, 1965), perceived social support (Sherbourne & Stewart, 1991), optimism (Scheier & Carver, 1985), collective efficacy (Sampson, Raudenbush, and Earls, 1997), community cohesion (Chavis et al., 1986), and spirituality (Neff, 2006), the latter of which included two dimensions of religiosity and one spirituality dimension. As with stress, we calculated a resilience composite score by assigning a score of '1" to participants with scores in the top quartile of the sample distribution of a given variable, and a "0" to those who were in the bottom three quartiles. We then summed the seven dichotomous variables to create a composite variable with a range from 0–7, with higher scores indicating higher resilience resources.

2.3.6. Neighborhood

Using census data on characteristics of census tracts where our participants resided at the time of birth, we extracted two indices representing neighborhood-level social, economic, and socioeconomic deprivation using Principal Components Analysis. The first index reflects areas characterized by high percentages of foreign-born Hispanic/Latino residents who spent more than 30% of their income on housing and who lived in a crowded home (> 1 person/room); and where high percentages of the population had less than a high-school education at 25 years of age. The second index reflects neighborhoods characterized by high percentages of African Americans, single mothers, and unemployed residents. Relatively few neighborhoods had more than one individual from our study.

3. Data analysis strategy

We used multiple imputation procedures to impute missing values because of large losses to follow-up and to avoid mischaracterization of participants' trajectories. Using IVEware we generated ten imputations through chained equations procedures (Graham, Olchowski, and Gilreath, 2007; He, 2010; Ragunathan et al., 2001; Rubin, 1987; Spratt et al., 2010). Those who were lost to follow up by 12 months postpartum did not differ by race/ethnicity, relationship status, per capita household income or years of education from those in this sample. However, women who were lost were more likely to be older, though very slightly, or from Los Angeles compared to those who were successfully followed. All these variables, along with others, were included in the imputation models.

After imputation for missing data, we conducted descriptive analyses and examined variable distributions. We then employed a series of multiple regression models predicting T3 (12 month) clinical allostatic load. The initial model included two dummy-coded variables for race/ethnicity, with Non-Hispanic Whites serving as the referent group. We added additional variables to subsequent multivariate models to determine whether and to what extent poverty, stress, resilience, neighborhood factors, and/or diagnosed medical conditions explained differences in high allostatic load among the racial/ethnic groups. As we added each set of variables (e.g., poverty, stress, neighbourhood indices) to subsequent regression models, we calculated the percent reduction in regression estimates for race/ethnicity. However, this was not a formal statistical test of mediation (MacKinnon, Fairchild, and Fritz, 2007) nor did we conceptualize these variables, for the purposes of this study, as being in the pathway between race/ethnicity and AL. For all regression analyses, we averaged results across the ten imputed data sets and adjusted the standard errors using the MI *estimate* procedure in Stata 13.

4. Results

Most (57.7%) mothers reported household incomes under 200% of the official poverty level (Table 1). Nearly two-thirds were cohabiting or married to the index child's father (63%). Mean years of education was 13. Across the racial/ethnic groups, Latinas had a significantly higher proportion of incomes less than 200% FPL (71%) and significantly fewer years of schooling (on average, 11 years). African American women had significantly higher rates of non-cohabitation or not being married (57%), as shown in Table 1.

Table 2 presents bivariate associations between key variables and the clinical AL index at one year after delivery. There were statistically significant associations at the $P < 0.05$ level for race (African American versus combined White and Latina) and for ethnicity (Latina versus African American and White), as well as with the percent poverty level variable (between lowest levels and 300–400% FPL and > 400% FPL), with stress, resilience resources, and Neighborhood Index 2. All associations were in the expected directions. Minority women, poorer women, and women with higher stress and lower resilience resources had higher AL, as did those living in neighborhoods with higher concentrations of single heads of household, unemployment, and African Americans (Neighborhood Index 2) (Table 2, left half). Standardized coefficients and the inter-quartile range of the coefficients obtained from the 10 multiply imputed samples, for the same associations are presented in the right half of Table 2 illustrate the relative strength of association of each variable. Thus, African American race, Neighborhood Index 2 and Stress had the strongest associations with AL (Table 2, right half).

To determine whether economic, psychological, and neighborhood indices explain excess risk by race/ethnicity in high AL, we fit a series of linear regression models, with results displayed in Tables 3 and 4. We focused on the proportion of excess risk in high AL by race/ethnicity that was explained as we adjusted for each of the different economic, psychological and medical variables. That is, we looked at changes in the estimates for the relationship between race/ethnicity and AL as we fit models with increasing numbers of adjustment variables. The betas for Latinas and African Americans were attenuated by 40% and 22.5%, respectively, after adding poverty group to the models (Model 2), yet even with this adjustment race/ethnicity remained significant at the $P < 0.05$ level. Adding the stress composite and resilience resources variables (Models 3 and 4) did not change the betas for race/ethnicity by much. The largest change in the race/ethnicity betas was with the addition of resilience resources for Latinas, with a 6% attenuation in the beta from Model 2 ($P =0.06$). Upon the addition of the two Neighborhood variables (Models 5 and 6), the beta for African American race was attenuated by 18% over what we say in Model 2 (see Model 6). Next we wanted to test the possibility that there was an interaction effect between the stress composite and resilience resources variables. When we added this interaction term to the model (Model 7), the beta for Latinas changed by 6% over that seen in Model 2.

It is possible that postpartum AL is both a reflection of cumulative stress and also to pregnancy related conditions (Morrison et al., 2013). Therefore, we fit one final model to adjust our models on race/ethnicity differences in AL for recent pregnancy medical conditions and birth outcome. We are cautious in interpreting this model as it is possible that these complications in pregnancy are instead a consequence of pre-pregnancy AL levels (Hux & Roberts, 2015). We fit Model 9 with adjustments for the most prevalent and likely confounders in this category of factors: gestational diabetes, pregnancy hypertension, and preeclampsia in the mother, and preterm birth and low birth weight of the index child. The beta for African Americans in Model 9 was further attenuated by 10% over what was observed in the model with all our variables present (Model 8) to 0.44, and the beta for Latinas changed very little.

In sum, based on the models we fit, the poverty, social, health, stress, resilience resources, and neighborhood variables explained about 36% of the variance for the beta for African American race and 42% for Latina ethnicity over unadjusted models; most of the variance was explained by household poverty classification (all of the reduction of variance for the Latina beta).

5. Discussion

We hypothesized that inequalities by race/ethnicity among African American and Latina as compared to White women in AL, would be explained (i.e., coefficients attenuated) by economic, stress, and resilience assessed at the individual level and neighborhood deprivation assessed at the community level. We found that poverty group accounted for the majority of the attenuation of the betas for race/ethnicity; when we entered poverty levels into the models, there was a 40% reduction for the African American coefficient and a 25% reduction for the Latina coefficient. Our findings strongly support prior research suggesting that it is important to simultaneously consider income levels together with race or ethnicity when studying health inequalities (Braveman, 2008; Williams et al., 1997).

Based on the considerable literature arguing that health inequalities are strongly socially determined (Pearlin, 1998), we also hypothesized that stress and resilience resources composite variables would partially explain the race/ethnicity inequity in AL. The robust measures of individual-level stressors and resilience resources included well-established indicators of these complex constructs, including experiences of discrimination, life events, chronic stress, collective efficacy, perceived social support, and mastery. Although stress and resilience resource composites were independently associated with AL, when added to the models these factors further attenuated the race/ethnicity betas by only 3% to 6%. As expected, stress and resilience resources were strongly associated with economic position (those with low family incomes had higher stress *and* lower resilience resources), which may have resulted

Table 1

Demographic and socioeconomic characteristics and descriptive statistics for the US Multisite Child Community Health Network (CCHN) Study 2008–2012. Total sample and for each race/ethnicity (n=1766).

| | Race/Ethnicity | | | | | | Test of Group Difference | | |
| | African Americans (n = 942) | | Whites (n = 402) | | Latinas (n = 422) | | | | |
Categorical variable	n	(%)	n	(%)	n	(%)	χ2	df	p
Poverty group							240.87	8	< .0001
< 200% FPL	594	(63.1)	125	(31.1)	300	(71.1)			
200–300% FPL	115	(12.2)	50	(12.4)	41	(9.7)			
300–400% FPL	83	(8.8)	60	(14.9)	27	(6.4)			
> 400% FPL	112	(11.9)	157	(39.1)	32	(7.6)			
Missing	38	(4.0)	10	(2.5)	22	(5.2)			
Relationship Status							531.51	6	< .0001
Not Married or Cohabitating	539	(57.2)	54	(13.4)	67	(15.9)			
Cohabitating, Not Married	265	(28.1)	68	(16.9)	176	(41.7)			
Married	134	(14.2)	280	(69.7)	179	(42.4)			
Missing	4	(0.4)	0	(0.0)	0	(0.0)			
Site							669.08	8	< .0001
Baltimore	324	(34.4)	81	(20.2)	0	(0.0)			
Lake County, IL	66	(7.0)	149	(37.1)	217	(51.4)			
Los Angeles County	69	(7.3)	60	(14.9)	114	(27.0)			
Eastern North Carolina	223	(23.7)	95	(23.6)	4	(1.0)			
Washington, DC	260	(27.6)	17	(4.2)	87	(20.6)			
Continuous variable	M	(SD)	M	(SD)	M	(SD)	F	df	p
Per capita household income	10,733	(12,067)	26,954	(37,271)	9686	(13,205)	94.67	2, 1702	< .0001
Education (years)	12.81	(2.16)	15.42	(3.06)	11.05	(2.96)	298.31	2, 1763	< .0001
Age	24.336	(5.09)	29.77	(5.98)	25.87	(5.28)	145.62	2, 1763	< .0001
T3 Clinical Allostatic Load	4.65	(1.62)	3.86	(1.45)	4.57	(1.66)	36.01	2, 1763	< .0001
Stress composite	2.03	(1.66)	1.50	(1.53)	1.64	(1.51)	18.4	2, 1763	< .0001
Resilience composite	1.85	(1.61)	2.24	(1.70)	1.44	(1.33)	26.72	2, 1763	< .0001
Neighborhood Index 1	-0.28	(0.60)	–0.50	(0.54)	0.63	(0.99)	321.68	2, 1763	< .0001
Neighborhood Index 2	0.84	(1.05)	–0.58	(0.67)	–0.25	(0.67)	445.09	2, 1763	< .0001

Table 2

Bivariate associations between study variables and T3 Allostatic Load for the US Multisite Child Community Health Network (CCHN) study for testing the economic, psychological and neighborhood explanations of racial disparities in clinical Allostatic Load (AL) 2008–2012 (n=1766).

| | Unstandardized coefficients and 95% CI | | Standardized coefficients and inter-quartile range (IQR) derived from 10 multiply imputed samples | | |
| | | | β | | |
Variable	Coef.	95% CI	Median	IQR	
Race/ethnicity					
African American	0.80**	(0.54, 1.02)	0.25	0.24	— 0.26
Latina	0.53***	(0.24, 0.83)	0.14	0.12	— 0.16
Poverty Categories					
200–300% FPL	-0.10	(-0.40, 0.19)	-0.02	-0.03	— -0.01
300–400% FPL	-0.39*	(-0.70, -0.08)	-0.07	-0.08	— -0.07
> 400% FPL	-0.69***	(-0.96, -0.43)	-0.17	-0.18	— -0.15
Stress	0.11***	(0.05, 0.16)	0.11	0.10	— 0.12
Resilience	-0.09**	(-0.14, -0.03)	-0.09	0.10	— -0.08
Neighborhood Index 1	0.07	(-0.05, 0.19)	0.03	0.03	— 0.04
Neighborhood Index 2	0.22**	(0.13, 0.32)	0.15	0.14	— 0.17

Abbreviations: CI, confidence interval; IQR, interquartile range; FPL, Federal Poverty Level

* p < 0.05;
** p < 0.01;
*** p < .001.

in the stress and resilience resource composites having smaller independent effects in explaining the inequalities when added to the models after economic group.

We formulated two composite neighborhood variables that further explained the race/ethnicity inequity; race/ethnicity coefficients were attenuated by between about 20 to 40% when we added these variables to the models adjusted for household income. In particular, the one neighborhood index which captured neighborhoods characterized by high percentages of single-parent households, unemployment, and African American residents, explained a large portion of the inequalities in AL, and this was above and beyond the race or ethnicity and poverty group of the mother, and her self-reported stress and resilience levels.

Contrary to what we expected, the comprehensive stress composite and resilience resources, and a term representing their interaction, failed to further explain AL race/ethnicity inequalities after accounting for poverty group. Moreover, after accounting for poverty group, only the stress composite was associated with levels of AL in our sample. This suggests that experiences of stress and availability of resources are determined, in part, by socioeconomic position and has implications for the importance of considering both in future studies of AL.

This study has limitations. It is possible that we are missing information on key determinants of postpartum AL such as a pre-pregnancy history of cardiovascular disease or pre-pregnancy chronic disease. As we enrolled women postpartum and the focus of our analyses are on the postpartum period, we were unable to account for prior health conditions. Also, in our main analysis, we did not model any of our covariates as mediators. Yet, it is plausible that variables such as stress and resilience could be in the pathway between race/ethnicity and AL. We ran additional models, using approaches that correctly account for mediation (Richiardi et al., 2013), and found neither stress nor resilience mediated the relationship between race/ethnicity and AL. Constraints on participant time and funding limited the assessments we could make. For example, our measure of poverty

Table 3
Regression analyses for the US Multisite Child Community Health Network (CCHN) study tor testing the economic, psychological and neighborhood explanations of racial disparities in clinical Allostatic Load (AL), Data Collected 2008–2012, Models 1–4.

	Model 1		Model 2		Model 3		Model 4	
	Coef	95% CI	Coef	(SE)	Coef	95% CI	Coef	95% CI
Constant	3.89***	(3.71, 4.06)	4.14***	(3.93, 4.35)	4.14***	(3.93, 4.35)	4.14***	(3.93, 4.35)
Race/Ethnicity								
African American	0.80***	(0.58, 1.02)	0.62***	(0.40, 0.84)	0.60***	(0.38, 0.82)	0.61***	(0.40, 0.83)
Latina	0.53***	(0.24, 0.83)	0.32*	(0.02, 0.63)	0.33*	(0.02, 0.64)	0.30	(-0.02, 0.61)
Poverty Category								
200–300% FPL			-0.06	(-0.35, 0.24)	-0.04	(-0.33, 0.26)	-0.04	(-0.34, 0.25)
300–400% FPL			-0.29	(-0.59, 0.01)	-0.25	(-0.56, 0.06)	-0.26	(-0.57, 0.04)
> 400% FPL			-0.49***	(-0.77, -0.22)	-0.45***	(-0.72, -0.18)	-0.45***	(-0.72, -0.18)
Psychological Factors								
Stress					0.06*	(0.01, 0.12)		
Resilience							-0.05	(-0.11, 0.01)

Abbreviations: CI, confidence interval; FPL, Federal Poverty Level**p < 0.01;
* p < 0.05;
*** p < .001.

group incompletely captured economic resources since measures that include assets and debt have been found to be more accurate predictors of health inequalities by race than income or poverty status alone (Braveman, 2008; O'Campo et al., 1997). We also did not account in these analyses for employment (e.g. job titles, occupational status), or other indicators of socioeconomic position that may further explain the inequalities as this information was not in our surveys. Also, budget

constraints prevented us from collecting primary data on neighborhood stressors identified by our community partners as being important to postpartum stress, including pollution, crime and safety, public transportation, social disorder, housing affordability, child care availability, employment opportunities, and community resources. Many of these will be correlated with the variables we did include in our Neighborhood Indices. Yet, had this information been available we

Table 4
Regression analyses for the US Multisite Child Community Health Network (CCHN) study tor testing the economic, psychological and neighborhood explanations of racial inequities in clinical Allostatic Load (AL), Data Collected 2008–2012, Models 5–8.

	Model 5		Model 6		Model 7		Model 8		Model 9	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Constant	4.14***	3.93, 4.36	4.17***	3.96,4.39	4.16***	3.95,4.38	4.10***	3.87,4.32	4.13***	3.89, 4.37
Race/Ethnicity										
African American	0.62***	0.40, 0.84	0.51***	0.27,0.76	0.50***	0.26,0.74	0.45***	0.21,0.69	0.44***	0.20,0.68
Latina	0.32*	0.00, 0.64	0.31*	0.00,0.62	0.31*	-0.02,0.63	0.32*	0.00,0.64	0.31	0.00,0.62
Poverty category										
200–300% FPL	-0.05	-0.35, 0.24	-0.04	-0.34,0.25	-0.02	-0.32,0.28	-0.02	-0.31,0.27	-0.02	-0.31,0.27
300–400% FPL	-0.29	-0.59, 0.22	-0.27	-0.57,0.03	-0.22	-0.52,0.08	-0.21	-0.51,0.10	-0.21	-0.50,0.08
> 400% FPL	-0.49***	-0.76,-0.22	-0.46***	-0.74,-0.18	-0.40**	-0.67,0.13	-0.37**	-0.65,-0.10	-0.36**	-0.63,-0.09
Psychological Factors										
Stress					0.05*	0.00,0.11	0.05	-0.01,0.10	0.06*	0.00,0.12
Resilience					-0.03	-0.09,0.03	-0.03	-0.09,0.03	-0.02	-0.08,0.04
Stress x Reslience					0.03	-0.01,0.07	0.03	-0.01,0.07	0.03	-0.01,0.07
Neighborhood Factors										
Neighborhood Index 1[a]	0.00	-0.12,0.13					-0.01	-0.14,0.11	-0.01	-0.14,0.11
Neighborhood Index 2[b]			0.08	-0.03,0.19			0.09	-0.02,0.20	0.09	-0.02,0.20
Medical Conditions										
Gestational Diabetes									0.64*	0.10,1.18
Pregnancy Hypertension									0.47	-0.08,1.01
Preeclampsia									0.42*	0.05,0.79
Preterm Birth									-0.15	-0.59,0.29
Low Birth Weight									0.11	-0.37,0.59

Abbreviations: CI, confidence interval; FPL, Federal Poverty Level
[a] Neighborhood Index 1 reflects areas characterized by high proportions of residents who are foreign-born Latinos who spent more than 30% of household income on housing, live in housing with 1 person per room and a high rate of individuals 25 and older who do not have a high-school education.
[b] Neighborhood Index 2 reflects areas characterized by high proportions of residents who are African American, in single-parent households, and unemployed.
* p < 0.05;
** p < 0.01;
*** p < .001.

might have been able to create unique indicators for rural, suburban and urban settings as the literature and a concept mapping activity across the five sites suggested that the importance of those stressors differed by type of setting (Schaefer-McDaniel et al., 2010; Laraia et al., 2006). Unfortunately, these measures are unavailable through secondary data (e.g., census) but could be investigated in future research using neighborhood observational data (Schaefer-McDaniel et al., 2010).

Despite these limitations, this is the most comprehensive, multi-level, longitudinal study of stress and women's health inequalities to date, unique in its careful assessment of multiple stressors and resilience resources (Dunkel Schetter et al., 2013), as well as the only study on postpartum health and allostatic load. We relied on strong participation from our cross-site community partners into many aspects of the study from selection of key constructs and measures to ensuring that the perspectives and desires of our respective diverse communities as to topics of and procedures of study were being represented (Ramey et al., 2015; Shalowitz et al., unpublished manuscript; Dunkel Schetter et al., 2013; O'Campo et al., 2016). Finally this study is unique in taking an inequalities approach in analyses by attempting to explain them, rather than only reporting on the magnitude of the disparities. CCHN's community and multidisciplinary scientists and practitioners are responsible for these innovations.

Once accounting for economic, psychological (stress and resilience), neighborhood, and medical condition variables, our models explained 45% of the inequalities between Whites and African Americans and 43% between non-Hispanic Whites and Latinas. There are various possibilities for why these variables did not fully explain AL inequalities between African American and Latinas as compared to Whites. One is that we did not examine other key social determinants of health such as housing affordability or employment and other factors mentioned above that often vary by race and ethnicity in the US. Increasingly studies using the life course perspective are documenting importance of adverse and traumatic childhood conditions which we also were not able to capture in our study (Gonzalez et al., 2009; Smith, Gotman, and Yonkers, 2016; Slopen et al., 2015). A final and intriguing possibility is that we have yet to fully conceptualize the sources of these inequalities and that cultural, socioeconomic, psychosocial, and structural factors that underlie them are elusive. This work suggests that all low income mothers are at risk in the postpartum period for a subsequent pregnancy with adversities and for unhealthy aging. Past research has identified several strategies to reduce poverty including raising the minimum wage, expanding the Earned Income Tax Credit, promoting pay equity policies or even a universal unified child credit. These strategies have been identified as helping to close the race disparities in outcomes during the childbearing year (Lu et al., 2010). Future work can further explore what can be done to understand and start early in the life course to eradicate effects of poverty on poor health among ethnic and racial groups given their persistence and the health inequalities involved.

Acknowledgements

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