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Neighborhood Socioeconomic Context and Change in Allostatic Load Among Older Puerto Ricans: the Boston Puerto Rican Health Study

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Abstract

Neighborhood context may influence health and health disparities. However, most studies have been constrained by cross-sectional designs that limit causal inference due to failing to establish temporal order of exposure and disease. We tested the impact of baseline neighborhood context (neighborhood socioeconomic status factor at the block-group level, and relative income of individuals compared to their neighbors) on allostatic load two years later. We leveraged data from the Boston Puerto Rican Health Study, a prospective cohort of aging Puerto Rican adults (aged 45–75 at baseline), with change in AL modeled between baseline and the 2nd wave of follow-up using two-level hierarchical linear regression models. Puerto Rican adults with higher income, relative to their neighbors, exhibited lower AL after two years, after adjusting for NSES, age, gender, individual-level SES, length of residence, and city. After additional control for baseline AL, this association was attenuated to marginal significance. We found no significant

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association of NSES with AL. Longitudinal designs are an important tool to understand how neighborhood contexts influence health and health disparities.

Keywords

Allostatic load; Neighborhood context; Relative income; Puerto Ricans

Introduction

An emerging body of literature documents an association between low neighborhood socioeconomic status (NSES) and worse health across a broad array of outcomes beyond individual socioeconomic characteristics (1-5). In the past few years, this literature has begun to document neighborhood associations with allostatic load (AL), an indicator of cumulative biological risk (6-12). AL has been linked to higher cardiovascular disease, type 2 diabetes, arthritis (13), higher risk of 10-year all-cause mortality (14) and depression (15). A larger body of literature has documented gradients in AL by individual-level SES, where higher SES individuals generally (although not universally) exhibit lower AL (16). This evidence suggests that neighborhood socioeconomic conditions may “get under the skin”, affecting health through wear and tear on the body associated with cumulative exposure to stressful life conditions (6).

Although neighborhood SES is the most common measure of neighborhood context tested for its health effects (17, 18), other dimensions are also likely to matter. For example, recent research has examined the hypothesis that the shape of the income distribution within a community is important for individual health. This relative deprivation hypothesis suggests that what really matters to health is not the absolute value of one’s socioeconomic position, but one’s socioeconomic standing in relation to others (19-22).

According to Wilkinson (1999), poorer people in developed societies compare themselves unfavorably with the rest of society, and this comparison is harmful to health (23), self-esteem and life-satisfaction (20). Moreover, Cox et al. (2007) adds that social comparison with neighbors may have similar detectable effects on health. Individuals who perceive themselves as poor may experience chronic stress as a result of the psychosocial impact of their perceived lower relative social position (24). Chronic stress may result in dysregulation in multiple biological systems (i.e. AL) (6).

Racial residential segregation is a central feature of American inequality, and it is hypothesized to influence health of minorities through multiple pathways, for example by exposing minorities to unfavorable neighborhoods with chronic stressors (e.g. neighborhoods with higher risk of violent victimization), by restricting socioeconomic mobility (e.g. exposure to lower quality schools), and by reduced access to environments conducive for healthy behaviors (e.g. exposure to unhealthy foods (25)). Higher exposure to these types of external contextual stressors is, in turn, linked with higher AL (6-12). Research has documented that the impact of racial residential segregation on the Hispanic population is likely to be smaller than that for African Americans, with the exception of Puerto Ricans (26). Puerto Ricans in the continental United States have a more jeopardized health status than Mexican Americans and a disease burden that parallels that of African Americans (27, 28). To our knowledge, no prior studies have tested the health effects of neighborhood context within the Puerto Rican population, which is of increasing demographic importance given the projected increase in Latino populations over the next half-century.

Despite the increasing body of literature linking neighborhood context to AL, existing studies are limited in several ways. First, most are cross sectional, which does not establish the temporal order between neighborhood exposure and the health outcome. Using multi-level methods and longitudinal data, we assess the temporal relationship of the association between neighborhood processes at baseline and AL after 2 years, controlling for possible confounders, which allows for stronger causal inferences. Second, most studies have used census tracts as a neighborhood unit, which may not align as well with individuals' perceptions of their own neighborhoods compared to smaller neighborhood units, such as block-groups (29). This latter aspect of measuring neighborhood might be more important for minority populations, in particular the Puerto Rican population, who tend to live in minority neighborhoods (30). Finally, while previous research accounts for race/ethnicity as a covariate, few studies specifically focus on neighborhood impact among minority populations in the United States. Evidence suggests that racial/ethnic minorities may experience their neighborhood differently than non-Hispanic whites, even when the surroundings are similar. For example, Mexican-born women perceive their neighborhoods as more dangerous than US-born women (31). Thus, analyses focusing on minority populations are essential to understand the distinct impact of neighborhood on health.

Despite evidence that neighborhoods are key determinants of individual health outcomes, little evidence exists to explain specific mechanisms linking the neighborhood environment to health (32). One psychosocial explanation for the poor health of people living in disadvantaged neighborhoods states that socioeconomic inequality increases an individual's sense of being deprived of status, leading to higher levels of stress and adverse health consequences (21, 33, 34). This notion leads to the prediction that surrounding wealth (relative to one's own) would be detrimental to health (21). On the other hand, Sampson (2002) argues that neighborhood social capital, conceptualized in terms of the differential ways in which communities are socially organized, is the relevant concept underlying neighborhood effects (35). Yet income inequality may undermine social capital via stressful social comparisons, which damages health through individual psychosocial processes and detrimental physiological mechanisms (19).

We aimed to test this psychosocial explanation of deprivation and health inequalities. Our analysis focused specifically on Puerto Ricans, one of the most deprived and segregated Hispanic populations. We hypothesized that neighborhood impact on AL is due to a combination of neighborhood level socio-economic status (NSES) and stressful social comparisons with neighbors (relative income). Our research questions include: Is there an association between relative income and AL beyond NSES? If so, does this association provide support for the psychosocial theory of deprivation and health inequalities? The present study addresses gaps in the literature by testing whether neighborhood socioeconomic status and relative income (e.g. household income compared to one's neighbors), are associated with AL in the Puerto Rican population, using a longitudinal design.

Data and Methods

We use data from the Boston Puerto Rican Health Study (BPRHS), a prospective cohort study of Puerto Rican adults living in the greater Boston area. The focus on Puerto Ricans builds on findings from an earlier NIH funded study that included other Hispanic groups and non-Hispanic whites in the greater Boston Area, and which showed a very distinctive pattern of health based disadvantage for Puerto Ricans relative to the other groups. The BPRHS is the only longitudinal data collection that includes the Puerto Rican population in large numbers to conduct this type of analysis. The design of the BPRHS has been described elsewhere (36). Briefly, participants were sampled from high-density Hispanic areas, defined as year 2000 census tracts with populations of at least 25 Puerto Rican adults, ages 45-75 y. Participants were recruited using door-to-door enumeration within randomly selected block-groups with 10 or more Hispanics, by random approach during community events, and through calls to the study office from flyers distributed at community locations. Inclusion criteria/eligibility included self-identified Puerto Rican ethnicity, aged 45-75 y, and being able to answer questions in English or Spanish. Individuals who were unable to answer questions due to serious health conditions or who had a low Mini Mental State Examination (MMSE) score (≤10) were excluded (36). Participants completed a comprehensive set of survey questionnaires and a neuropsychological test, via in person interviewing. In addition, participants were given instructions on fasting for a blood draw. In the day following the interview, or as soon as possible thereafter, a certified phlebotomist returned to the participant's home to collect urinary and saliva samples, and to draw blood. All interviewers were thoroughly trained by experienced staff to administer the questionnaires and perform measurements following standardized procedures. The Institutional Review Boards for Human Research at Tufts Medical Center and Northeastern University approved the protocol of the study.

Baseline data were collected between 2004 and 2009 (n=1504), and a second wave of data was collected from 2006 to 2011 (n=1258). Thus, our analytical sample includes a maximum of 1,258 participants; although, due to missing values in the variables under study, the sample sizes differ between the first five models and the last model. An average of 2.18 years passed between baseline and wave 2. At baseline, participants reported having been living in their house for 6.8 years, on average. This length of residence suggests that the exposure to neighborhood deprivation had been for a sufficient amount of time for expected effects (37). We geocoded the individual's baseline address to census 2000 geography using ArcGIS version 10.1. Participants' homes were located in 318 block-groups (176 census tracts) in the Boston metropolitan area. The largest cities in the greater Boston area in which the participants resided included: Boston, Lawrence, Chelsea, and Cambridge. Thus, our sample represents a mix of mainly urban, but also suburban areas.

Outcome

Allostatic load is a well-established concept and has been shown to be a relevant measure for this population (13). The AL score was created by summing across indices of cardiovascular and metabolic dimensions of biological risk, based on work by the MacArthur Studies of Successful Aging (38). These include 10 parameters that reflect physiologic activity across a range of important regulatory systems: systolic and diastolic blood pressure (cardiovascular system measures); waist-hip ratio (long term indicator of metabolism and adipose tissue deposition); serum high-density lipoprotein (HDL) and total cholesterol concentrations (long-term atherosclerotic risk indicator); serum DHEA-S (a functional HPA axis antagonist); plasma concentration of total glycosylated hemoglobin (glucose metabolism measure); urinary cortisol (HPA axis measure); and urinary norepinephrine and epinephrine (sympathetic nervous system activity index) (38, 39). An 11th parameter was included to account for inflammation (C-reactive protein). We used the AL score previously defined by Mattei et al. (2010) in this Puerto Rican population, using clinical cutoff values for each parameter, when available (none were available for neuroendocrine parameters, and for these, the upper quartile was used) (13). AL was measured by summing the number of parameters for which a participant fell above (or below, when appropriate) the defined cut-off point. Additionally, a point was assigned to account for relevant medication use (in the case of hypertension, diabetes, lipid-lowering or testosterone) when the respective parameter was within the established cutoff (13, 40). Thus, AL ranged from 0 to 11. All parameters were equally weighted. Higher AL values indicate higher biological risk. AL was measured at both baseline and 2-year follow up.

Neighborhood Measures

We utilized year 2000 US Census data at the block-group level, as a proxy for neighborhoods, since it sequentially preceded our baseline measurement of the AL outcome. A NSES factor was developed using factor analysis of six census variables (41), including: percent of adults older than 25 years with less than a high school education, percent of male unemployment, percent of households with income below poverty, percent of households receiving public assistance, percent of female-headed households with children, and median household (HH) income. We reversed the latter variable for the analysis, as its interpretation was in the opposite direction as the rest of the scale's components. The Cronbach's alpha for the neighborhood variables was 0.87. We used the standardized factor score from the first factor for subsequent analysis. To facilitate interpretability of the factor, we reversed the measure, such that higher values of the NSES factor indicate higher socioeconomic status. The NSES factor was measured at baseline only.

We computed a measure of relative income by subtracting the Census 2000 median income in the neighborhood (block-group level) from the respondent's baseline HH income. Relative income is operationalized at the individual level by virtue of the fact that it is derived from both an individual level and a neighborhood level measure, which is consistent with approaches from prior literature (24). However the measure is capturing (relative) inequality of the household within the neighborhood with respect to income, which is why we call it a neighborhood context measure. Thus, negative values indicate that the individual HH is surrounded by higher income HHs and, thus, the individual is relatively more deprived than neighbors. Positive values mean that the HH is surrounded by lower income HHs and, thus, the participant is relatively better off than neighbors. For ease of interpretability, we re-scaled the income variables so that 1 point equals $10,000. A relative income measure provides a useful comparative variable that is contextual, as it compares the relative circumstances of each individual within its neighborhood (24).

Covariates

Individual-level covariate data were obtained from the baseline interview of the BPRHS cohort. Covariates included gender, age (centered at age 45 y) and individual-level socioeconomic position operationalized as a binary variable indicating if the household was below the U.S. federal poverty line, accounting for household size and year of assessment. Individual residence variables include city and length of time lived at the current residence. We adjusted for city to account for bias deriving from the differential structure of cities compared to suburban areas, which has an important impact on neighborhood form. Time on the US mainland was also considered, as exposure to neighborhood may differ based on recency of arrival; however inclusion of this variable did not substantively change the results or interpretation (Table A1, Appendix) and we omitted the variable for parsimony. Baseline AL was also included in the analysis to evaluate change in AL over the follow-up period. Lastly, time between baseline and follow-up was included as a covariate to adjust for any variation in the time between surveys.

Statistical Analysis—Two level hierarchical linear regression models for continuous outcomes were estimated using SAS version 9.3. Level 1 included BPRHS participants (individual-level data) and level 2 included the census block-groups (neighborhood-level data). Initially, the variance at the neighborhood level was not significant, suggesting that AL did not vary significantly between neighborhoods. However, as our main interest was to disentangle context-induced sources of neighborhood level variation and to make inferences about the neighborhoods in which Puerto Ricans live, we continued with a two-level model to account for the clustering of our observations and to avoid underestimation of standard errors (Type I error), to more appropriately account for the hierarchical nested structure of our data (5).

To test associations between baseline neighborhood socioeconomic context (NSES and relative income) and AL at follow-up, we regressed AL at follow-up on each baseline covariate separately. Next, we evaluated the joint association of NSES and relative income only, on AL. Then we controlled for individual-level demographic and socioeconomic variables such as age, gender and income-to-poverty ratio (IPR), as well as residence variables, and then baseline AL. Following Glymour (2005), we undertook sensitivity models to test whether baseline adjustment for AL inflated the coefficients for neighborhood relative income or NSES, relative to models without baseline adjustment (42). We found no inflation of the coefficients, suggesting that baseline AL score can be used as a proxy for positive confounders of the relation between neighborhood impact and AL change (42). We also ran sensitivity analyses including time between baseline and 2nd wave data collection, but results did not change and thus it was not included in the final models. Lastly, models were approximately grand-mean centered for age, and the neighborhood SES factor, to avoid off-support inference by keeping the estimates within the range of available data.

Results

Descriptive statistics for the baseline individual and block-group neighborhood level variables show that the mean age of the sample was 58 y, more than 70% were women, and almost 60% of the households had income below the poverty threshold (Table 1). The mean length of current residence was 6.8 years and 64.3% of the participants lived in the city of Boston. On average, block-group Census data, operationalizing neighborhood context, showed that these blocks contained 18.5% female-headed households, 37% of adults with less than high school education, 8.9% receiving public assistance, and median household income of 2.78, which represents $27,786. The mean neighborhood SES factor score was zero, as expected for a standardized variable. The mean relative income was -$1.001, meaning that household income was, on average, $10,010 lower than neighborhood median income, indicating that participants in our sample tended to be more deprived than their neighbors. The mean for AL at baseline was 4.56 (SD=1.91) and at 2 year follow-up was 4.79 (SD = 1.83). The correlation between relative income and the neighborhood SES factor was -0.43 ($p<0.0001$). The correlation between individual components that make up AL and AL, relative income and NSES factor, were examined at both baseline and two-year (Table A2, Appendix).

Results from multilevel linear regression analyses testing the association between baseline relative income and AL at follow-up show an inverse association, as hypothesized, where relatively advantaged individuals, or those with an income higher than their neighborhood's median income, were more likely to have lower AL 2 years later (Table 2, model 1; β (SE)=-0.052 (0.027), P=0.05). In Model 2, testing the joint association of relative income and NSES, the negative association of relative income and AL strengthened (β (SE)= -0.076 (0.030), P=0.01). The addition of individual-level demographic variables somewhat reduced the relative income-AL association, (Model 3: β (SE)= -0.056 (0.029), P=0.05), but the relative income coefficient increased again after controlling for individual level socioeconomic status in Model 4 (β (SE)=-0.063 (0.033), p=0.06) and for residence variables (city and length of time in neighborhood) in Model 5 (β (SE)=-0.068 (0.033), P=0.04). Finally, in Model 6, the association remained suggestive at the $P<0.1$ level of significance, after additionally adjusting for baseline AL (β (SE)= -0.044 (0.028), P=0.10).

The NSES factor score only showed significance in Model 2 (β (SE)= -0.120 (0.061), P=0.05) when jointly adjusting for relative income, indicating that higher NSES was associated with decreasing AL over time (as hypothesized). However, this association became non-significant after adjusting for individual-level demographic and socioeconomic variables. Finally, length of residence was also tested as a modifier of the neighborhood-allostatic load association but there was no significant effect (results not shown).

Discussion

This analysis examines an important contextual influence—the role of relative deprivation – for minority population health. After adjusting for individual level demographic and socioeconomic variables, the estimated net association between the absolute variable of NSES and AL was not significant over 2 years of follow-up for this Puerto Rican population. However, the inverse association of relative deprivation on AL was present in all models, and significant or marginally significant in most.

We tested the hypothesis that a combination of neighborhood level socio-economic status (NSES) and stressful social comparisons with the neighbors (relative income) is associated with poorer health. Assessing neighborhood effects on dysregulation in multiple biological systems (AL) as a result of the psychosocial impact of their perceived relative social position provides a more cohesive view than studying individual risk factors one at a time. Cumulative biologic risk is a way to consider how unequal life experiences (e.g. neighborhood socioeconomic environments) contribute to an increased risk for an array of health outcomes (6).

Our inability to detect an independent association between NSES and AL after controlling for individual demographic variables, including SES, may be because these neighborhoods were too homogenous with respect to NSES, with limited variability to detect a meaningful effect of neighborhood context on AL. Or, it could be that our study with its longitudinal design ruled out reverse causation (of people migrating to worse neighborhoods as a result of declining health) as an explanation for a neighborhood association with AL. Our results suggest a potentially independent effect of relative income on AL after 2 years. This association provides tentative support to the psychosocial theory of deprivation and health inequalities. The impact of relative deprivation within disadvantaged neighborhoods may be a more telling indicator for health than the absolute NSES environment. These findings are similar to previous research. For instance, Allender et al. (2012) found that relative deprivation of a ward in comparison to its neighbors is associated with CHD mortality and that poor districts surrounded by rich areas have worse CHD mortality rates than poor districts surrounded by other poor areas (22).

We modeled relative income as a contextual variable, operationalized at the individual level, by situating each individual in the income context of his/her surrounding neighborhood. Contextual analyses require data sets including individuals nested within areas (e.g., neighborhoods). By simultaneously including both neighborhood- and individual-level predictors in regression equations with individuals as the units of analysis, these strategies allow examination of neighborhood or area effects after individual-level confounders have been controlled (41). Multilevel models allow separation of contextual and compositional effects in a quantitative sense. A central empirical question concerning contextual effects is whether the neighborhood level variation remains significant when a range of relevant individual variables (eg: age, gender, income, housing tenure) are included in an overall model to allow for the population composition of particular places (43).

A major limitation of past work on neighborhood contextual effects is that most studies do not include length of residence. While we do not have complete information on previous residence history, the average of seven years (with a standard deviation of 6.98 years) that people reported living in the current residence suggests reasonable residential stability for studying the impact of neighborhood on health, although it is acknowledged that it represents a relatively small portion of the lifespan of older adults. Because this study was restricted to Puerto Rican older adults, we cannot contrast the Puerto Rican experience with that of other groups. However, this study adds to the literature on the health effects of neighborhood context within an increasingly important population, given the aging of the American population in general, and the projected increase in the Latino populations over the next half-century.

Limitations

Some limitations should be noted. First, we have small sample sizes within block-groups, restricting our ability to estimate between-neighborhood variance. To account for this, we ran an ordinary least squares analysis to compare results, including neighborhood block-groups as indicator variables, and results were similar (Table A3, Appendix). Given that such fixed-effects models control for any time-stable confounding across neighborhoods, this sensitivity analysis provides evidence that results were not seriously confounded by unmodeled variables. Secondly, as with any observational study, there is a threat to internal validity by unmeasured potential confounders, which limits causal inference. Third, the definition of the geographic area relevant to the health outcomes under study has been the subject of some debate. Administratively defined areas such as block groups are often used as rough proxies for neighborhoods. However, the size and definition of the relevant geographic area may vary according to the processes through which the area effect is hypothesized to operate and the outcome being studied (37, 41). We selected the smallest census unit for which we could obtain socioeconomic data, the block-group, which has also been documented as comparable to how people conceptualize their neighborhood, according to qualitative research (29). Fourth, identifying the relevant reference group with which people might compare themselves for operationalizing relative deprivation is not a simple task (41, 44). Our study focuses on comparisons within a neighborhood, assuming that people would be influenced by local residential comparisons. However, social comparisons may occur among co-workers, among friends or other peers (regardless of residential proximity), or even via mass media, which we did not model here. Furthermore, the impact of neighborhoods and social comparison may also be mediated by level of acculturation. It should be noted participants were given the choice of language, an indicator of acculturation, for the interview and that a large majority (86.4 percent) of the participants completed the interview in Spanish. Future research should examine the mechanisms through which neighborhood context and acculturation differentially impact minority health.

A fifth limitation relates to the AL measure that we used. Literature suggests that AL summary index is a meaningful measure, since it captures the multiple and interrelated dysregulations in physiologic systems that develop over time (6). We based our AL measure on the measures originally used by the MacArthur Aging studies, and accounted for C-reactive protein and medications use. Reports from the MacArthur Studies show that AL predicted morbidity and mortality (45). Moreover, prior work in this population compared approaches in the relationship of AL to physical function and cognitive function and found that this adapted measure was the most strongly associated with these outcomes (13). We have since used this measure successfully in several studies.

Our sample of Puerto Ricans was mainly low income, which could limit the degree to which results are generalizable to other populations. Our study probes health patterns among

Puerto Ricans in the Boston region, and their experiences are typical for Puerto Ricans in the Northeast, where they comprise large numbers, and are subject to high residential segregation, economic disenfranchisement, as well as poor health. However even outside of the Northeast, in states like Florida, Illinois, and parts of California, Puerto Ricans are an important population for understanding health disparities given their increasing demographic importance with the projected growth of Hispanics in the coming half century (46).

Finally, although we adjusted for baseline AL in the final model, potential bias may have been introduced by omitting baseline AL in models 1 through 5. However, research has shown that while adjusting for baseline health status ameliorates certain biases, it introduces others (42). Because AL is a lifelong progressive condition, we assume that baseline AL and change in AL from baseline to year two have prior common causes. Factors that affected baseline AL, for example low NSES, may continue to operate during follow-up. Thus, it is useful to examine this cumulative measure of AL alone, before investigating recent AL change. If increases in AL began before the baseline measure, the biological markers would be worse for individuals with poorer health. Baseline biomarkers are thus influenced by both low NSES and other causes of poorer health. Conditioning on a function of the baseline biomarkers (AL) may create a spurious correlation between its causes (low NSES) and unmeasured causes, which may induce a spurious relation between low NSES and subsequent change in AL. Therefore, examination in both ways is helpful for understanding these associations. Lastly, since our sample size decreased in the final model, the conclusions drawn from this smaller sample cannot be directly compared to the other models.

Conclusions

This longitudinal multilevel study of aging Puerto Ricans allowed us to investigate how neighborhood exposures are associated with health through wear and tear on the body associated with cumulative exposure to stressful life conditions across time. Our results show that an income advantage relative to one's neighbors is associated with a lower AL score after a two-year period. Our study extends previous findings that neighborhood context may influence a wide array of health outcomes, and our findings are strengthened by our longitudinal multilevel design and analysis. Such findings may be especially important for understanding contributors to health disparities (47, 48), particularly in the US where high exposure to neighborhood deprivation, particularly for ethnic and racial minorities, obstructs access to neighborhood resources, services, and contexts considered salubrious for a safe quality of live and opportunities for social advancement (48). Understanding not only how and why health is associated with residential and spatial opportunities, but also how such health disparities can be reduced via residential interventions and policies via the social determinants of health, are important directions for future work.

Acknowledgments

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Appendix

Table A1

Hierarchical Linear models: Associations of baseline neighborhood socioeconomic status and relative income with allostatic load at wave 2, controlling for Years in the US

	Model 1			Model 2			Model 3			Model 4			
	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Estin
Relative Income [a]	-0.054	0.027	0.05	-0.078	0.030	0.01	-0.056	0.029	0.05	-0.063	0.033	0.06	-0.0
NSES Factor[b]	-0.039	0.056	0.49	-0.120	0.063	0.06	-0.076	0.057	0.18	-0.082	0.610	0.18	-0.0
Age (centered at 45 y) Gender (ref = female)							0.063	0.074	<0.0001	0.059	0.008	<0.0001	0.0
Male							0.262	0.123	0.03	0.250	0.124	0.05	0.2
IPR (ref = above poverty level Below poverty level										0.045	0.130	0.73	0.0
LOS(years)										0.005	0.005	0.27	0.0
City (ref = suburban area)													
Urban													0.0
Baseline AL													
Sample Size	[a]1089 [b]1030			1030			1030			1030			92

[a]Income modeled as a 1-unit increase in the variable corresponds to a $10,000 increase

[b]NSES (neighborhood socioeconomic status) factor is standardized, so a 1 unit increase corresponds to a 1-SD increase in NSES

Model 1: Relative Income or NSES Factor
Model 2: Relative Income + NSES Factor
Model 3: Model 2 + Age + Gender
Model 4: Model 3 + individual poverty ratio (IPR) + length of stay in the U.S. mainland (LOS)
Model 5: Model 4 + length of residence
Model 6: Model 5 + Baseline AL

Table A2

Correlation table with AL sub components

	Baseline Biomarkers			Year Two Biomarkers		
	AL at baseline	Relative Income	NSES factor	AL at year 2	Relative Income	NSES factor
Average systolic blood pressure	0.339 ***	-0.062 *	0.025	0.324 ***	-0.005	0.014
Average diastolic blood pressure	0.209 ***	0.034	0.023	0.125 ***	0.064 *	0.039
Average of waist measurements	0.438 ***	-0.034	-0.038	0.390 ***	-0.031	-0.013
Cholesterol (mg/dl)	-0.153 ***	0.062 *	-0.003	-0.222 ***	0.025	0.028
Glycosolated hemoglobin %	0.420 ***	-0.024	-0.066 *	0.407 ***	-0.040	-0.054 *
Urine Cortisol	0.159 ***	-0.050 Ɨ	0.045	0.194 ***	-0.052 Ɨ	0.006
Nor-Epinephrine	0.334 ***	-0.022	0.005	0.015	0.038	0.027
Epinephrine	0.235 ***	-0.009	0.045	0.020	0.012	-0.041

	Baseline Biomarkers			Year Two Biomarkers		
	AL at baseline	Relative Income	NSES factor	AL at year 2	Relative Income	NSES factor
HDL (mg/dl)	-0.268 ***	0.008	0.061 *	-0.262 ***	-0.014	0.038
DHEAS	-0.165 ***	0.057 *	0.055 *	-0.130 ***	0.046	0.047 ƚ
C-reactive proteini (mg/l)	0.252 ***	-0.007	-0.019	0.189 ***	-0.021	-0.041

*** p<0.0001

** p<0.01

* p<0.05

ƚ p<0.1

Table A3

Ordinary Least Squares Regression models: Associations of baseline neighborhood socioeconomic status and relative income with allostatic load at wave 2.

	Model 1			Model 2			Model 3			Model 4			
	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Est
Relative Income[a]	-0.054	0.027	0.05	-0.078	0.030	0.01	-0.058	0.029	0.05	-0.066	0.033	0.05	-0
NSES Factor[b]	-0.039	0.056	0.49	-0.120	0.063	0.06	-0.083	0.061	0.18	-0.093	0.065	0.15	-0
Age (centered at 45 y) Gender (ref = female)							0.062	0.007	<0.0001	0.062	0.077	<0.0001	0
Male IPR ref = above poverty level							0.252	0.123	0.04	0.248	0.012	0.04	0
Below poverty level										-0.062	0.129	0.63	0
Length of residence													0
City (ref = suburban area)													
Urban													0
Baseline AL													
Sample Size	[a]1089 [b]1030			1030			1030			1030			9

[a]Income modeled as a 1-unit increase in the variable corresponds to a $10,000 increase

[b]NSES (neighborhood socioeconomic status) factor is standardized, so a 1 unit increase corresponds to a 1-SD increase in NSES

Model 1: Relative Income or NSES Factor
Model 2: Relative Income + NSES Factor
Model 3: Model 2 + Age + Gender
Model 4: Model 3 + individual poverty ratio (IPR)
Model 5: Model 4 + length of residence + city of residence
Model 6: Model 5 + Baseline AL

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Research Highlights

- We examine longitudinally the association between neighborhood context and AL
- Neighborhood SES does not show an association with allostatic load
- Relative advantage/disadvantage is associated with biomarkers of older Puerto Ricans
- Income advantage relative to one's neighbors is associated with a lower AL over time

Table 1

Boston Puerto Rican Health Study Descriptive Statistics (N=1,258)

Variable Name	%	Mean	Std. Dev.
Baseline Individual Variables			
Age, years (mean)		57.1	7.62
Female (%)	71.9		
Households below Poverty Line (%)	58.6		
Participants living in Boston City (%)	64.3		
Length of residence, years (mean)		6.84	6.98
Relative Income (mean)		-1.001	2.07
Allostatic Load Baseline		4.56	1.91
2nd wave follow-up Variables			
Allostatic Load year 2		4.79	1.83
Baseline Neighborhood variables (Census block-group level)			
Percent of female-headed households with children		18.5	11.81
Percent of adults older than 25 with less than a high school education		36.9	16.11
Percent of male unemployment		6.30	5.30
Percent of households with income below the poverty line		29.6	14.22
Median household income		2.78	1.46
Percent of households receiving public assistance		8.85	6.13
NSES Standardized Factor		0.00	0.95

Table 2

Hierarchical Linear models: Associations of baseline neighborhood socioeconomic status and relative income with allostatic load at wave 2.

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p	Estimate	S.E.	p
Relative Income [a]	-0.052	0.027	0.05	-0.076	0.030	0.01	-0.056	0.029	0.05	-0.063	0.033	0.06	-0.068	0.033	0.04	-0.044	0.028	0.10’
NSES Fact or [b]	-0.039	0.052	0.48	-0.120	0.061	0.05	-0.076	0.057	0.18	-0.086	0.061	0.16	-0.093	0.061	0.13	-0.060	0.050	0.23
Age (centered at 45 y) Gender (ref = female)							0.063	0.007	<0.0001	0.063	0. 007	<0.0001	0.060	0.008	<0.0001	0.029	0.007	<0.0001
Male							0.262	0.123	0.03	0.258	0.123	0.04	0.280	0.123	0.03	0.172	0.106	0.11
IPR										0.057	0.128	0.66	0.049	0.128	0.70	-0.010	0.109	0.93
Length of residence													0.014	0.008	0.08	0.009	0.007	0.20
City of residence													0.043	0.107	0.69	-0.038	0.087	0.67
Baseline AL																0.557	0.026	<0.0001
Sample Size	[a] 1030			1030			1030			1030			1030			929		
	[b] 1089																	

Model 1: Relative Income or NSES Factor
Model 2: Relative Income + NSES Factor
Model 3: Model 2 + Age + Gender
Model 4: Model 3 + individual SES
Model 5: Model 4 + length of residence + city of residence
Model 6: Model 5 + Baseline AL

[a] Income modeled as a 1-unit increase in the variable corresponds to a $10,000 increase

[b] NSES (neighborhood socioeconomic status) factor is standardized, so a 1 unit increase corresponds to a 1-SD increase in NSES