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Neighborhood perceptions and allostatic load: Evidence from Midlife in the United States study

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ABSTRACT

Allostatic load, which represents the cumulative wear and tear on physiological systems resulting from long-term exposure to stress, provides a theoretical framework that can be applied to understand the association between neighborhood conditions and health outcomes. Within allostatic load theory perception plays a key role, as the cognitive appraisal process associated with one's perceptions determines whether external stimuli—such as neighborhood conditions—are deemed threatening or benign. With data from the Midlife Development in the United States, this study employed structural equation modeling to assess the association between neighborhood perceptions and cumulative, systems-level allostatic load scores. The findings demonstrate that neighborhood perception, as operationalized as a combination of perceived trust in neighbors, perceived neighborhood safety, and perceived neighborhood conditions, was inversely associated with allostatic load even when controlling for objective neighborhood conditions.

1. Introduction

The social context within which people live has important implications for psychological states, which in turn influence health and well-being outcomes (Arcaya et al., 2016; McEwen, 2009). This context includes individual and family level factors, broader social relationships, and the larger social environment. From cardiovascular disease and immune deficiencies to depression, anxiety, and schizophrenia, the social environment and its associated stressors influence a wide range of health outcomes (Kawachi et al., 1997; Mair et al., 2010; McEwen, 2017). An important aspect of the larger environment is the neighborhood where individuals live and spend a disproportionate percentage of time (van Deurzen et al., 2016). Neighborhood conditions such as physical blight or social disorder can cause stress, which is associated with negative health outcomes (Taylor and Repetti, 1997). Allostatic load theory—which represents how stressors can get under the skin and negatively impact biological processes leading to disease outcomes—can be applied to understand the biological effects of neighborhood conditions (McEwen and Mirsky, 2002).

Subjective interpretation of stressors plays an important role in determining the individual stress response (McEwen and Stellar, 1993). The ways in which individuals appraise and interpret neighborhood conditions—their neighborhood perceptions—can influence how they respond to stressors that can lead to negative health outcomes. This study seeks to explicate the association between perceived neighborhood conditions and allostatic load as a marker of exposure to stress, while controlling for both individual sociodemographic characteristics and objective neighborhood measures. This study hypotheses that neighborhood perceptions are inversely associated with allostatic load.

1.1. Chronic stress and allostatic load

Chronic exposure to stress is associated with a wide range of negative health outcomes (see Juster et al., 2010; McEwen, 2010). Allostatic load theory, which expands on the work of Selye (1936, 1956) and Sterling and Eyer (1988), was proposed by McEwen and Stellar (1993) as a theoretical framework through which the association between stress and health outcomes can be explained. Allostatic load represents the "cumulative wear and tear" (McEwen and Stellar, 1993, p. 2094) on the body in the form of biological dysregulation that results from chronic exposure to stress. Per this theory, stress triggers biological dysregulation, which in turn leads to the development of disease.

The biological systems that respond to stress are known as stress systems and include the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic-adrenal-medullary (SAM) pathway of the sympathetic nervous system (SNS) (Beckie, 2012; Elenkov and Chrousos, 2002). Exposure to stress triggers a cascading process of biological responses that begin with decision making centers of the brain and can either

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initiate or suppress the stress systems, which have downstream effects on a wide array of physiological functions via the cardiovascular system, the metabolic system, the immune system, and the brain (Radley et al., 2017). The stress systems communicate with the rest of the body through the primary mediators cortisol, epinephrine, norepinephrine, and dopamine (McEwen, 2004; Juster et al., 2010).

Primary mediators have short-term effects that are protective, allowing for immediate responses that enable the body to react to stressors in a protective manner. It is only when long-term exposure to stress results in dysregulation of these primary mediators that their effects become harmful (McEwen, 1998, 2004). Examples of disease outcomes that are associated with increased biological dysregulation in the form of allostatic load include cardiovascular disease (Juster and Lupien, 2012; Mattei et al., 2010; Rosmond and Bjorntorp, 2000; Santacroce and Crandell, 2014), type 2 diabetes (Crews, 2007; Mattei et al., 2010; Rosmond and Bjorntorp, 2000), obesity (Carlsson et al., 2011), preeclampsia (Hux and Roberts, 2014), osteoporosis (Stetler and Miller, 2011), multiple sclerosis (Elenkov and Chrousos, 2002), rheumatoid arthritis (Straub and Cutolo, 2001; Wilder and Elenkov, 1999), cognitive decline (Lucassen et al., 2017), memory and attention impairment (De Kloet, E. R., Joëls, M., & Holsboer, 2005; Lucassen et al., 2017; Seeman et al., 2001), and overall mortality (Borrell et al., 2010; Duru et al., 2012; Howard and Sparks, 2015; Hwang et al., 2014; Karlamangla et al., 2006; Seeman et al., 2004; Seeman et al., 2001).

1.2. Environmental and neighborhood conditions, stress, and allostatic load

In recent years, research has sought to better understand the sources of stress that may cause the biological dysregulation that leads to negative disease outcomes. To date, examples of this research include relationships with spouses (Brooks et al., 2014), children (Seeman et al., 2002), co-workers and work supervisors (Mauss et al., 2015), and other non-familial social relationships (Seeman et al., 2014).

Neighborhood conditions can also act as stressors, resulting in higher levels of allostatic load. In one study, individuals living in neighborhoods with the lowest neighborhood socioeconomic status had the highest levels of allostatic load after controlling for individual covariates (Merkin et al., 2009). King, Morenoff, and House (2011) used hierarchical regression to disaggregate the variance in cumulative biological risk score that is attributable to individual characteristics as compared to neighborhoods, finding that individuals in higher income neighborhoods had lower risk scores.

While objective neighborhood conditions have long been studied in relation to their impact on health outcomes (for a review, see Ross and Mirowsky, 2001), more recently there is a growing recognition of the importance of perceived neighborhood conditions. Some researchers even suggest that perceptions of one's neighborhood may be even more important than objective, measurable factors in predicting health outcomes (e.g., Ambrey et al., 2014; Galaviz et al., 2016). McEwen and Stellar (1993) note the importance of perception—i.e., subjective interpretation of an external stimulus as a threat—as a key component of the stress response. Lazarus and Folkman (1984) argued that stress represents the relationship between individuals and their environments, and this relationship is mediated by a cognitive process, known as cognitive appraisal, whereby a potential stressor is evaluated to determine the appropriate response or method of coping (Aldwin, 2011). Even as a group of people experience the same situation, individuals may respond differently, in part because each individual perceives and then appraises the situation in a unique manner that is influenced by past experiences and previous exposures to similar stressors (Aldwin, 2007; Lazarus and Folkman, 1984). As the first step in the stress appraisal process, perception plays a key role in how one responds to a stressor (Cooper and Dewe, 2004).

The importance of perception within the stress appraisal process is supported by empirical findings that individuals' perceptions of their communities and their health and well-being outcomes are related. For example, seniors who perceive their neighborhoods as unsafe are less likely to engage in physical activity (Maisel, 2016), while parents are less likely to let their children play outside or visit community centers when they perceive their neighborhoods as unsafe (Galaviz et al., 2016). In a longitudinal study, Robinette et al. (2016) found that individuals who perceived their neighborhoods as being less safe at wave one of the study reported more health-related problems at wave two. This expands on previous literature linking more negative perceptions of one's neighborhoods to lower self-rated health and physical functioning (Bowling et al., 2006; Weden et al., 2008) as well as an increase in chronic health conditions (Ross and Mirowsky, 2001). Specific disease outcomes associated with negative neighborhood perceptions include higher blood pressure (Gary et al., 2008), diabetes (Moreno et al., 2014), and risk of stroke (Kim et al., 2013). More negative neighborhood perceptions are also associated with poorer mental and emotional well-being (Toma et al., 2015), increased depression (Curry et al., 2008; Wilson-Genderson and Pruchno, 2013), and increased anxiety (Gary et al., 2007).

One challenge in generalizing results from the literature is the diverse ways in which researchers operationalize neighborhood perceptions. Examples include survey questions about available neighborhood amenities such as store, community facilities and transportation (Bowling et al., 2006; Gary et al., 2008; Moreno et al., 2014; Weden et al., 2008); neighborliness and trust in neighbors (Bowling et al., 2006); crime and safety (Bowling et al., 2006; Gary et al., 2008; Moreno et al., 2014; Weden et al., 2008); physical conditions (Gary et al., 2008; Moreno et al., 2014; Weden et al., 2008); social disorder (Curry et al., 2008; Ross and Mirowsky, 2001); and overall satisfaction (Weden et al., 2008). Despite obtaining different measures related to neighborhood perceptions, it is common, as seen in a number of the studies cited above, for researchers to consolidate responses to individual questions into a single scale that represents neighborhood perceptions (e.g., Bowling et al., 2006; Gary et al., 2008; Moreno et al., 2014; Weden et al., 2008).

To date, limited research focuses on the potential linkages between neighborhood perception and allostatic load, even given the large body of evidence connecting neighborhood perceptions to negative health outcomes and high allostatic load to negative health outcomes (e.g., Buschmann et al., 2018; van Deurzen et al., 2016). McEwen, Nasveld, Palmer, and Anderson (2012) propose that allostatic load may mediate the relationship between neighborhood perceptions and negative health outcomes. Neighborhood stressors may trigger higher levels of allostatic load, which then lead to disease outcomes (van Deurzen et al., 2016). As a result, it is important to study the association between neighborhood perceptions and allostatic load, as better understanding these relationships may aid in developing interventions to address negative health outcomes associated with perceptions of neighborhood conditions.

2. Methods

2.1. Sample

This cross-sectional study utilized existing data from the Midlife in the United States (MIDUS) study. MIDUS is a national, longitudinal study of health and well-being (Ryff et al., 2006, 2014). The aim of the MIDUS study is to better understand the ways in which psychological, social, and behavioral factors impact mental and physical health as individuals age. There are three waves of MIDUS data and this study utilized data from wave two (M2) as well as the MIDUS Refresher sample. The Refresher sample added participants at M2 to expand the overall study sample moving forward. MIDUS has a complex, longitudinal study design with the first wave of data (M1) collected between 1995 and 1996 via a national, random-digit-dialing protocol. Non-institutionalized, English-speaking adults (ages 25–74) in the United States were eligible to participate in the study. M2 data was collected between 2004 and 2009 and Refresher data was collected between 2011 and 2014. Each wave of MIDUS data collection is divided into a series of projects. The core of MIDUS is the survey project, which includes data collected via a telephone interview and self-administered, written questionnaires.

Participants who completed the survey project at M1 were recruited for participation at M2. In addition, African American participants from Milwaukee, Wisconsin were recruited as part of an oversample with the goal of increasing the participation of African Americans in the study. Participants who completed surveys at M2 were recruited to participate in the biomarkers project, which required intensive, two-day stays at one of three locations (University of California—Los Angeles, University of Wisconsin—Madison, Georgetown University) (subsample of individuals who completed the biomarkers study, N = 1,993). This study utilized data from the M2 and Refresher survey project and the M2 and Refresher biomarkers project.

Census-tract data from the 2006–2010 American Communities Survey 5-Year Estimates (ACS) (U.S. Census Bureau, 2010) were linked to the MIDUS data to allow for objective neighborhood measures, which were not collected in the MIDUS study to be included in the analysis. ACS data was linked to the individual observations by the University of Wisconsin-Madison Institute on Aging, and the deidentified data provided to the researcher. This method of data linking ensures that individual participants and specific geographies can not be identified. This study includes all participants without missing values on any of the model covariates (N = 1,687).

2.2. Measures

Allostatic Load. Allostatic load is conceptualized as systems-level dysregulation (McEwen and Stellar, 1993). The goal of this approach is to capture dysregulation across multiple systems and is a common method used in the literature for operationalizing allostatic load (examples of systems-level approaches to allostatic load across studies: Gustafsson et al., 2011, 2012; Hickson et al., 2012; McMillan et al., 2017; Read and Grundy, 2014; Vadiveloo and Mattei, 2017; Zilioli et al., 2015).

To capture systems-level dysregulation, a multi-step process is employed that calculates dysregulation within seven biological systems based on twenty-five biomarkers. The biological systems and the biomarkers used to assess each are the *sympathetic nervous system* (norepinephrine, epinephrine, dopamine), *parasympathetic nervous system* (heart rate, low-frequency heart rate variability, high-frequency heart rate variability, root mean squared successive differences of the beat-to-beat interval (RMSSD), standard deviation of heart cycle length variability (SDRR)), *Hypothalamic-Pituitary-Adrenal (HPA) Axis* (cortisol, DHEA-S), *inflammatory* system (C-reactive protein, interleukin-6 (IL-6), fibrinogen, E-Selectin, intercellular adhesion molecule 1 (ICAM-1)), *cardiovascular system* (diastolic blood pressure, systolic blood pressure, pulse pressure), *glucose* metabolism (Hba1c, fasting glucose, HOMA), and *lipid metabolism* (HDL cholesterol, LDL cholesterol, total-to-HDL cholesterol, triglycerides). First, each biomarker was dichotomized as either high or low risk based on the clinical values. For biomarkers that do not have established clinical cutoffs, the sample distribution was utilized (1 = *high risk,* 0 = *low risk*). For low and high frequency heart rate variability, RMSSD, and SDRR, values in the lowest quartile of the sample distribution were classified as high risk, as lower levels of heart rate variables are markers of biological dysregulation. Cortisol and D-HEAS were split so that values in the lowest and highest 12.5% of the sample distribution were coded as high risk in order to capture both hyper- and hypocortisolemia (Bellingrath et al., 2009; Hellhammer et al., 2004; Juster et al., 2013). Values for the remaining biomarkers were coded as high risk if they fell within the highest 25% of the sample distribution. Next, systems-level allostatic load scores were calculated by averaging within-system biomarker scores. The operationalization of allostatic load via the sum of dysregulated systems based on high risk quartiles of the above noted biomarkers is a common approach in allostatic load research, especially with MIDUS data (e.g., Friedman et al., 2015; Gruenewald et al., 2012; Hamdi et al., 2016; Priest et al., 2015; Slopen et al., 2016; Vadiveloo and Mattei, 2017; Zilioli et al., 2015). For biological systems with three or more biomarkers, systems scores were calculated even if there was missing data for one of the biomarkers. This approach reduced the number of observations eliminated due to missing data while continuing to provide an accurate measure of system dysregulation. Similar methods can be seen throughout the literature (e.g., Bruce et al., 2017; Hamdi et al., 2016; Mori et al., 2014). Finally, an overall, cross-systems allostatic load score was calculated by summing each of the systems-level biomarker scores (range = 0 to 7). Given that a different number of biomarkers are available for each biological system, this approach effectively scales the biomarkers so that each of the seven biological systems has the same weight and influence on the overall allostatic load score (Gruenewald et al., 2012).

Neighborhood Perceptions. The focal independent variable of neighborhood perception is a latent variable based on responses to a series of questions from the M2 survey. MIDUS includes four questions from Keyes (1998) Health of Neighborhoods Scale. These questions focus on two domains identified by Keyes as trust and safety. Three additional questions were added to the scale to assess respondents' perceptions of physical neighborhood conditions. These three domains (trust, safety, and conditions) were then consolidated to create a more general measure of neighborhood perception. Respondents rated all seven questions on a Likert-style scale (1 = *A lot*, 2 = *Some*, 3 = *A little*, 4 = *Not at all*). The question domains and the questions are as follows: *Safety* ("I feel safe being out alone in my neighborhood during the daytime," "I feel safe being alone in my neighborhood at night"), *Trust* ("I could call on a neighbor for help if I needed it," "People in my neighborhood trust each other") and *Condition* ("Buildings and streets in my neighborhood are kept in very good repair," "My neighborhood is kept clean," "I feel very good about my home and neighborhood"). A confirmatory factor analysis was employed to assess scale reliability and create a latent construct that is intended to provide a broader assessment of neighborhood perceptions.

Objective neighborhood variables. The following Census tract-level variables were included in the model to represent objective neighborhood conditions: median owner-occupied home value (*continuous*), median household income (*continuous*), percentage of residents unemployed (*continuous*), percentage of residents living in poverty (*continuous)*, and neighborhood vacancy *(continuous)*.

Individual covariates. Age (*continuous*), sex (*female*, *male*), race (*Caucasian*, *African American*, *other*), ethnicity (*non-Hispanic*, *Hispanic*), homeownership status (*homeowner with a mortgage*, *homeowner without a mortgage*, *renter*), total household income (continuous), educational attainment (*less than high school diploma*, *high school diploma or GED*, *some college*, *associates degree or vocational certification*, *bachelor's degree*, *graduate degree*), employment status (*employed*, *retired*, *homemaker*, *unemployed or temporarily laid off*, *other*), years living in the neighborhood (*continuous*), and household size (*continuous*) were all included as covariates in the analysis.

2.3. Analytic approach

Analysis consisted of structural equation modeling (SEM) with Mplus, version 8.3 (Muthén & Muthén, 1998–2017) and was a two-step process. First, confirmatory factor analysis (CFA) was used to represent the latent construct of neighborhood perceptions. Second, a structural model that included bootstrapped standard errors was used to assess the association between the latent construct of neighborhood perceptions and allostatic load while including both neighborhood contextual variables and individual covariates. A supplemental analysis using this model was completed in order to assess the indirect associations between neighborhood-level factors and allostatic load via neighborhood perception. The full SEM conceptual model is displayed in Fig. 1.

Multiple fit statistics were employed to assess the degree to which both the model for the latent construct of neighborhood perceptions and the final structural model fit the underlying data. Four of the most common fit statistics used in SEM are the chi square test of model fit, root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Standardized Root Mean Square Residuals (SRMR) (Kline, 2016). In assessing model fit, it is most appropriate to consider multiple fit indices and not rely on any one measure. The chi-square test assesses the degree to which the proposed model is different from the saturated model. Therefore, for the best model fit, it should not be statistically significant. For RMSEA, values less than 0.08 demonstrate good model fit, while values less than 0.05 represent excellent fit (Kline, 2016). The CFI shows the percentage improvement over the null model, with a value greater than 0.90 representing a good fit and a value greater than 0.95 an excellent fit (Acock, 2013; Byrne, 2010). SRMR should be below 0.10 (Kline, 2016).

3. Results

3.1. Sample characteristics

Individual and neighborhood characteristics are displayed in Table 1. Respondents were majority white (76.76%), more likely to be female (55.42%) and had a mean age of 52.25 (*SD* = 12.27). The sample was mostly distributed between respondents with a high school diploma (18.44%), some college (21.28%), a bachelor's degree (26.56%), or a graduate degree (20.75%). The rest had less than a high school diploma (4.56%) or an associates degree (8.42%). Total mean household income was $77,277 (*SD* = 61,250). The majority of respondents were homeowners with roughly half of the entire sample having a mortgage (55.07%), a quarter owning their homes outright (25.79%), and the rest were renters (19.15%). The average household size was 3.25 (SD = 2.00) and the average leng of time people lived in their neighborhoods was 15.24 years (SD = 43.43). The mean allostatic load score was 2.12 (*SD* = 1.02). While the potential range was from 0 to 7, the actual range of the sample was 0–5.92. The mean and standard deviation for each individual biomarker is presented in Table 2. This table also provides the cut-offs utilized to create the dichotomized allostatic load scores based on the sample distributions and citations for clinical cutoffs.

The sociodemographic characteristics of this analytic sample are consistent with the characteristics of the full MIDUS 1 sample (see Midlife Development in the United States, n.d. for a comparison). Analysis comparing MIDUS 1 data to United States Census Bureau's Current Population Survey shows that in most sociodemographic categories, MIDUS 1 respondents mirror the national population's sociodemographic characteristics (Midlife Development in the United States, n.d.). The one exception relates to income, as MIDUS participants tend

Table 1
Sample characteristics (*N* = 1,687).

Variables	Mean (SD)	Percentage
Individual Characteristics		
Allostatic Load Systems Score	2.12 (1.02)	
Age	52.25 (12.27)	
Total Household income (000s)	77.28 (61.25)	
Sex		
Female		55.42
Male		44.58
Race		
White		76.76
Black		16.83
Other		6.40
Ethnicity		
Non-Hispanic		96.27
Hispanic		3.73
Educational Attainment		
Bachelor's degree		26.56
Less than a high school diploma		4.56
High school diploma		18.44
Some College		21.28
Associates degree		8.42
Graduate degree		20.75
Employment Status		
Employed		55.07
Retired		18.73
Homemaker		5.99
Unemployed/laid off		3.91
Other		16.3
Home Occupancy Status		
Homeowner with a mortgage		55.07
Own home without a mortgage		25.79
Renter		19.15
Household income (000s)	77.28 (62.25)	
Household size	3.25 (2.00)	
Years living in neighborhood	15.42 (43.43)	
Neighborhood Characteristics (Census tract-level)		
Median home value (000s)	22.04 (23.76)	
Median household income (000s)	58.96 (26.02)	
Percent of adults unemployed	5.16 (3.27)	
Neighborhood vacancy rate	10.29 (9.20)	
Neighborhood-level poverty	12.62 (10.63)	

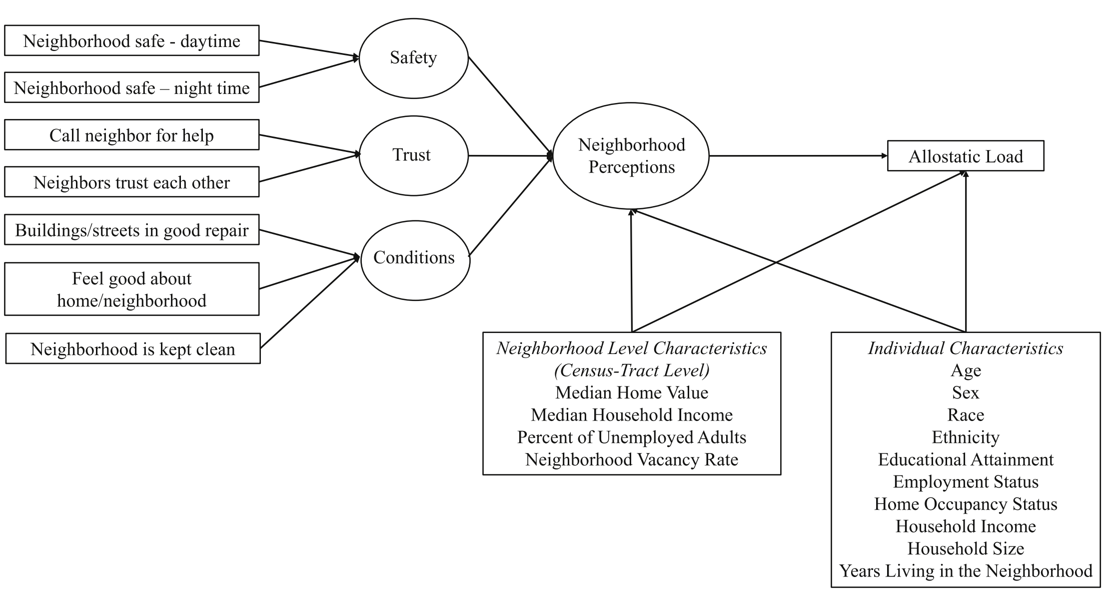

Fig. 1. Study conceptual model.

Table 2
Biomarker characteristics (N = 1,687).

Variables	Mean (SD)	Distribution-based cutoff value	Clinical-based cutoff value	Source for Clinical Values
HPA Axis				
Urine cortisol adjusted for creatine (ug/g)	19.39 (27.25	<=5.80 or >=33.00		
Blood DHEA-S (ug/dL)	114.56 (80.39)	<=34.00 or >=206.00		
Sympathetic Nervous System				
Urine Epinephrine adjusted for creatine (ug/g)	28.66 (28.66)	18.38		
Urine Norepinephrine adjusted for creatine (ug/g)	11.14 (24.90)	>=13.20		
Urine Dopamine adjusted for creatine (ug/g)	494.39	>=651.91		
Parasympathetic Nervous System				
Heart rate (beats per minute)	72.33 (10.69)		>70 males; >80 females	Nanchen (2018)
RMSSD	2.95 (0.63)	<=2.53		
SDRR (milliseconds)	3.47 (0.47)	<=3.17		
Low frequency heart rate variability (0.04–0.15 Hz)	5.46 (1.18)	<=4.72		
High frequency heart rate variability (0.15–0.50 Hz)	4.93 (1.33)	<=4.10		
Inflammatory System				
Serum interleukin-6 (IL6) (pg/mL)	2.80 (2.57)	>=3.40		
Blood C-Reactive protein (ug/mL)	2.84 (4.40)	>=3.43		
Blood fibrinogen (ug/dL)	344.33 (81.13)	>=392.00		
Serum soluble E-Selectin (ng/mL)	42.04 (20.96)	>=50.83		
Serum soluble ICAM-1 (ng/mL)	277.55 (130.06)	>=322.28		
Cardiovascular System				
Systolic blood pressure	128.97 (16.92)		>=120	Whelton et al. (2017)
Diastolic blood pressure	76.24 (10.09)		>=80.00	Whelton et al. (2017)
Pulse pressure	52.72 (13.62)		>=60.00	Homan & Cichowski (2019)
Lipid Metabolism				
HDL cholesterol	56.59 (18.39)		<40 males; <60 females	Grundy et al. (2019)
LDL cholesterol	103.89 (35.31)		>=100	Grundy et al. (2019)
Total to HDL cholesterol	3.57 (1.35)		>=5.00 males; >=3.33 females	Grundy et al. (2019)
Triglycerides	126.71 (119.82)		>150	Grundy et al. (2019)
Glucose Metabolism				
Blood fasting glucose levels mg/dL	101.53 (26.79)		>=100	Grundy et al. (2019)
Blood hemoglobin (HbA1c) percentage	5.92 (1.15)		>5.7	American Diabetes Association (2018)
Insulin resistance (HOMA-IR)	3.94 (4.53)	>=4.5		

to have higher incomes than the general population.

As for census-tract level neighborhood characteristics, the average median owner-occupied home value was $22,036 ($SD$ = 23,762) and the average median household income was $58,962 ($SD$ = 26,019) with an average percentage of individuals who were unemployed within a Census-tract of 5.16 percent (SD = 3.27). The mean Census-tract vacancy was 10.29 percent (SD = 9.20) and the mean Census-tract poverty rate was 12.62 percent (SD = 10.63).

3.2. CFA model

Table 3 displays the correlation matrix for the variables in the CFA. While all variables are statistically significantly associated, the amount of shared variance between any two variables is relatively small, ranging from a low of 4.5 percent ((“I feel safe being out alone in my neighborhood during the daytime,” and “I could call on a neighborhood for help if I needed it”) to a high of 50 percent “My neighborhood is kept clean,” and “I feel very good about my home and neighborhood”).

Standardized factor loadings and R^2 values for the latent construct of neighborhood perceptions are displayed in Table 4. The model consists of three latent variables that represent the three subdomains of safety, trust, and conditions. These three latent constructs each contribute to an overall neighborhood perceptions latent construct. The full model has a very good fit to the data ($X^2 = 73.206$, $df = 11$, $p < 0.001$; RMSEA = 0.058 (90% CI [0.046, 0.071], p = 0.138); CFI = 0.977; SRMR = 0.024).

3.3. Structural model

The structural model utilizes the neighborhood perceptions CFA as a predictor of allostatic load while including covariates. Multiple models were tested and included all the previously noted sociodemographic characteristics. The most parsimonious model with the best model fit statistics was selected. The final model was a very good fit to the data ($X^2 = 622.288$, $df = 161$, $p < 0.001$; RMSEA = 0.041 (90% CI [0.038, 0.045]), p = 1.00; CFI = 0.910; SRMR = 0.034). The complete list of standardized coefficients are provided in Table 5. The model shows that when controlling for all covariates, a one standard deviation increase in the neighborhood perceptions latent construct value is associated nearly a one-eighth standard deviation decrease in allostatic load ($\beta = -0.124$, $p < 0.001$). That is, individuals who report more positive perceptions of their neighborhoods on the MIDUS questionnaire also have lower levels of physiological dysregulation in the form of allostatic load.

Individual characteristics that were associated with higher allostatic load included being black as compared to white ($\beta = 0.056$, $p < 0.05$), having completed some college or an associates degree as compared to a bachelor’s degree ($\beta = 0.071$, $p < 0.05$ and $\beta = 0.056$, $p < 0.05$, respectively), self-identifying employment status as other as compared to being employed ($\beta = 0.052$, $p < 0.05$) and renting a home as compared to owning it with a mortgage ($\beta = 0.066$, $p < 0.05$). Being female ($\beta = -0.065$, $p < 0.01$) and owning a home without a mortgage as compared to owning one with a mortgage ($\beta = -0.058$, $p < 0.01$) were both associated with lower allostatic load. None of the neighborhood characteristic variables were directly associated with allostatic load. The full model accounts for 11% of the variance in allostatic load

Table 3
Correlation matrix for neighborhood perception variables.

	1	2	3	4	5	6	7
1. Neighborhood safe - daytime	1.000						
2. Neighborhood safe - at night	0.487	1.000					
3. Call neighbor for help	0.212	0.247	1.000				
4. Neighbors trust each other	0.292	0.376	0.536	1.000			
5. Buildings/streets in good repair	0.249	0.291	0.228	0.338	1.000		
6. Feel good about home/neighborhood	0.308	0.362	0.424	0.476	0.547	1.000	
7. Neighborhood is kept clean	0.332	0.373	0.330	0.437	0.642	0.710	1.000

*All variables are statistically significantly correlated at the $p < 0.001$ level.

Table 4
Standardized parameter estimates and R2 for latent constructs (*N* = 1,687).

Variable	Standardized Estimate	R-Squared
Safety	0.71***	0.51
Neighborhood safe - daytime	0.64***	0.41
Neighborhood safe - at night	0.76***	0.58
Trust	0.78***	0.61
Call neighbor for help	0.64***	0.40
Neighbors trust each other	0.84***	0.71
Condition	0.80***	0.64
Buildings/streets in good repair	0.70***	0.49
Feel good about home/neighborhood	0.81***	0.66
Neighborhood is kept clean	0.88***	0.78

***$p < 0.001$.

Table 5
SEM model of predictors of allostatic load (*N* = 1,687).

Variable	Std. Coef.	Bootstrapped Std. Err.
Focal independent variable		
Neighborhood Perception	**−0.124*** **	0.036
Individual characteristics		
Age	**0.285*** **	0.031
Sex		
Male	*ref.*	-
Female	**−0.064** **	**0.024**
Race		
White	*ref.*	-
Black	**0.056***	0.028
Other	0.042	0.027
Ethnicity		
Non-Hispanic	*ref.*	-
Hispanic	−0.013	0.027
Educational Attainment		
Bachelor's degree	*ref.*	-
Less than a high school diploma	0.039	0.029
High school diploma	0.042	0.029
Some College	**0.071***	0.028
Associates degree	**0.056***	0.024
Graduate degree	−0.001	0.028
Employment Status		
Employed	*ref.*	-
Retired	−0.005	0.03
Homemaker	0.021	0.023
Unemployed/laid off	0.049	0.025
Other	**0.052***	0.025
Home Occupancy Status		
Homeowner with a mortgage	*ref.*	-
Own home without a mortgage	**−0.058***	0.025
Renter	**0.066***	0.025
Household income	−0.030	0.028
Household size	−0.011	0.026
Years living in neighborhood	−0.016	0.019
Neighborhood Characteristics (Census tract-level)		
Median home value	−0.045	0.027
Median household income	−0.016	0.033
Percent of adults unemployed	−0.017	0.029
Neighborhood vacancy rate	−0.012	0.026
Neighborhood-level poverty	−0.006	0.038
R-Squared		0.11

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

($R^2 = 0.11$).

With respect to neighborhood perceptions, the full model also accounted for nearly one-third of the variance in neighborhood perceptions ($R^2 = 0.32$). Median household value ($\beta = -0.80$, $p < 0.01$), percent of neighborhood unemployment ($\beta = -0.138$, $p < 0.01$), and percent of individuals in poverty ($\beta = -0.214$, $p < 0.001$) were all inversely associated with neighborhood perceptions. As a result, a supplemental analysis was completed that calculated the indirect, direct, and total associations of the neighborhood-level variables on allostatic load via neighborhood perceptions. The results, including bootstrapped 95% confidence intervals, are displayed in Table 6. While none of the direct or total associations were statistically significantly associated with allostatic load, the indirect associations of median home value ($\beta = 0.010$, 95% CI: 0.002, 0.021), percentage of adults unemployed ($\beta = 0.017$, 95% CI: 0.005, 0.035), and neighborhood poverty ($\beta = 0.027$, 95% CI: 0.009, 0.048) were all positive, meaning an increase in each of these variables is indirectly, via neighborhood perception, was associated with increased allostatic load.

4. Discussion

This study sought to explicate the relationship between neighborhood perceptions and allostatic load. The results of the SEM analysis show that neighborhood perception is inversely associated with allostatic load. More specifically, a one standard deviation increase in neighborhood perception is associated with nearly a six percent decrease in allostatic load. While small, this is a meaningful and important change in allostatic load. These results align with the limited research in this area, such the findings by van Deurzen et al. (2016) that higher perceptions of disorder and pollution among residents in Denmark were associated with higher allostatic load.

Table 6
Indirect, direct, and total associations of objective neighborhood measures with allostatic load.

Variables	Direct[a]	Indirect[a] (via neighborhood perceptions)	Total[a]
	Est. (95% CI)	Est. (95% CI)	Est. (95% CI)
Median home value	−0.045 (−0.088, −0.004)	**0.010** (0.002, 0.021)	−0.035 (−0.084, 0.005)
Median household income	−0.016 (−0.079, 0.050)	−0.007 (−0.017, 0.001)	−0.022 (−0.085, 0.041)
Percent of adults unemployed	−0.017 (−0.076, 0.039)	**0.017** (0.005, 0.035)	0.000 (−0.058, 0.058)
Neighborhood vacancy rate	−0.012 (−0.062, 0.039)	−0.005 (−0.014, 0.002)	−0.016 (−0.067, 0.034)
Neighborhood-level poverty	−0.006 (−0.081, 0.073)	**0.027** (0.009, 0.048)	0.021 (−0.054, 0.097)

[a] Results displayed include estimates as well as bootstrapped 95% confidence intervals in parentheses.

That objective neighborhood measures were not directly associated with allostatic load may appear to be at odds with previous research that has established connections between neighborhood conditions and specific biological risk factors such as cardiovascular and metabolic risk (e.g., Moreno et al., 2014; Schulz et al., 2013). Yet these results are consistent with emerging research in the field. Specifically, Buschmann et al. (2018) found that objective neighborhood measures were not associated with allostatic load when controlling for individual characteristics, but the association with neighborhood perception remained.

The indirect associations between objective neighborhood measures and allostatic load via neighborhood perceptions is also informative. First, it is important to note that the general consensus has shifted in the literature that a statistically significant total association is not a prerequisite for interpreting significant indirect associations (see Loeys et al., 2015; Zhao et al., 2010). These findings further support the role and importance of neighborhood perception in determining how and if neighborhood conditions impact health outcomes via allostatic load. It suggests that interventions to improve neighborhoods adequately incorporate community members' perceptions and address the factors that are perceived to be the most important, even if other initiatives may have larger or more objectively measurable results. This can be a challenge, as different stakeholder groups within a given community—e.g., residents, community leaders, business owners—may have different perceptions about the importance of specific community issues and how best to address them (Holmes et al., 2000). Therefore, it is vital that any comprehensive community change effort integrate the widest range of stakeholder groups in order to identify stressors that are perceive to be the most important and will have largest potential benefit for health and well-being outcomes.

4.1. Limitations

There are limitations of this study. First, the data is cross-sectional, therefore a causal relationship between neighborhood perceptions and allostatic load cannot be established. Future research should utilize longitudinal data to help determine if neighborhood perceptions predict allostatic load or if increased allostatic load is the cause of negative perceptions of the neighborhood. Second, while neighborhood contextual variables were integrated into the analysis, the data does not allow one to identify specific neighborhoods, therefore making it impossible to address potential clustering of data via multilevel data analysis methods. The lack of consensus in the literature on the use of clinical values and sample distributions as cutoffs for biological dysregulation is a shortcoming of allostatic load literature more generally. This limitation also applies to the current study. Finally, the measures of neighborhood perception and objective neighborhood conditions were limited. Future research should seek to expand on these measures identify which specific variables have the most impact on allostatic load. The variables in the current study accounted for roughly one-third of neighborhood perceptions. It is likely that future studies that accound for more variable may find an even stronger link between neighborhood perceptions and allostatic load.

5. Conclusion

Allostatic load is an important measure of the effect of stress on physiological functioning and is a predictor of future negative health outcomes. This study finds that neighborhood perception is an important factor to consider in understanding allostatic load. Neighborhood perceptions are associated with allostatic load such that individuals who perceive their communities as sources of stress may internalize that stress in the form of allostatic load, which can lead to morbidity and mortality.

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Declaration of competing interest

None.

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