Power, Place and Mental Health:
Pathways between Neighborhood Vulnerability and Depressive Symptoms

by

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Dedication

As I think about my journey, I'd first like to dedicate this dissertation to the previous versions of myself that came and went as I faced the challenges that come along with pursuing a doctoral degree as a Black woman in a place like Michigan. I have to pat myself on the back for never giving up. I made it to this point through fortitude, resilience and perseverance and can present this body of work with so much pride.

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List of Abbreviations

ACL	American's Changing Lives Study
AF	Affluence
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
BM	Black Men
BW	Black Women
CES-D	Centers for Epidemiological Studies Depression Scale
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
DA	Disadvantage
DAG	Directed Acyclic Graph
EDD	Everyday Discrimination
EDU	Proportion of census tract households with 16 or more years of education
FHK	Proportion of Female Headed census tract households with kids
INC	Proportion of census tract households with income greater than or equal to $75,000 per year
LCM	Latent Growth Curve Modeling
MLR	Maximum Likelihood Robust Estimation
NHB	Proportion of census tract residents who are non-Hispanic Black
NVI	Neighborhood Vulnerability Index

NV	Neighborhood Vulnerability
PBA	Proportion of census tract households receiving public assistance
POV	Proportion of census tract households living in poverty based on federal poverty guidelines
PRF	Proportion of census tract households with professional employment
RMSEA	Root Mean Square Error of Approximation
SV	Social Vulnerability
SEM	Structural Equation Modeling
SRMR	Standardized Root Mean Square Residual
TLI	Tucker Lewis Index
UNE	Proportion of census tract residents who are unemployed
U.S.	United States
WW	White Women
WM	White Men

Abstract

Depression is the leading contributor to disability and the fourth leading cause of non-fatal disease burden worldwide. Over the past several decades, persistent race and gender differences in depression prevalence have been reported. Studies have shown women have twice the lifetime risk of first onset of depression compared to men, with differences in severity and chronicity between race and gender groups. In addition, structural factors such as those within the neighborhood context (poverty, unemployment, education, etc.) may contribute to depression outcomes. Race and gender appear to modify the influence of structural factors on depressive symptoms, making the etiology of this disorder of particular public health importance. Based on these observations, through this dissertation, we considered the role of neighborhood context and its contribution to the burden of depressive symptoms among race and gender groups.

In the first study, we created a composite measure of exposure to neighborhood context, the Neighborhood Vulnerability Index (NVI). The NVI consists of 8 census tract indicators of social disadvantage and affluence using data from a nationally representative longitudinal population-based sample at five timepoints between 1986 and 2011; the findings highlighted stark inequities in which groups are exposed to neighborhood vulnerability. Furthermore, race by gender trajectories show the compounding effect of race and gender on neighborhood vulnerability, where Black women navigate the most vulnerable environments. The results

highlight the persistent and reinforcing pattern of inequitable neighborhood conditions along racial and gender lines in the United States.

Next, we examined the longitudinal association between neighborhood vulnerability and depressive symptoms and found a positive association with some heterogeneity between groups. Neighborhood vulnerability was most strongly associated with depressive symptoms for Black men, had the weakest association among Black women and a similar impact on white men and women. The impact of neighborhood vulnerability on depressive symptoms was consistent over the course of the 26 year follow up.

Lastly, through the third aim of this dissertation we examined the roles of vigilance and discrimination, two types of race-related stress and coping, as mediators in the association between neighborhood vulnerability and depressive symptoms. We found evidence of strong mediation by vigilance and no evidence of mediation by discrimination. There were differences between race and gender groups, with an association more strongly mediated for Black Americans compared to whites and for men compared to women; however, many of the indirect effects were only marginally significant.

Taken together, the results of this dissertation provide evidence of a significant contribution of neighborhood context to the development of depressive symptoms among U.S. adults. By taking an innovative approach that considers the structural and interpersonal aspects of neighborhood characteristics, we offer a more nuanced view of depression etiology among race and gender groups. The pattern of findings between groups suggests race and gender contribute to differences in vulnerability to the effect of neighborhood context and social stress

on depressive symptoms. Consideration of neighborhood vulnerability in depression etiology and interventions may offer opportunities for improving the mental health of the U.S. adult population as they age.

Chapter 1 Introduction

Depression Among U.S. Adults

In the U.S, lifetime risks of depressive disorders (major depression, persistent depression, atypical depression, etc.) have become an important and growing public health concern over the past several years (Kessler & Wang, 2008; Mojtabai et al., 2016). Depression is currently the leading contributor to disability and the fourth leading cause of non-fatal disease burden worldwide (Reddy, 2010). Depressive disorders affect one in five persons and have a serious mental and physical health impact on those who suffer from it (*NIMH: Depression*, 2021).

Depressive symptoms have serious implications for role functioning and a negative impact on the lifespan in terms of educational attainment, financial success and marital stability (Greenberg et al., 2003; Kessler, 2012). Depression is characterized by symptoms such as sadness, anxiety, emptiness, social withdrawal, guilt, suicidal thoughts and worthlessness that impair an individual's cognitive functioning, emotions and quality of life. It also manifests physically in the form of pain, fatigue, restlessness, abnormal sleep patterns and appetite changes (Anxiety and Depression Association of America, 2016; National Institute of Mental Health, n.d.). Per the National Institute on Mental Health, over 16 million adults report depressive symptoms annually and this condition disables more Americans than all other mental or behavioral disorders (*NIMH: Depression*, 2021). Of the adults who experience moderate to

severe symptoms, 80% of them report difficulty with work, home, or social activities (Centers for Disease Control and Prevention, 2018).

Depressive disorders are characterized by disability due to prolonged depressive distress that is not attributed to any salient event (Kraemer, 2007). Depressive symptoms, often measured as an indicator of depressive disorders, have been shown to have an impact on long term health and well-being as risk factors regardless of clinical significance (Ruo et al., 2003; Schiffer et al., 2008). This dissertation focuses on depressive symptoms, a common indicator of depressive disorders and significant predictor of health and well-being.

Race and Gender Disparities

Over the past several decades, persistent gender differences in depression prevalence have been reported. Studies have shown women have twice the lifetime risk of first onset of depression compared to men (Myrna M. Weissman & Mark Olfson, 1995; Sutton, 2012). This increased risk begins during adolescence and persists throughout adulthood but does not apply to recurrence or chronicity (Kessler, 2003). There are several proposed explanations for the gender differences in depression. Some potential explanations are individual-level factors such as emotional regulation, ruminative coping styles and a genetic predisposition to neuroticism and anxiety, but they do not fully account for the gap between men and women (Cavanagh et al., 2017; Kuehner, 2016). The gender disparity is also unexplained by experiences such as pregnancy, menopause, hormone replacement therapy and the use of oral contraceptives (Kessler, 2003; Piccinelli & Wilkinson, 2000; "Women and Depression," 2011). The disproportionate impact likely has consequences for women's higher incidence of cardiovascular

disease and diabetes since depression is a risk factor for first onset of these diseases (Van der Kooy et al., 2007; Xiang & An, 2015).

Epidemiologic data also shows differences in depression burden between racial/ethnic groups. For example, white adults have higher rates of depression diagnosis compared to their Black counterparts (R. K. Bailey et al., 2019a; Curtin & Warner, 2016; Hasin et al., 2005). White Americans are also known to have less exposure to social stress and other risk factors for depression compared to Black Americans, creating a misunderstood paradox (Barnes et al., 2013). The explanations for the higher prevalence of depression diagnosis in white Americans hinge on a lack of resilience, or an inability to adapt under adverse conditions (Assari, 2016; Assari & Lankarani, 2016b; Breslau et al., 2006). There are also researchers that suggest depression rates are actually higher in Black adults and the lower rates are due to selection bias in community-based samples, but this hypothesis lacks empirical support (Barnes et al., 2013). On the other hand, Black Americans are more likely to report severe and persistent depressive symptoms compared to white Americans, which may be due to Black American's prolonged exposure to multiple sources of social stress (Barnes, 2014; Keyes, 2009; Martin et al., 2013). The lower risk of depression among Black Americans may be partially explained by protective factors that originate in childhood and coping behaviors that prevent symptoms from reaching the point of clinical significance, but neither of these hypotheses have been fully investigated (Breslau et al., 2006; Mezuk et al., 2013).

The relationships between race, gender and depression are complex. Depression differentially affects all groups in ways that call for a better understanding of its etiology.

Throughout the history of studying depression, the proposed explanations for group-based differences are primarily individual-level differences in coping skills, perception, health behaviors, identity and personality (Assari & Lankarani, 2016a; R. K. Bailey et al., 2019a; Banks & Kohn-Wood, 2007; Kessler, 2003; Yang & Park, 2019). Some theorists have critiqued explanations that focus on the individual, arguing that they are biased by preconceived stereotypes (Ussher, 2010, Stoppard, 2010). For example, Schultz and Hunter recently discussed how the focus on the individual is due to pathologization and attempts to reinforce stereotypes (2016). For example, some study results have suggested women are more emotional than men, and others argue these conclusions are biased by the stereotypes held by the academics conducting this research (Bluhm, 2013). Even though several explanations have been investigated in psychiatry and psychology, none have been shown to consistently account for a substantial proportion of the gender or race differences in risk of depression. These observations suggest the major factor(s) contributing to a higher risk of depression in some groups may lie outside the individual and in aspects of socio-structural context.

Depression Etiology and Structural Factors

There are well known structural risk factors for depression that disproportionately impact some groups, such as racism and sexism. For example, while all people of color can experience a combination of gender and race-based oppression, anti-Black racism is arguably more severe, longstanding and hostile (Brown et al., 2000; Williams & Williams-Morris, 2000). Moreover, while all women may be at increased risk of depression due to sexism, only Black women are

exposed to misogynoir, a combination of racism and sexism that is specific to their group (M. Bailey & Trudy, 2018; Beauboeuf-Lafontant, 2008; Hooks, 2015).

Classism, or poverty-based oppression, is another structural risk factor linked to depression that intersects with race and gender to influence mental health. For those living below the poverty level, depressive symptoms are twice as common compared to those not living in poverty (Pratt & Brody, 2015). Across race and gender groups, poverty is a significant predictor of depression, with more chronic symptoms among Black adults and women (Kim et al., 2013; Riolo et al., 2005). In some groups, those who do not live in poverty do not always enjoy the protections of higher socioeconomic position. For example, Black Americans have been shown to experience depression regardless of changes in their socioeconomic position, and to a greater extent than their less educated white counterparts (Curry Owens & Jackson, 2015; Martin et al., 2013). Based on these observations, it is critical to consider the role of socio-structural context and its contribution to the burden of depressive symptoms. Race and gender appear to modify the influence of structural factors on depression outcomes, making the etiology of this disorder of particular public health importance.

Depression and Neighborhood Context

The emergence of theories on the sociology of mental health and ecosocial determinants of health lead to the acknowledgement of neighborhood context as fundamental to the stress process and mental health outcomes (Krieger, 1994; Pearlin, 1999; Wheaton & Clarke, 2003). For decades, the neighborhood environment has been used to measure exposure to structural factors as a method to uncover contextual drivers of inequities (A.-V. Diez Roux, 2007;

Williams & Collins, 2001). The neighborhood literature utilizes constructs such as disadvantage, affluence, social cohesion and poverty to explore contextual predictors of health outcomes (Morenoff & Lynch, 2004). Although results are mixed, research on neighborhoods and mental health have linked many of these constructs to depression outcomes net of individual characteristics (Mair et al., 2008a). The impact of place on the networks and socioeconomic resources that individuals have access to positions neighborhood context as a fundamental cause of health, and its influence on exposure to the risk of depression can be viewed under a lens of vulnerability (Adger, 2006; Brennan, 2017; Hussein et al., 2018; Phelan et al., 2010). For example, an unemployed individual living in a neighborhood with a high proportion of unemployed residents may be vulnerable to additional stress as they navigate job scarcity and widespread joblessness (Elliott, 2000; Hurd, Stoddard, et al., 2013). Mental health vulnerability can also be affected by neighborhood racial composition. This is illustrated by studies showing the impact of segregation on exposure to different neighborhood social environments and structural conditions (Do et al., 2008, 2019; Mendenhall et al., 2006; Williams & Collins, 2001).

Theories on the mental health impact of neighborhoods are varied, in that it is unclear whether mental health is more or less vulnerable among those who experience more chronic stressors where they live. The differential vulnerability hypothesis argues that those who are chronically exposed to stress may be less reactive to it, or immune, while those with fewer chronic stressors may be at a higher risk of poor mental health outcomes (Kessler, 1979; Wheaton, 1982). For example, although white Americans are, on average, healthier than most groups, previous research suggests their privilege makes them more susceptible to the negative

impact of stressors as resilience is viewed as a muscle strengthened by adversity (Assari, 2016; Roubos, 2016). Furthermore, several longitudinal analyses have shown whites to be at an increased risk of morbidity and mortality due to depressive symptoms, low educational attainment, kidney disease and chronic health conditions in comparison to Black adults (Assari et al., 2015; Assari & Burgard, 2015; Assari & Lankarani, 2016b; Williams et al., 2007). Alternative hypotheses argue high contextual stress actually makes individuals more reactive as they navigate these environments over a longer period of time. This is supported by well-established associations between chronic stress and health outcomes. For example, allostatic load, or the cumulative burden of exposure to chronic stress, is associated with poorer mental health outcomes such as depressive symptoms, psychological distress, anxiety and memory performance (Guidi et al., 2021).

Other factors that determine vulnerability to neighborhood context, such as perception-based mediators, are thought to partially explain the link between neighborhoods and mental health, as they affect the severity and dilution of contextual stressors (Pearlin, 1999). Perception has the potential to contribute to inter and intra neighborhood variability in mental health outcomes as some research suggests the mental health impact of neighborhood context is conditional on social status (race, gender), and subjective experiences (Browning et al., 2013; Echeverría et al., 2008; Karriker-Jaffe et al., 2012; Schieman, 2005a). Many neighborhood studies have focused on social stressors that influence the impact of neighborhood contextual factors on an individual's mental health, identifying multiple sources that may mediate the

association between neighborhoods and depression such as vigilance and perceived discrimination (Himmelstein et al., 2015a; Hines et al., 2018; Prelow et al., 2004).

Vigilance, or vigilant coping style, is defined by the anticipatory acts people engage in to prepare for and prevent experiencing bias (Hicken et al., 2018; LaVeist et al., 2014b). For example, a person may change their hair, voice, or style of dress in preparation for navigating social spaces where they are susceptible to discrimination and prejudice. Perceived discrimination, on the other hand, is defined by incidences of bias, measured through self-reports of major experiences of lifetime discrimination (e.g., unfairly fired, denied a bank loan, etc.) or everyday discrimination (e.g., receiving poor service, harassment) (Williams, 2016).

Perception-based measures such as vigilance and perceived discrimination are often used as robust measures of exposure to structural inequity. This approach is limited, however, in that perception-based measures only allow for classifying individuals as exposed if they a) understand and internalize how social systems such as racism, sexism and poverty have an impact on their daily experiences, and b) operate with a high level of awareness and appraisal of their social interactions on a regular basis, leaving many stressors that influence mental health unaccounted for. Therefore, it is necessary to integrate structural exposures such as neighborhood context in this research, as a larger upstream force that may or may not be perceived by individuals as impactful for mental health outcomes. Without consideration of neighborhood context, the relationships between place, social stress and depression may only be partially understood.

Summary and Specific Aims

Overall, this dissertation will address three main gaps in the current research on neighborhoods and depression. First, it is important to broaden our measurement and understanding of exposure to social context and the structural factors that impact vulnerability to depressive symptoms. Second, empirical tests of the relationship between neighborhood contextual factors and depression over time are vital to expanding our understanding of the impact of socially constructed identities on mental health outcomes. Several theories about the relationship between structural risk factors and depression have deepened our foundation of knowledge for beginning to understand the relationship between depression, social context, race and gender, but more empirical evidence is needed to support or invalidate these claims (P Clarke et al., 2011; M. Kim, 2014; Neitzke, 2016; Wheaton & Clarke, 2003). Third, an examination of the role of perception in the relationship between structural factors and depression will contribute to a more nuanced understanding of how gender, race and class stratification impact access to resources and opportunities for mental well-being.

This dissertation has three aims. First, to create a new composite measure of exposure to neighborhood vulnerability across a 26-year time period that is consistent across race and gender groups. This measure partially addresses the limitations of perception-based measures of exposure to structural disadvantage and provides a tool that can be used for future epidemiological studies examining the effects of neighborhood context on health. Second, to conduct an empirical test of the association between exposure to neighborhood vulnerability and trajectories of depressive symptoms in a longitudinal dataset of U.S. adults followed

prospectively for 26 years (1986-2011). Finally, to empirically test the mediating role of perceived discrimination and vigilance in the association between neighborhood vulnerability and depressive symptoms to help disentangle the extent to which interpersonal experiences explain the impact of neighborhood vulnerability on mental health. To examine these analytic aims, I use longitudinal data from the Americans' Changing Lives Study, a nationally representative survey of Black and white adults followed over 26 years. With repeated measures of depressive symptoms and detailed residential histories, the ACL dataset provides robust racial, gender and neighborhood variability across time to address these aims. In sum, this dissertation deepens our understanding of the relationship between race, gender, perception, neighborhood context and their impact on depression throughout adulthood.

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Chapter 2 : Inequities in Exposure to Neighborhood Vulnerability over Time: Findings from a National Sample of U.S. Adults

Introduction

Our understanding of neighborhood and community level factors and their influence on health and well-being has emerged as a result of the burgeoning interest in the contribution of contextual factors, over and above individual level factors, to health outcomes. The characteristics of residential environments that may affect health are posited to contribute to social and race/ethnic inequities in health through the differential allocation of health promoting resources (e.g., safe recreational spaces, access to health care, employment opportunities) and health harming conditions (poor housing and working conditions, food deserts, crime) that stem from macro level processes that systematically sort large groups of the American population into different neighborhoods (Clarke and Nieuwenhuijsen, 2009, Mode, Evans and Zonderman, 2016, Waldstein et. al, 2016). For example, many studies have documented significant associations between neighborhood socioeconomic conditions and various health outcomes including mortality, adverse mental health outcomes, incidence of cardiovascular disease and diabetes using various methods of measuring exposure (Reijneveld, Pear, Pickett, 2001, Diez Roux and Mair, 2010, Schule and Bolte, 2015). However, few studies have examined how exposure to

these neighborhood conditions is inequitably experienced by individuals over adulthood. Longitudinal studies are well positioned to contribute to our understanding of the accumulation of neighborhood (dis)advantages and their impact on health throughout the life course but must first overcome the challenge of measuring differences in neighborhood context across time and between population groups.

Neighborhood indicators of (dis)advantage are often viewed as structural factors, defined as aspects of the economic and social environments that create the context in which risk production occurs (Freisthler and Maguire-Jack, 2015, Kolak, Bhatt and Park, 2020). Structural risk factors disproportionately impact population subgroups. For example, while all minoritized groups experience race-based oppression, it can be argued that very few groups, if any, have been exposed to this mistreatment as long as Black Americans, who stand on a socioeconomic and cultural base that is persistently undermined by larger society (Hooks, 1981, Pager and Shepherd, 2008, Bailey et. al, 2017, Brownlow et. al., 2019). Furthermore, while all women may be at increased risk of depression due to sexism, Black women's social context is drastically different from other racial/ethnic groups of women (Beauboeuf-Lafontant, 2008, Hooks, 2015). Black women experience *misogynoir*, a combination of sexism and racism that is unique to their identity (Bailey and Trudy, 2018). These perspectives suggest the need for measures of exposure to structural factors that capture differences in race and/or gender-based susceptibility.

Social factors such as race, gender and class undergird environmental exposure to structural racism, sexism, and classism that can have consequences for health that shifts between places over sociohistorical time. The ways in which social systems interact with place and time

to create exposure to harm and impact the ability to recover from harm can be viewed under a lens of *vulnerability*. The social systems embedded in the structure of America's policies, institutions and environments are unavoidable and chronically expose members of minoritized groups to an increased risk of issues related to mental health (chronic stress, anxiety, depression), physical health (chronic disease, chronic inflammation) and death (maternal mortality, lower life expectancy) (Chambers et. Al, 2018, Carter, Johnson, Kirkinis et.al., 2019, Mitchell, Sangalang, Lechuga-Pena et. al., 2020). The vulnerability created by these social systems exists regardless of variations in personality, perceptions, coping skills and other individual level characteristics. Furthermore, this vulnerability is multifaceted and can be described using aspects of identity within the socioeconomic context of the neighborhood environment and time. While intersecting identities partially account for an individual's exposure, the social, economic, and political characteristics of their location in time and place vary its intensity and potential impact on health outcomes.

Identity-based social and economic marginalization and its interaction with time and place combine to create *Neighborhood Vulnerability* in neighborhood environments. Neighborhood Vulnerability, a combination of social and economic vulnerability, is defined as the risk of harm due to a group or individual's social identity within the places they inhabit and the time in which they inhabit them (Brennan, 2017, Adger, 2006). Social vulnerability is the risk of adverse life outcomes and experiences resulting from social stigma (stereotypes, prejudice and discrimination) that expose a group to potential harm based on perceived social characteristics (gender, race, age etc.); as such, it limits their ability to cope with and recover

from this harm (Discrimination, 2019). Economic vulnerability is the risk of adverse life outcomes and experiences resulting from socioeconomic status (income, education and occupation) that expose a group to potential harm based on their access to resources (money, wealth, social networks, education, healthcare, etc.) and limits their ability to cope with and recover from this harm (Brennan, 2017, Adger, 2006, Link & Phelan, 1995).

In the neighborhood environment, vulnerability can be captured using a combination of social and economic characteristics of the population (i.e., education, income, poverty, racial composition). It is important to note, however, that constructs such as disadvantage, affluence and neighborhood vulnerability are not just a mere reflection of residents but the result of macrolevel systems that systematically sort certain groups into certain neighborhoods. The production of vulnerability begins with processes such as income and racial residential segregation, inequitable allocation of resources and political neglect and the social and economic characteristics of neighborhood populations represent perceptible manifestations of these processes (Massey et al., 1987; Wilson & Wilson, 2012). Indicators of neighborhood structural conditions also illustrate the relationships between interacting neighborhood attributes that reflect differences in political power and concentration of resources that shape what opportunities and services people can access in the places they live (Berg et al., 2020; Krieger, 2020). Overall, vulnerability at the neighborhood level is pervasive and influences mental health outcomes regardless of individual social and economic resources.

Previous studies have measured exposure to place-based risk using multiple definitions of neighborhood (i.e., census tract, community area, self-defined geographical community) to

compute index measures that include various aspects of community context (i.e., income, education, employment, poverty, racial composition). Many indexes are computed by synthesizing decennial census data using different combinations of the following indicators: level of income, poverty, unemployment, public assistance, female-headed households, educational attainment, and employment in professional or managerial positions (Pickett and Pearl, 2001, Ponce, Hoggatt, Wilhelm, Ritz, 2005, Chuang, Cubbin, Winkleby, 2005, Wang, Kim, Gonzales, MacLeod, Winkleby, 2007, Scott, Dubowitz, Cohen, 2009, Wen, 2009, Matthews and Yang, 2010, Yang and Matthews 2010, Moore et. al, 2013,). These measures are often combined using some method of summing or averaging, with limitations that are well documented (Song, Lin, Ward, & Fine, 2013). Composite measures computed using addition or an overall mean assume an equal contribution of each indicator, often require standardization to rescale indicators, and lack methodological clarity (Barclay et al., 2019). Of the few studies that use factor analysis, most estimate a unidimensional construct measured at a single time point (Morenoff et. al., 2007, Freedman, Grafova, Schoeni, Rogowski, 2008, Bird, Seeman, Escarce et. al. 2010).

The objective of this paper is to compute a Neighborhood Vulnerability Index (NVI) that combines multiple indicators of neighborhood risk into one composite score using census tract data linked to a longitudinal sample of U.S. adults over a 25-year period and assess whether it is consistent between across race, gender, time. While previous analyses have created neighborhood disadvantage indices at a national level, they have not been estimated specifically for race and gender subgroups of the population followed prospectively over time. This paper

contributes to our understanding of which groups of the population are systematically exposed to neighborhood vulnerability by computing race/gender specific NVI for a national sample of over 3,000 Black and white Americans followed over adulthood (1986-2010).

Previous studies using index measures computed using factor analysis assume the relationships between variables among different groups are similar and scores are unbiased, or that the measure is invariant (Wodtke, Harding, Elwert, 2011, Clarke et. al, 2014, Berger et. al, 2017, Li, Johnson, Newman and Riley, 2019). Factorial invariance refers to the equivalence of the relationships between indicators used to define a theoretical construct such as neighborhood vulnerability and can inform whether comparisons of mean differences in scores between groups are valid and unbiased (Putnick and Bornstein, 2016). In this study, the assumption of configural, metric and scalar invariance are tested longitudinally and between race/gender groups. Once factorial invariance is assessed, I examine changes in Neighborhood Vulnerability over time and identify stark race and gender inequities in which Americans are persistently exposed to neighborhood vulnerability over a 25-year period.

Methods

Data comes from the Americans' Changing Lives (ACL) survey (House, Kessler & Herzog, 1990, House et. al, 1994, House et. al, 2005), a stratified, multi-stage area probability sample of non-institutionalized adults age 25 and older, living in the coterminous United States, and followed over a 25-year period. Black Americans and adults over age 60 were oversampled. The first wave of the study was conducted in 1986 with 3,617 adults (68% sample response rate

for individuals). Surviving respondents were re-interviewed in 1989, 1994, 2001-2002, and 2011-2012. A sixth wave of data collection is currently in the field. This analysis focuses on the 3,497 respondents who self-reported their race as Black (34%) or white (66%). We exclude 130 respondents of other racial identifications (e.g., Asian, Native American, and Hispanic) due to small sample size. The ACL data are appropriately weighted to adjust for: a) differential initial selection probabilities, b) survey non-response, and c) post-stratification adjustments to the 1986 age-race-sex-region specific Census Bureau estimates of the U.S. population. For each later wave, additional weights adjust for panel non-response using predictor variables from prior waves (Lepkowski and Couper 2002). These weights make the ACL sample representative of the age, gender, and race distribution of the U.S. population in 1986. Except for differences due to post-1986 immigration and outmigration, the sample is representative of American residents in the originally sampled age-cohorts as they aged over 25 years (House et al. 1990, Kessler et al. 1992).

Each respondent's address at each wave was geocoded and linked to data from the U.S. Decennial Census and the American Community Survey for each year. Census tract boundaries can change over time; therefore, tract boundaries were normalized to the 2010 tract boundaries using the Longitudinal Tract Database (Logan, Xu, and Stults, 2014). With five waves of data, I estimate a composite measure of exposure to Neighborhood Vulnerability for all respondents using confirmatory factor analysis and compare scores by gender and race subgroups over time.

The ACL dataset contains U.S. Census Bureau data on the social and economic characteristics of U.S. census tracts linked to each participant at each wave. Census tracts have

on average about 4,000 people and are designed to capture homogenous areas that roughly map to neighborhoods. For Wave 1, the value of each tract variable was interpolated based on the 1980 and 1990 Census data to estimate values for 1986. The same process was used to estimate Wave 3 (1994) values using the 1990 and 2000 census. Wave 2 (1989) and Wave 4 (2001) values correspond to the 1990 and 2000 U.S. Census survey data, respectively. Wave 5 (2011) tract data come from the 2010 midpoint five-year estimates from the American Community Survey (2008-2012).

A set of nine tract level sociodemographic variables were selected to estimate the NVI. These tract level variables were selected as indicators of three subconstructs of neighborhood vulnerability: affluence (AF), disadvantage (DA) and social vulnerability (SV). Disadvantage represents the co-absence of economic, social, and family resources in the neighborhood (Ross and Mirowsky, 2001). Distinct from simply being the absence of neighborhood disadvantage, neighborhood affluence is associated with higher levels of social control and leverage over local institutions that can foster social environments with more opportunities for health and well-being (Browning & Cagney, 2003). The three indicators of social vulnerability, selected based on theory and literature review, were selected to account for the impact of gender and race on exposure to neighborhood vulnerability.

Affluence. Affluence is measured using tract level percentages of households with 16 or more years of education (EDU), households with income greater than or equal to $75,000 per year (INC), and adults in professional employment (PRF). Professional employment is defined as those occupations in the executive, managerial, technology and professional industries that

require a high degree of expertise and training. Categories for professional employment are based on the U.S. Bureau of Labor Statistics six-digit Standard Occupation Code system used for the decennial census (1990, 2000) and American Community Survey (2010) (Scopp, 2003, U.S. Bureau of Labor Statistics, 2010).

Disadvantage. Disadvantage is measured using tract level proportions of unemployed adults (UNE), persons receiving public assistance income (PBA), and households in poverty (POV). Unemployment is defined as not working, currently looking for work and available to accept a job. Public Assistance is defined as financial resources (direct cash assistance and/or vendor payments) given to persons contingent upon their need from a government operated welfare program. Households in poverty are defined as those who fall below federal income thresholds determined by household size and composition.

Social vulnerability. Social vulnerability is measured using tract level proportions of non-Hispanic Black residents (NHB), and female headed households with kids (FHK). Female headed households with kids are defined as those with an unmarried head of household and children. These variables were chosen to capture gender-and race-specific markers of social vulnerability at the neighborhood level. All observed sociodemographic variables were continuously measured and represent census tract percentages ranging from 0-100%.

Analysis

Measuring Neighborhood Vulnerability. Confirmatory factor analysis was used to estimate the three latent sub-constructs describing neighborhood vulnerability (disadvantage, affluence, social vulnerability) in R (version 3.6.6) lavaan package. CFA model identification

requires the selection of a scaling variable to identify the mean and variance of each latent variable. The lavaan package automatically constrains the intercept and factor loading of the first indicator variable specified; models were respecified for scaling to be based on the indicator with the highest factor loading (Little, 2006). Each CFA model estimates (1) a matrix of factor loadings for the relationship between each observed variable and corresponding latent construct; (2) a vector of intercepts for each observed variable; (3) a vector of means of each latent variable, (4) a matrix of variances and covariances of each latent variable and (5) a matrix of residual variances and covariances for the observed variables.

Three measurement models estimating NVI were compared, and a final model was selected based on thresholds of multiple indicators of absolute, parsimonious and comparative fit (Brown, 2006). The Comparative Fit Index (CFI) (Bentler, 1995) and the Tucker-Lewis Index (TLI) (Tucker & Lewis 1973) assess the fit relative to other models; values of 0.95 or greater are indicative of good fitting models (Bentler & Chou, 1987). The Akaike Information Criterion (AIC) (Akaike, 1987) makes adjustments for model parsimony (Burnham & Anderson, 2004); increasingly smaller values indicate good fitting, parsimonious models. The Root Mean Square Error of Approximation (RMSEA) produces a measure of model misspecification per degree of freedom; values less than 0.08 indicate better fitting, parsimonious models (Jöreskog & Sörbom, 1982). The standardized root mean square residual (SRMR) (Bentler, 1995) assesses absolute fit based on the square-root of the difference between the residuals of the sample covariance matrix and the hypothesized model; where a value of 0 indicates perfect fit and values less than 0.08 indicate better fit (Hu & Bentler, 1999). Chi-square tests were expected to be biased due to the

large sample size and are reported yet were excluded from the process of identifying the best fitting model (West, Taylor and Wu, 2012). Modification indices and residuals were examined in conjunction with theoretical and practical interpretation to guide model modification (Kaplan, 1989, Kaplan, 1991, Hayduk, 1990). In the final model building step, neighborhood vulnerability was added as a second order latent variable and factor scores for the neighborhood vulnerability index were extracted for each participant at each wave.

Testing Measurement Invariance. The first level of invariance is configural invariance, which tests whether the factor structure, or the set of census tract variables used to measure the NVI, is the same between groups. If configural invariance holds, the stability of metric invariance, or whether each census tract indicator corresponds to each corresponding latent dimension to a similar magnitude across groups, can be assessed. If the NVI demonstrates configural and metric invariance, scalar invariance, or whether mean differences in census tract indicators is captured by the latent NVI, can be assessed (Steenkamp and Baumgartner, 1998, Rudnev, 2018). If the NVI demonstrates full scalar invariance it can be meaningfully compared across timepoints and population groups with less concern for false conclusions due to biased scores.

Measurement invariance was assessed to test the configural, metric and scalar invariance of the NVI. Invariance was tested between waves (time invariance), race (non-Hispanic Black and white), gender (men and women), and race by gender groups using the standard iterative method comparing constrained models (Millsap, 2011). Since full scalar invariance of the measure is necessary for meaningful comparison of scores between groups (and/or across time)

partial measurement invariance was not assessed (Gavin, Brown & Harris, 2017, Edwards Houts & With, 2018, Steinmetz, 2013).

Configural invariance was tested using a multi-group CFA, which simultaneously estimates the measurement model separately in each group. Invariance at the configural level was assessed by examining the overall fit of the multi-group model using the thresholds for fit indices specified above. Model fit indices and CFI≥0.95 were used to determine whether conditions for configural invariance were met. For metric and scalar invariance, comparisons of nested models using likelihood ratio tests and a change in CFI less than 0.02 were used to determine whether invariance was upheld (Pentz and Chou, 1994, Putnick and Bornstein, 2016). If configural invariance was upheld, metric invariance was tested by adding equality constraints on the factor loadings of the census tract indicators to the multi-group model and comparing CFI values. If both configural and metric invariance were upheld, scalar invariance was tested by additionally imposing equality constraints on the indicator intercepts while retaining the factor loading constraints.

All factor variances and all residual variances were freely estimated. Maximum Likelihood (ML) estimation assumptions in confirmatory factor analysis (CFA) include independence of observations, normally distributed indicator variables and correct specification of the model (Kline, 2005). Due to moderate normality violations and missing data, models were estimated using a robust version of maximum likelihood estimation (MLR) (Griffin and Steinbrecher, 2013) which provides parameter estimates with corrections to standard errors and

fit indices that are robust to non-normality and equivalent to maximum likelihood (Brown, 2006, Yuan & Bentler, 2000, Satorra & Bentler, 1994, Curran, 1996).

2.4 Results

Descriptives. The analytic sample consisted of all 3,497 Black and white participants at baseline residing in 412 U.S. census tracts. Of them, 2,185 (62%) were women and 1,129 (32%) were Black. **Table 2.1** shows means and standard deviations of each indicator variable at each wave. Census tract social vulnerability and disadvantage indicators were relatively stable between 1986 and 1994, then decreased in 2000 followed by an increase in 2012. Mean values of affluence indicators increased gradually throughout the course of the study.

Measuring Exposure to Neighborhood Vulnerability. The process of identifying the best measurement model for NVI involved estimating a set of two theoretically alternative CFA models (**Figure 2.1**) whose fit indices are detailed in **Table 2.2**. The initial estimation of Model A showed a negative variance for Female Headed Households, indicating high multicollinearity between this and other indicators of social vulnerability (Heywood, 1931). Model B represents the re-specification of Model A to include social disadvantage, a new latent variable combining the indicators of social vulnerability and disadvantage after removing female headed households due to high correlation with female headed households with kids. Model B was selected as the final model after examining fit indices (RMSEA: 0.07, SRMR: 0.02, CFI: 0.98, TLI: 0.97, AIC: 751272), factor loadings, and standardized variances. All factor loadings for tract indicators fell within an acceptable range (>0.5), indicating a moderate to strong influence of each observed variable on the variation of each latent construct (Harrington, 2009).

The final measurement model is presented in **Figure 2.2**. Factor loadings for public assistance (0.90) and poverty (0.90) were especially high, representing strong indicators of social disadvantage between tracts. The loadings for unemployment and female headed households with kids were also relatively strong (0.82 and 0.79, respectively) while the proportion of non-Hispanic Black residents (0.65) had the lowest loading of the five indicators. The three indicators of affluence had very similar loadings, with college education (0.94) and professional employment (0.93) explaining more of the common variance in census tract affluence than income (0.83).

To estimate an overall measure of NVI, a second order CFA included both lower order constructs (affluence and social disadvantage) that loaded onto a higher order factor, neighborhood vulnerability. Affluence was negatively correlated with neighborhood vulnerability while social disadvantage was positively correlated. Results show indicators of affluence have a stronger influence on the variance in neighborhood vulnerability compared to social disadvantage with factor loadings of -0.96 vs. 0.59, respectively. The addition of neighborhood vulnerability as a higher order latent did not result in a worse fitting model (χ^2: 1000.48, df: 15, RMSEA 0.07, SRMR: 0.02, CFI: 0.98, TLI:0.97, AIC: 751272).

Factor scores for the NVI were estimated for each ACL respondent based on this model. Neighborhood Vulnerability Index scores ranged from 19.9 to -36.2 with lower, more negative scores indicating less exposure to vulnerability. **Table 2.3** shows NVI scores for each ACL subgroup at each wave. Disparities remained persistent between race and gender groups, with women and Black Americans having consistently higher scores compared to their race/gender

counterparts. Men had lower NVI scores across all waves compared to women in the overall sample and within racial groups. **Figure 2.3** shows cross-wave trajectories of NVI scores by gender, race and race by gender subgroups in the ACL study. Overall, exposure to neighborhood vulnerability decreased for the full ACL sample and for each gender and racial group between 1986 and 2011.

Testing Measurement Invariance. Measurement invariance tests were conducted between waves, and by race, gender and race by gender subgroups to assess whether the relationships among census tract variables in the NVI varied by group membership and time. **Table 2.4** shows each series of models, where the fit of model 1 testing configural invariance was compared to model 2 testing metric invariance. If conditions for invariance were met, the fit of model 2 was compared to model 3 testing scalar invariance. Configural (CFI: 0.986), metric (ΔCFI=0, LRT $p<0.01$) and scalar (ΔCFI=0, LRT $p<0.001$) invariance were upheld between gender groups, meaning that the NVI is measured consistently among men and women. Race invariance was validated at the configural (CFI: 0.969, LRT $p<0.001$) and metric (ΔCFI=0.002, LRT $p<0.001$) levels, but scalar invariance (pertaining to item intercepts) was not upheld (ΔCFI=0.038, LRT $p<0.001$). Similarly, race by gender group invariance was upheld at the configural (CFI:0.98) and metric (ΔCFI=0.01) levels only. The NVI did not meet conditions for any level of time invariance.

Tables

Table 2.1: Mean (SD) of Census Tract Sociodemographic Variables, ACL (1986-2012)

	Tract Variable	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Disadvantage	UNE	8.25(5.26)	8.41(6.11)	8.15(5.72)	6.23(4.68)	6.35(3.40)
	POV	17.29(13.72)	17.64(14.74)	17.21(14.03)	12.95(10.61)	16.42(12.06)
	PBA	11.02(9.57)	10.94(10.07)	9.82(9.37)	3.66(3.86)	14.78(11.86)
Affluence	EDU	14.91(11.55)	16.23(12.77)	17.13(12.71)	21.91(15.39)	25.49(17.54)
	INC	9.08(8.39)	14.30(12.86)	16.14(13.40)	25.07(17.68)	38.52(20.40)
	PRF	23.76(10.70)	25.20(11.63)	25.85(11.73)	33.95(13.92)	33.54(14.16)
Social Vulnerability	NHB	25.24(32.60)	25.71(33.24)	25.25(32.29)	18.62(28.70)	20.79(29.57)
	FHK	24.48(18.01)	26.17(19.64)	26.50(18.85)	24.35(16.75)	13.07(10.48)
	FHH	20.94(14.90)	22.60(16.20)	22.66(15.73)	20.17(14.29)	12.51(10.06)

UNE: Unemployment, POV: Poverty, PBA: Public Assistance, EDU: 16 or more years of education, INC: Annual income greater than $75,000, PRF: Professional Employment, NHB: non-Hispanic Black residents, Female headed households with kids, FHH: Female headed households. All variables are continuously measured and represent census tract percentages ranging from 0-100%.

Table 2.2: Goodness of fit Indexes for Final First Order CFA Models, American's Changing Lives Study (n=3497)

Model	χ^2	*df*	RMSEA (90%CI)	SRMR	CFI	TLI	AIC
A	1692.90*	21	0.11** (0.10, 0.11)	0.024	0.97	0.95	636887
B	1000.48*	15	0.07** (0.06, 0.07)	0.020	0.98	0.97	751272

*Significant at the p<0.001 level. **Significant at the p<0.05 level. df=degrees of freedom, RMSEA=Root Mean Square Error of Approximation. SRMR=Standardized Root Mean Square Residual, CFI=Comparative Fit Index, TLI=Tucker-Lewis Index, AIC=Akaike information criterion. All models estimated using MLR.

Table 2.3: Model Predicted Mean (SD) Neighborhood Vulnerability Index Scores for Subgroups in ACL, Waves 1-5

	1986	1989	1994	2000	2012
Women	3.2(5.3)	1.3(6.9)	0.36(6.9)	-5.4(7.9)	-6.6(10.7)
Men	2.6(5.2)	0.49(6.9)	-0.48(7.0)	-6.6(7.9)	-8.5(10.2)
Black	5.9(4.6)	4.5(5.9)	3.8(5.8)	-1.3(5.4)	-1.05(9.2)
White	1.6(4.9)	-0.78(6.6)	-1.8(6.7)	-7.4(8.1)	-10.2(9.8)
Black Women	6.2(4.6)	4.9(5.8)	4.2(5.7)	-0.79(5.1)	-0.41(9.3)
Black Men	5.4(4.7)	3.8(6.1)	3.1(6.0)	-2.6(5.7)	-2.5(9.1)
White Women	1.6(4.9)	-0.65(6.6)	-1.7(6.7)	-7.1(8.0)	-9.9(9.9)
White Men	1.4(5.1)	-0.98(6.8)	-2.1(6.8)	-7.7(8.1)	-10.7(9.8)
All ACL	3.0(5.9)	1.0(6.9)	0.1(6.9)	-5.9(7.9)	-7.4(10.5)

Unstandardized mean neighborhood vulnerability estimates for population subgroups at each wave of the ACL study. Lower, more negative scores indicate less exposure to neighborhood vulnerability.

Table 2.4: Results of Race, Gender and Race-by-Gender and Longitudinal Invariance Tests of Neighborhood Vulnerability Index

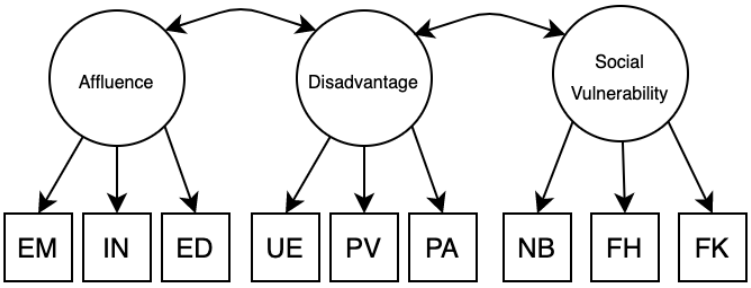
Group	Models	χ^2 (df)	RMSEA	SRMR	CFI	ΔCFI	*LRT*
Race (n=2)	Model 1r: Configural invariance	1321.95* (30)	0.08**	0.03	0.969	-	-
	Model 2r: Metric invariance	1691.59* (35)	0.08**	0.05	0.967	0.002	p<0.001
	Model 3r: Scalar invariance	3667.28* (40)	0.12**	0.09	0.929	0.038	p<0.001
Gender (n=2)	Model 1g: Configural invariance	1025.52* (30)	0.07**	0.01	0.986	-	-
	Model 2g: Metric invariance	990.90* (35)	0.07**	0.02	0.986	0	p<0.01
	Model 3g: Scalar invariance	1040.89* (40)	0.07**	0.02	0.986	0	p<0.001
Race by Gender (n=4)	Model 1rg: Configural invariance	1424.16 (60)	0.08**	0.03	0.975	-	-
	Model 2rg: Metric invariance	1781.65 (75)	0.08**	0.05	0.966	0.009	p<0.001
	Model 3rg: Scalar invariance	3853.48 (90)	0.11**	0.09	0.926	0.04	p<0.001
Longitudinal (n=5)	Model 1t: Configural invariance	2783.35*	0.17**	0.04	0.95	-	-
	Model 2t: Metric Invariance	-	-	-	-	-	-
	Model 3t: Scalar Invariance	-	-	-	-	-	-

Configural invariance was assessed using multi-group confirmatory factor analysis models. Metric invariance was assessed using multi-group models with factor loading equality constraints. Scalar Invariance was assessed using multi-group models with factor loading and intercept equality constraints. χ^2= Chi-square. df=degrees of freedom, RMSEA=Root Mean Square Error of Approximation. SRMR=Standardized Root Mean Square Residual, CFI=Comparative Fit Index, ΔCFI = Change in CFI, TLI=Tucker-Lewis Index. LRT: Likelihood Ratio Test. *Significant at the p<0.001 level. **Significant at the p<0.05 level.

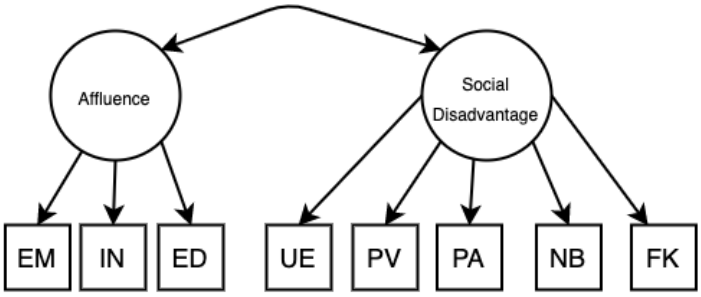
Figures

Figure 2.1: Alternative Measurement Models for Neighborhood Vulnerability

Model A

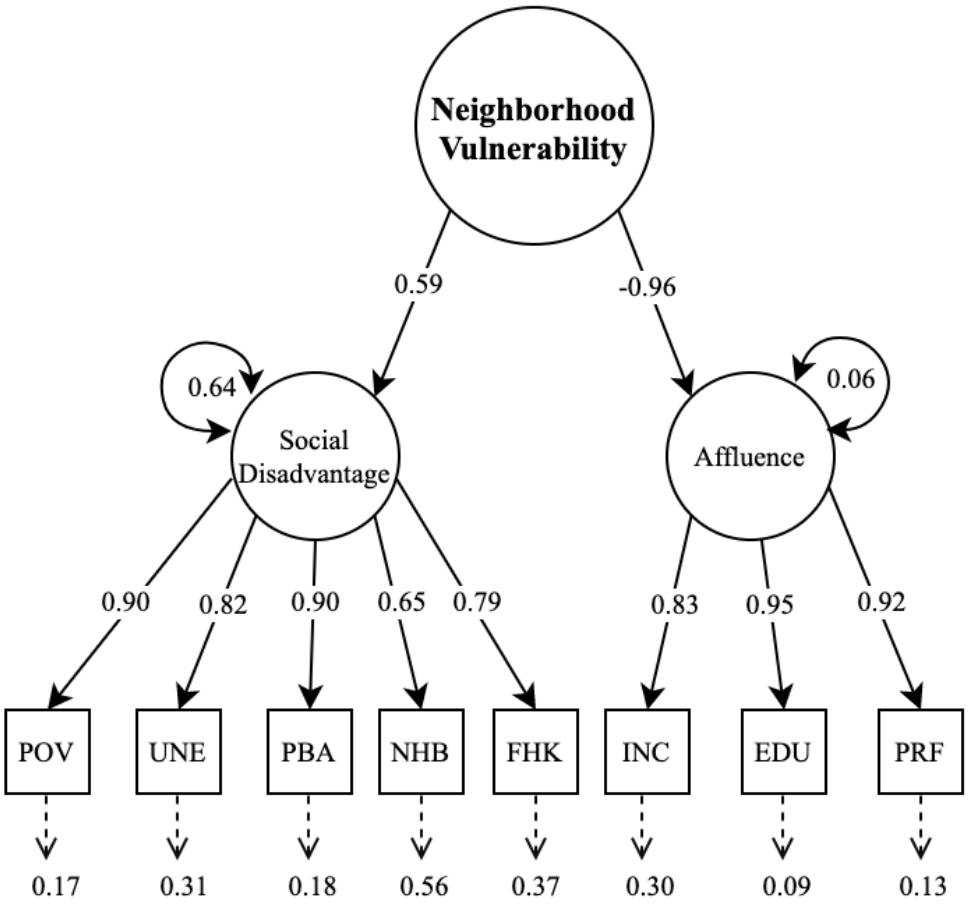


Model B



Two and three factor theoretical models for the measurement of neighborhood vulnerability. PV: Proportion of census tract residents living in poverty, UE: Proportion of census tract residents who are unemployed, PA: Proportion of census tract resident receiving public assistance, NHB: Proportion of census tract residents who are non-Hispanic Black, FK: Proportion of census tract female headed households with kids, IN: Proportion of census tract residents with annual income greater than or equal to $75,000, ED: Proportion of census tract residents with 16 or more completed years of education, EM: Proportion of census tract residents with professional employment.

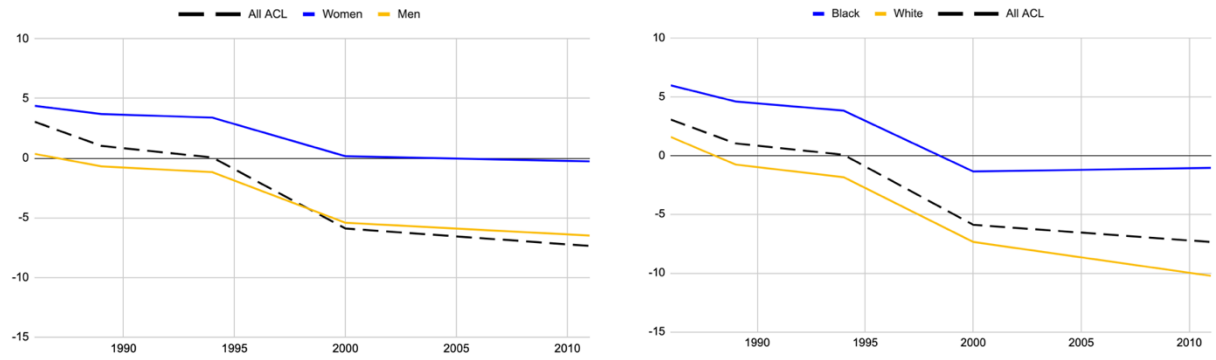
Figure 2.2: Measurement Model for Neighborhood Vulnerability, Americans' Changing Lives Study (1986-2011)

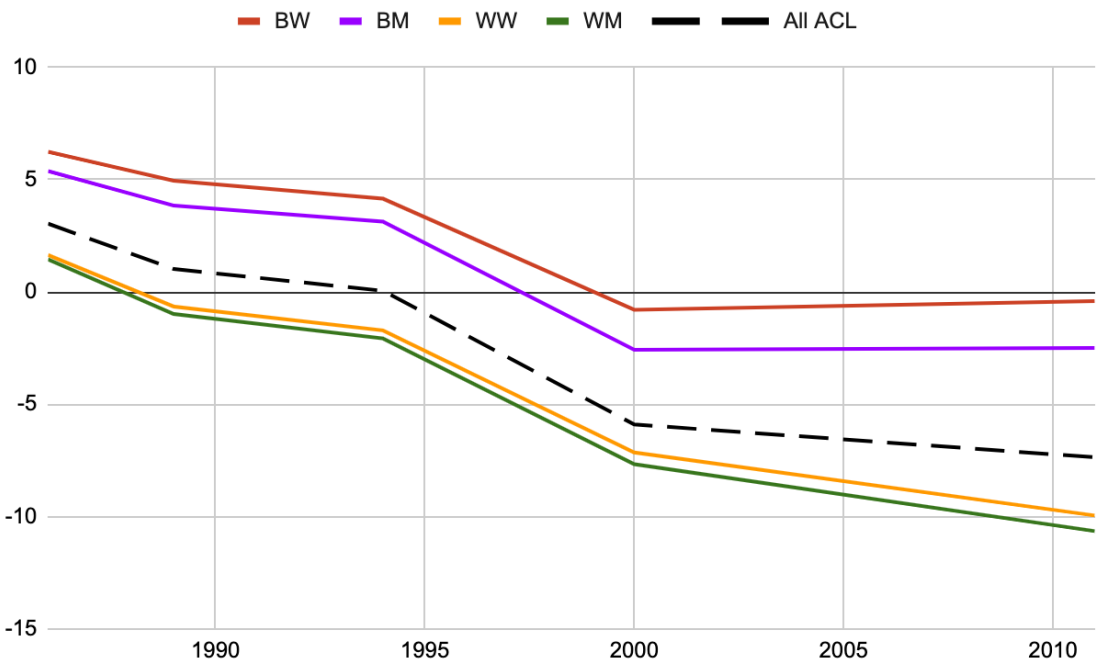


Fit Indices: χ^2: 1000.48 ($p<0.001$) df: 15 CFI: 0.98 TLI: 0.97 RMSEA: 0.07 (CI 0.06, 0.07) SRMR: 0.02 χ^2: Chi-square, df: degrees of freedom. RMSEA: Root Mean Square Error of Approximation. SRMR: Standardized Root Mean Square Residual, CFI: Comparative Fit Index, TLI: Tucker-Lewis Index.

All factor loadings are standardized. Indicators: POV: Proportion of census tract residents living in poverty, UNE: Proportion of census tract residents who are unemployed, PBA: Proportion of census tract resident receiving public assistance, NHB: Proportion of census tract residents who are non-Hispanic Black, FHK: Proportion of census tract female headed households with kids, INC: Proportion of census tract residents with annual income greater than or equal to $75,000, EDU: Proportion of census tract residents with 16 or more completed years of education, PRF: Proportion of census tract residents with professional employment.

Figure 2.3: Neighborhood Vulnerability Index Trajectories by Group, American's Changing Lives Study (1986-2011)





BW: Black Women, BM: Black Men, WW: White Women, WM: White Women. Trajectories based on the mean of model estimated neighborhood vulnerability index scores for each group at each wave. ACL: American's Changing Lives Study.

Discussion

The Neighborhood Vulnerability Index (NVI) consists of 8 indicators of social disadvantage and affluence using data from a nationally representative longitudinal population-based sample. Study results show a two-dimensional model of neighborhood vulnerability is a good fit for this sample of U.S. adults ages 25 and older at baseline. The final model for NVI measures this construct based on two underlying dimensions - affluence and social disadvantage.

As expected, affluence and social disadvantage have opposite influences on neighborhood vulnerability. In addition, affluence accounts for a higher amount of variance in neighborhood vulnerability compared to social disadvantage. These findings are supported by research on the social and economic capital of affluent communities, specifically how they have the ability to generate exclusive resources in ways that spatially segregated impoverished communities do not (Reardon and Bischoff, 2011). For example, a study relocating low-income families to more affluent neighborhoods showed those who lived in well-resourced areas for a longer period of time had better employment, education and health outcomes (Ludwig, Liebman, Kling, et al., 2008). On the contrary, when groups of affluent individuals move into disadvantaged neighborhoods, they are unlikely to lose their affluence, in fact, it is more likely their presence will shift the makeup of the neighborhood towards their own interests and income through processes such as cultural displacement, political displacement and gentrification (Hyra, 2014, Golding, 2016). These results suggest the strong longitudinal influence of living in an affluent neighborhood given its ability to reverse the impact of, or protect against, the effect of prolonged exposure to neighborhood disadvantage over time.

Based on invariance tests, the NVI measured the same theoretical construct in each group (configural invariance) and the tract indicators had a similar contribution to its variance at each timepoint (metric invariance). However, the NVI did not meet conditions for full scalar invariance by race or race by gender groups. However, these violations are more informative than invalidating and serve as a guide to practical interpretation of the NVI. Scalar non-invariance (pertaining to item intercepts) may be indicative of the impact of racial segregation on

exposure to neighborhood vulnerability, and the combined impact of race and gender on neighborhood exposures for Black women. In other words, item intercepts, or starting values, are heavily influenced by racial group membership; however, this effect was not observed in the gender invariance tests. This pattern of results is consistent with the well-established influence of race on the type of neighborhood in which people live and a negligible influence of gender alone. These results are also consistent with previous research as scalar invariance is often unachievable and rare in large scale studies (Marsh et al., 2017). Similarly, longitudinal non-invariance is common in assessments of tract-based indexes as context is expected to shift over time (Berg et. al., 2020, Miles et. al., 2015).

The NVI can be interpreted as a measure of exposure to health risks based on neighborhood socioeconomic status (education, income, employment), social characteristics (racial composition, gender dynamics) and time. Based on the distribution of NVI scores, there were differences in exposure to neighborhood vulnerability by race/gender group at each timepoint. While neighborhood vulnerability has been decreasing in this nationally representative sample overall, a persistent gap exists between men and women, with the gap widening after 2000. A significant dip occurred between 1986 and 1990 followed by another dip between 1995 and 2000. NVI score trajectories also show a gap in exposure to neighborhood vulnerability between non-Hispanic Black and white Americans, with a disparity that widens over the course of the study. There is a more dramatic decrease for non-Hispanic whites than Blacks, with similar significant drops from 1986 to 1990 and 1995 to 2000. The race by gender trajectories show a similar trend, with the disparity in exposure to neighborhood vulnerability

between Black men and women being wider than the gap between white men and women, and Black women being exposed to the highest levels of vulnerability at all timepoints. Despite progress towards less vulnerability overall, these trends are indicative of worsening structural inequities at the local neighborhood level between gender and race groups.

The decreases in exposure to neighborhood vulnerability parallel the period of economic expansion in the U.S. between 1991 and 2001, when there were consistent advancements in median household income, homeownership, poverty, and educational attainment (Sasson, 2016, Anthony, 2018, Duffin, 2019, Marotta, 2019, U.S. Census Bureau, 2020). However, U.S. trends in socioeconomic gains did not equitably benefit all groups. The racial disparities in NVI scores that widen during this period are consistent with inequities in income, unemployment and poverty rates between Black and white Americans in the U.S. over the past several decades (Lichter, 1989, Mason, 2011, Herring and Henderson, 2016, Assari, 2017, Caliendo, 2018). While exposure to neighborhood vulnerability declined, the health and well-being of Black Americans remained more vulnerable at all timepoints. Studies also show Black Americans who socioeconomically advance don't always experience the same health and mortality protections as their white counterparts (Turner, Brown and Hale, 2017, Assari, Lapeyrouse and Neighbors, 2018, Assari, 2018).

The NVI is comparable to other indexes using census tract indicators to describe community health risks. For example, the Neighborhood Socioeconomic Status (NSES) index, a time-invariant measure of longitudinal exposure to census tract socioeconomic factors, was created using a unidimensional CFA model and similar variables (Miles, et.al, 2015). The NVI

builds on the NSES by including variables that capture additional aspects of the neighborhood risk environment, suggesting two dimensions (social disadvantage and affluence) that influence exposure in opposite directions. In addition, linking the NVI to a nationally representative longitudinal sample of U.S. adults allows for describing exposure to neighborhood vulnerability by race and gender at different time points to show inequities in exposure to neighborhood vulnerability over time.

The NVI also corresponds to other community-based indexes that have been used for various purposes in health research, public health prevention and urban planning. For example, the Child Opportunity Index (COI) was developed to identify communities with limited educational, health, environmental and socioeconomic resources (Noelke, McArdle, Baek, Huntington, Huber, Hardy, et. al., 2020). Similarly, the Community Vulnerability Index (CVI) is used to measure the potential impact of infectious disease outbreaks to advise public health resource allocation both in the U.S and abroad (Surgo Foundation, 2020). While these indexes incorporate a variety of neighborhood characteristics (transportation, food access and healthcare availability, etc.), their comparability to the NVI demonstrates the ways in which structural factors can be used to characterize and quantify the underlying factors that contribute to more or less susceptibility to health risks at the environmental level.

This analysis examined race/gender inequities in exposure to neighborhood vulnerability over time and is one of very few studies to assess invariance of a tract-based measure. Using an index derived from contextual aspects of U.S. census tracts at five timepoints between 1986 and 2011, the findings highlight stark inequities in which groups are exposed to neighborhood

vulnerability in this national sample of U.S. adults. Exposure to neighborhood vulnerability is disproportionately experienced by Black Americans compared to whites across all time points. While results show exposure to neighborhood vulnerability decreased over time in the sample overall, the rate of decline was slower for census tracts where Blacks lived compared to whites (and to a lesser extent for women compared to men), resulting in widening disparities in exposure to neighborhood vulnerability across this 26-year period. Furthermore, race by gender trajectories show the compounding effect of race and gender on neighborhood vulnerability, where Black women navigate the most vulnerable environments. The results highlight the persistent and reinforcing pattern of inequitable neighborhood conditions along racial and gender lines in the United States.

Strengths & Limitations. This analysis has many strengths. The use of factor analysis (compared to summing or averaging indicators) to estimate the NVI limits measurement error and allows each indicator to make a unique, weighted contribution to the variance of the overall measure. In addition, the use of a longitudinal nationally representative dataset allows for a description of the history of exposure to neighborhood vulnerability among U.S. adults at the local level. Finally, invariance tests of the NVI met conditions for race (configural, metric) and gender (configural, metric, scalar) invariance, validating the use of the measure to describe between group NVI inequities at a given time point.

Some limitations should also be noted. Census tract indexes are limited to variables available in publicly accessible census data, and all limitations of the source of the data will persist throughout the NVI. While these data are the most feasible to use for longitudinal

measures of environmental characteristics, census tracts are arbitrary boundaries that may not fully represent socio-spatial exposures (Kramer, Cooper, Drews-Botsch, et al., 2010). Furthermore, census tract indicators were interpolated for intercensal years; however, in the neighborhood literature, this data is consistently used (Merkin, Basurto-Davila, Karlamangla, Bird, Lurie et. al, 2009, Cerda, Diez-Roux, Tchetgen, Gordon-Larsen and Kiefe, 2010, Clarke, Morenoff, Debbink, Golberstein, Elliott and Lantz, 2014).

The NVI also did not meet conditions for full scalar invariance by race or race by gender groups or time invariance. Small deviations from invariance do not necessarily preclude subsequent group analyses, and there is no clear consensus on standards for the cutoffs for small violations (Putnick and Bornstein, 2016, Reise, Widaman, and Pugh, 1993). Consequently, future cross-race or-gender analyses using NVI may still be valid, but longitudinal applications should be limited. Finally, the decreases in exposure to neighborhood vulnerability over time could be partially due to the survival of those who were less vulnerable at baseline. If study attrition did result in systematic differences in the tracts represented in the model, this may have had an impact on the distribution of the NVI and conclusions drawn from this analysis (Halamová, J., Kanovský, M., Gilbert, P. et al., 2019). The loss of participants who lived in the most vulnerable census tracts would overestimate the decreases in neighborhood vulnerability; however, some research has found overall neighborhood socioeconomic increases in U.S. census tracts over time with differences by racial composition (Timberlake & Grigsby, 2015). In addition, the ACL study weights reduce the impact of differential study attrition on results. Replication of this

analysis in other nationally representative samples and further exploration of invariance are needed to address the limitations within this study.

Conclusions and Future Research. This analysis has expanded the literature on measuring neighborhood exposure to risk and vulnerability in a number of ways. Based on the final model, exposure to neighborhood vulnerability is declining in the overall sample and between race and gender groups. However, we observe a persistent racial and gender disparity in exposure at each time point. Results support the experience of distinct socio-structural contexts for marginalized groups of U.S. adults over time, which has implications for the persistence of health and socioeconomic disparities (Williams and Collins, 2001, Do, Finch, Basurto-Davila, Bird, et. al, 2008, Wen and Kowalski-Jones, 2012, White, Haas and Williams, 2012, Kravitz-Wirtz, 2016). The differences in access to neighborhood resources and opportunities between race and gender groups is reflected in the clustering of minoritized groups in socially disadvantaged environments. Moreover, the lack of affluence (a combination of education, income and professional employment) is a stronger driver of neighborhood vulnerability, indicating the potential benefit of equitable resource allocation in vulnerable communities. Black and white Americans live in vastly different census tracts, which speaks to the potential power of neighborhood equity in reducing health inequities in society more broadly. The impact of racial and income segregation is compounded by race and gender based oppression, as evidenced by the NVI disparities between men and women in all groups. Measures such as the NVI provide a new method of accounting for contextual exposure to health risks that is otherwise unaccounted for by focusing on perceptions of individuals.

Future studies should seek to replicate these results using the NVI in other population-based samples. In addition, repeated analyses in more diverse samples would allow for additional racial/ethnic group comparisons and provide the ability to further examine patterns of exposure to neighborhood vulnerability among U.S. adults over time. Finally, assessing whether the NVI is a significant predictor of health outcomes could provide evidence of a direct link between structural factors and health, further supporting the need to shift local policies, systems and environments to reduce racial health inequities.

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Chapter 3 Neighborhood Vulnerability and Trajectories of Depressive Symptoms among U.S. Adults: Differences by Race and Gender

Introduction

Depression in adults is associated with a significant burden of all-cause mortality, morbidity, and disability in the U.S.. Lifetime risks of depressive illnesses (major depression, persistent depression, atypical depression, etc.) have increased over the past several years (Lépine & Briley, 2011). Individuals with depression are more likely to commit suicide or experience cardiovascular death via myocardial infarction or stroke (Brådvik, 2018; Deschênes et al., 2020; Jonas & Mussolino, 2000). In addition, severe depressive symptoms have been found to be associated with significantly higher risk of functional impairment, cognitive decline, disability, decreased workplace productivity and unemployment (Dong et al., 2020; Evans-Lacko & Knapp, 2016; Hammer-Helmich et al., 2018; Zuelke et al., 2018). The social consequences of depressive disorders pose a burden on quality of life for individuals, their families and society at large.

It has been well-established that the burden of depression differs between social groups, such as race/ethnicity and gender. In the U.S., while non-Hispanic Black Americans are less likely to experience an episode of major depression than many other groups, they are more likely to experience severe depressive symptoms and persistent depression than whites (Dunlop et al., 2003; Pratt & Brody, 2015). For the majority of their adulthood years, women experience twice

the lifetime risk of clinical depression compared to men (Assari, 2017; Kessler, 2003). Moreover, structural factors are also associated with the epidemiology of depression. For example, Patel et al. found that income inequality at the national, neighborhood and individual level is associated with a higher population prevalence of depression (2018). Thus, the relationship between depression, race and gender calls into question the impact of structural conditions as a major contributor to depression outcomes.

Recently, attention has been directed towards contextual risk factors for mental health outcomes, such as characteristics of the built and social environment as contrasted with more proximal risk factors, such as individual skills (coping style, health behaviors, etc.) and experiences (trauma, discrimination, etc.)(Meyer et al., 2014; Neitzke, 2016). The characteristics of neighborhood environments provide structural context for mental health risks (Philippa Clarke et al., 2014; Hill & Maimon, 2013). Life course perspectives emphasize the impact of chronic exposure to various inequities on mental health, highlighting the need to empirically study how chronic stressors in the local residential environment impact mental distress over time (Colman & Ataullahjan, 2010; Curry Owens & Jackson, 2015). Chronic stressors in neighborhoods, such as neighborhood poverty, unemployment and violence, operate as structural constraints that can create threatening and demanding conditions that negatively impact the mental well-being of residents. For example, chronic exposure to neighborhood disadvantage makes it difficult to effectively cope with and overcome its impact on mental health, resulting in worse mental health outcomes for those who live in high disadvantage neighborhoods (Bohlig et al., 2013; Bolstad et al., 2020). In addition, cumulative exposure to disadvantage has been shown to predict poorer

mental health in adolescence and later life (C. S. Aneshensel & Sucoff, 1996; Singh et al., 2019). This perspective necessitates a shift away from the individual to a macro socio-structural level of analysis.

To date, the literature suggests that multiple aspects of neighborhoods may be associated with mental health risks over and above individual risk factors, though results are somewhat inconclusive. For example, incidence of depression is associated with neighborhood socioeconomic position, disadvantage, social cohesion and disorder (Hastings & Snowden, 2019; J. Kim, 2010; Lillis, 2009). However, most of this research has been cross-sectional and shown mixed results. In a review of 45 studies, only 52% showed a positive association between structural features of communities and depression/depressive symptoms (A. V. Diez Roux, 2016; Mair et al., 2008a). Investigations of heterogeneity among U.S. adults were scarce, with mixed results when stratified by race or gender. Of the four studies that reported results by gender, two found a stronger association between depressive symptoms and neighborhood conditions in women (Henderson et al., 2005; Yen & Kaplan, 1999), one found a stronger association in men (Gutman & Sameroff, 2004), and one found no evidence of heterogeneity (Echeverría et al., 2008). There were also four studies that investigated heterogeneity of neighborhood effects on depressive symptoms between Black and white adults, with only two finding differences between Black and white adults. One found a positive association between neighborhood socioeconomic context and depressive symptoms among white but not Black adults and the other found opposite effects between Blacks and whites (Gary et al., 2007; Henderson et al., 2005).

In addition, most longitudinal studies of the association between depression and neighborhood had relatively short (<10 years) follow up periods (Carol S. Aneshensel et al., 2007; Gutman & Sameroff, 2004; Natsuaki et al., 2007); with only one study using more than two waves of data (Galea et al., 2007). Shorter follow ups constrain our knowledge of the longitudinal, cumulative impact of neighborhood conditions on depressive symptoms and limit the ability to detect fluctuations and assess the impact of neighborhood context on the rate of change in depressive symptoms over time. Furthermore, many neighborhood studies focus on a single aspect of neighborhoods such as disadvantage, poverty or unemployment, making it difficult to understand the overlapping impact of multiple structural risk factors for depressive symptoms (Bolstad et al., 2020; Joshi et al., 2017; Sundquist et al., 2006). In sum, the current body of literature on neighborhoods and depression is characterized by conflicting findings, limited attention to gender and race heterogeneity, a lack of multidimensional measures of the neighborhood environment, and relatively short follow-up periods preventing a full understanding of the impact of neighborhood context for the patterning of depression over time.

To address existing gaps, we must first account for the myriad of risk factors in the neighborhood environment using a multidimensional measure of neighborhood exposures. To account for structural differences in the distribution of resources and opportunities, we use a novel measure, the Neighborhood Vulnerability Index (NVI), that combines multiple indicators of socio-environmental context into one measure (Battle & Clarke, 2020). Prolonged exposure to structural risk factors that impact mental well-being may have adverse outcomes. Life course perspectives on mental health outcomes elucidate the dynamic process that links various life

stages with shifting socio-historical contexts. Using a longitudinal cohort of U.S adults followed over 25 years, the first aim of this analysis is to estimate the association between depressive symptoms and the NVI over time. To understand the interaction between race, gender and place, the second aim of this analysis is to explore the role of race and gender as effect modifiers. Depressive symptoms are expected to be positively associated with changes in community context over time. This association is expected to vary markedly by social group, with the largest magnitude of change among marginalized racial and gender groups.

Methods

Data come from the American's Changing Lives (ACL) survey (J. House et al., 2005; J. S. House et al., 1990, 1994), a stratified, multi-stage area probability sample of non-institutionalized adults age 25 and older, living in the coterminous United States, and followed over a 25-year period. Black Americans and adults over age 60 were oversampled. The first wave of the study was conducted in 1986 with 3,617 adults (68% sample response rate for individuals). Surviving respondents were re-interviewed in 1989, 1994, 2001-2002, and 2011-2012. A sixth wave of data collection is currently in the field. This analysis focuses on the 3,497 respondents who self-reported their race as Black (34%) or white (66%). We exclude 130 respondents of other racial identifications (e.g., Asian, Native American, and Hispanic) due to small sample size. The ACL data are appropriately weighted to adjust for: a) differential initial selection probabilities, b) survey non-response, and c) post-stratification adjustments to the 1986 age-race-sex-region specific Census Bureau estimates of the U.S. population. For each later wave, additional weights adjust for panel non-response using predictor variables from prior

waves (Lepkowski & Couper, 2002). These weights make the ACL sample representative of the age, gender, and race distribution of the U.S. population in 1986. Except for differences due to post-1986 immigration and outmigration, the sample is also representative of American residents in the originally sampled age-cohorts as they aged over 25 years (House et al. 1990, Kessler et al. 1992).

Depressive symptoms. Depressive symptoms were assessed with a short form (11-items) of the Center for Epidemiologic Studies Depression Scale (Radloff 1977; Kohout, Berkman, Evans and Cornoni-Huntley 1993). Respondents were asked how often "in the past week" that they experienced each of the following: "I felt depressed"; "I felt that everything I did was an effort"; "My sleep was restless"; "I was happy" (reverse coded); "I felt lonely"; "I felt people were unfriendly"; "I enjoyed life" (reverse coded); "I did not feel like eating. My appetite was poor"; "I felt sad"; "I felt people disliked me"; "I could not get "going"". For each item respondents were asked how often they experienced each symptom during the past week: hardly ever (1), some of the time (2) and most of the time (3) (Kohout et al., 1993; Radloff, 1977). Responses were averaged to produce an index of depressive symptoms ranging from 1 to 3 for each wave.

Neighborhood Vulnerability. The residential addresses of ACL participants were geocoded and linked to census tract identifiers at each wave of the study. Census tracts are proxies for neighborhoods with approximately 4,000 people per tract. The neighborhood vulnerability score is an index measure computed using a factor analysis of 8 census tract indicators of social disadvantage (poverty, unemployment, receiving public assistance, racial

composition, female headed households) and affluence (household income, professional employment, educational attainment) (Battle & Clarke, 2020). Factor scores across all waves range from -36 to 20 (mean:0; sd:7.7), with lower, more negative scores indicating less exposure to vulnerability in the neighborhood environment. For the current analysis, the NVI is modeled as an ordinal variable with three levels of exposure (0=low, 1=moderate, 2=high). The 'low' category includes NVI scores less than one standard deviation below the mean, the 'moderate' category includes scores within one standard deviation above and below the mean, and the high category includes scores higher than one standard deviation above the mean.

Sociodemographic variables. The following time-invariant covariates that impact selection into neighborhoods and are risk factors for depression were included in the analysis: age, marital status, educational attainment and income. Age was defined continuously in number of years. Marital status was treated as a dummy variable coded 0 for participants who were not married at baseline and 1 for participants who were married. The unmarried group includes participants who were separated, divorced, widowed or never married. Education was modeled as a binary dummy variable contrasting participants with less than 16 years of education completed (reference) to participants with a college degree (16 or more completed years of education) to maintain consistency with the indicators used in the NVI. Baseline income was measured using 10 categories of annual household income (1=0 - $5, 2=$5 - 9,999, 3=$10,000 - $14,999, 4=$15,000 - $19,999, 5=$20,000 - $24,999, 6=$25,000 - $29,999, 7=$30,000 - $39,999, 8=$40,000 - $59,999, 9=$60,000 - $79,999, 10=$80,000 - or more). Time varying marital status and income variables were not included due to issues with model convergence and

fit; however, due to the age of the sample at baseline these variables were likely consistent over the course of the study and captured using baseline values. In addition, because the NVI is a cross sectional measure that is only measured at baseline, time varying covariates act as mediators that lie on the causal pathway and adjusting for them would underestimate the association between NV and depressive symptoms.

Analysis

Latent growth curve models (LCM) were used to assess the association between exposure to neighborhood vulnerability at baseline and the level and rate of change in depressive symptoms over time. LCMs are essentially confirmatory factor analysis models with imposed factor loadings on two latent growth factors. In latent growth modeling, estimating the latent growth factors, an initial value (intercept) and rate of change (slope) over time, are of primary interest. The structure of this model can be expressed by multiple equations. The *level 1 trajectory equation* estimates the random growth factors for individuals as defined by the following statement:

$$y_{it} = \alpha_i + \lambda_t\beta_i + \varepsilon_{it} \qquad (1)$$

where y_{it} are repeated *CES-D* measures for individual *i* at time *t*, α_i is the random intercept (baseline *CES-D* score) for individual *i*, β_i is the random slope of the trajectory for individual *i,* λ_t is the value of the slope loading for time *t* and ε_{it} is a residual score for individual *i* at time *t*. The random intercepts and slopes determine the individual trajectory of depressive symptoms and

allows these trajectories to differ over individuals. In the SEM framework, time is a latent parameter of the model (the values of λ_t on the slope, β_i) rather than a variable in the data.

The mean intercept and mean slope are also of interest, and are defined by the *level 2 intercept and slope equations* for the unconditional LCM:

$$\alpha_i = \mu_\alpha + \zeta_{\alpha i} \quad (2)$$

$$\beta_i = \mu_\beta + \zeta_{\beta i} \quad (3)$$

where μ_α and μ_β are the mean intercept and slope across all individuals, and ζ represents the variance from the mean intercept or slope for individual *i*. While the unconditional model is defined by the means of the intercepts and slopes and the deviations from these means, the conditional model includes time-invariant variables that predict the intercepts and slopes. The trajectory equation above is the same for both the conditional and unconditional model; however, the level 2 equations above are modified to include covariates in the conditional model. We model the influence of time-invariant covariates on initial values and rate of change using the neighborhood vulnerability index (*NVI*) as a working example:

$$\alpha_i = \mu_\alpha + \gamma_{\alpha 1}(NVI)_i + \zeta_{\alpha i} \quad (4)$$

$$\beta_i = \mu_\beta + \gamma_{\beta 1}(NVI)_i + \zeta_{\beta i} \quad (5)$$

Where $\gamma_{\beta 1}$ represents the covariate coefficients of *NVI* for individual *i*. Substituting equations (4) and (5) into equations (1), (2) and (3) yields the full conditional model:

$$CES\text{-}D_{it} = (\mu_\alpha + \lambda_t \mu_\beta) + (\gamma_{\alpha 1} + \lambda_t \gamma_\beta) NVI_i$$

$$+ (\zeta_{\alpha i} + \lambda_t \zeta_{\beta i} + \varepsilon_{it})$$

LCM assume a linear association, and non-linear trajectories require adjustments to model specification. The linear model did not fit the data well (CFI: 0.70, TLI:0.79, RMSEA:0.13, SRMR:0.10), so quadratic, cubic and latent basis models were estimated to capture non-linearity in trajectories of depressive symptoms over time. Only the latent basis model showed adequate fit (CFI: 0.97, TLI:0.97, RMSEA:0.04, SRMR:0.05). In latent-basis curve models, loadings on the slope factor are freely estimated. To give the slope factor scale, two loadings must be constrained; in this analysis the loading of the first time point was set to 0 and the loading of the second time point to 1, following the practice in existing literature (Duncan & Duncan, 2009; Ghisletta et al., 2015; Grimm et al., 2011). This allowed the slope at all subsequent timepoints to be freely estimated, as illustrated in **Figure 3.1**. The estimated loadings correspond to the proportion of total growth that has occurred up to and including that time point. Therefore, we estimate the proportion of change in depressive symptoms that occurs at each wave as predicted by baseline exposure to neighborhood vulnerability after adjusting for predictors of individual level vulnerability. This analysis was repeated using a multi-group LCM, which simultaneously estimates the main model in each race by gender group.

All models were estimated using the lavaan package in R version 3.6 (Rosseel, 2012). Nested models were compared using the following goodness of fit indices: (1) Chi-square - degrees of freedom (df) ratio, where lower values indicate better fit, (2) Bayesian Information Criterion (BIC) and (3) Akaike Information Criterion (AIC), where models with lower values

indicate better model fit, (4) Root Mean Square Error of Approximation (RMSEA) and (5) SRMR where values < 0.08 indicate better model fit, (6) Tucker Lewis Index (TLI) and (7) Comparative Fit Index (CFI) where values ≥ 0.95 indicate better model fit.

Results

Descriptive statistics. Among the 3,497 Black and white participants included in the analysis, 64.6% were women and 33.6% were Black. The mean age at baseline was 53 years, with white women being slightly older compared to all other groups (56.1 years). As of baseline, roughly half of the sample was married, with 14% having college degrees. Black women had the highest mean CES-D score at baseline (1.76) while white men had the lowest (1.59). Similarly, average neighborhood vulnerability index scores were highest for Black men and women (5.37 and 6.24, respectively) compared to white men and women (1.42 and 1.61).

Unconditional growth model. Results for the unconditional latent-basis growth curve model are presented in **Table 3.2**. The mean CES-D score at baseline was 1.66 ($p<0.001$) and depressive symptoms declined significantly over the course of the study ($p<0.001$). Because the latent basis model includes freely estimated slope parameters capturing nonlinearity in CES-D over time, there is no one single parameter reflecting change over time. As a result, only statistical significance is indicated in the Tables; Figures are used to illustrate the trajectory change.

Neighborhood Vulnerability Index. When adding NVI to the model (**Table 3.2,** Model B), the estimated baseline mean CES-D score was 1.58 ($p<0.001$) for participants in the low NVI exposure group. Participants in the moderate and high exposure groups had significantly higher

mean CES-D scores of 1.8 and 2.0 (β=0.229, p<0.001), respectively. CES-D scores continued to significantly decline over the course of the study (p <0.001), but neighborhood vulnerability did not significantly change the rate of decline in depressive symptoms over time.

Sociodemographic Variables. Model C adds baseline age, educational attainment, marital status and income to the NVI adjusted model as time-invariant covariates. Exposure to neighborhood vulnerability continued to show a positive association with mean CES-D scores, net of covariates (β=0.105, p<0.001). Mean CES-D scores were significantly lower among those who were older (β = -0.124, p<0.001) and higher income (β = -0.314, p<0.001). Compared to those without at least a college degree (16 or more years of education), those with a college degree also had significantly lower CES-D scores (β = -0.090, p<0.001) and a similar trend was observed when comparing unmarried participants to married participants (β = -0.091, p<0.001). Only age and income had a significant impact on the rate of change in depressive symptoms while educational attainment and marital status did not. As age (p<0.05) and income (p<0.001) increased, depressive symptoms decreased more quickly.

Multi-group latent-basis curve model. **Table 3.3** presents the results from the multigroup version of the fully adjusted model (**Table 3.2**, Model C). The multigroup model is stratified by four race and gender subgroups to analyze the differential impact of exposure to NV on mean CES-D trajectories after controlling for individual sociodemographic characteristics. The first observation to note is the difference between intercept values for each group. Black women had the highest initial mean CES-D score (1.95, p<0.001) while white men had the lowest (1.70, p<0.001).

Second to note is the impact of NVI on CES-D baseline scores and trajectories by group. Overall, exposure to neighborhood vulnerability was positively associated with depressive symptoms for Black and white men and women. NV was associated with the largest increase in depressive symptoms among Black men, with moderate and high NVI exposure predicting average baseline CES-D scores of 1.99 and 2.13 ($p<0.05$), respectively. NV had the smallest impact on CES-D scores for Black women (ß=0.010, $p<0.05$). The association between NV and depressive symptoms was similar for white men and women; those with moderate and high exposure to neighborhood vulnerability had average baseline CES-D scores of about 1.86 and 1.95 ($p<0.05$).

For all groups, both income and age were significantly associated with lower CES-D scores. Age had the largest effect on depressive symptoms for Black men and women, and the smallest effect among white men (ß= -0.160 ($p<0.05$), ß = -0.164, $p<0.01$, ß = -0.039, $p<0.05$), respectively. Marital status significantly decreased CES-D scores among Black and white men only ($p<0.05$). In addition, the influence of educational attainment on CES-D scores was only significant for Black men and white women ($p<0.001$). White women were the only group for whom any variables shifted the rate of change in depressive symptom trajectories over the course of the study; only the effects of exposure to neighborhood vulnerability ($p<0.05$) and income ($p<0.01$) were found to be significant.

Figure 3.2 shows the predicted trajectories of depressive symptoms by level of exposure to NV in the full sample, and across race by gender groups (based on models from **Table 3.3**). Panel A shows distinct depressive symptom trajectories based on exposure to different levels of

neighborhood vulnerability where participants who live in high vulnerability census tracts have higher depressive symptoms over time compared to those who live in tracts with moderate and low exposure. There are also distinct trajectories for each race by gender group. In Panels B and C, Black women have the highest depressive symptoms over time followed by Black men, white women and white men. In high vulnerability tracts, depressive symptom trajectories appear to converge along racial lines, as shown in panel D.

Tables

Table 3.1: Baseline Characteristics of Race and Gender Subgroups in ACL (n=3,497) 1986

Variable	Mean (SD) or %				
	Black Women (n=778)	Black Men (n=396)	White Women (n=1481)	White Men (n=962)	All groups (n=3617)
CES-D	1.76 (0.31)	1.67 (0.29)	1.64 (0.26)	1.59 (0.24)	1.66 (0.28)
Neighborhood Vulnerability Index	6.24 (4.64)	5.37 (4.78)	1.61 (4.93)	1.42 (5.05)	3.02 (5.31)
Low	4.5	7.3	17.7	18.4	13.8
Moderate	66.8	67.7	79.2	79.1	75.1
High	28.7	25.0	3.0	2.5	11.1
Age (in years) (range 25-96)	52.96 (17.57)	51.9 (16.84)	56.1 (17.51)	51.1 (17.67)	53.64 (17.62)
Education					
Less than College Degree (0-15 years)	92.7	91.4	86.7	77.8	86.1
College Degree or more (16 or more years)	7.3	8.6	13.3	22.2	13.9
Marital Status					
Married	31.4	54.3	57.1	69.6	54.6
Unmarried	68.4	45.7	42.9	30.4	45.4
Annual Household Income					
<$10,000	57.3	34.6	29.0	17.0	32.5
$10,000 - $14,999	14.3	16.2	13.9	12.6	13.9
$15,000 - $19,999	7.1	9.3	12.4	10.3	10.3
$20,000 - $24,999	4.4	8.6	9.7	10.0	8.4
$25,000 - $29,999	4.9	7.6	7.6	11.2	7.9
$30,000 - $39,999	5.8	8.8	11.5	14.4	10.6
$40,000 - $59,999	5.1	9.8	9.5	15.7	10.1

$60,000 - 79,999	0.9	3.0	3.6	5.5	3.4
> $80,000	0.3	2.0	3.1	4.1	2.6

Baseline descriptive statistics for ACL study sample by race and gender subgroup. Means are unstandardized. SD: Standard Deviation. %: Percent. CES-D: Center for Epidemiological Studies Depression Scale

Table 3.2: Latent – Basis Growth Curve Models for Depressive Symptoms, ACL 1986-2012 (n=3,497)

	Model A Unconditional Growth Model	Model B + NVI Score	Model C + Sociodemographic variables
Intercept	1.66***	1.58***	1.72***
NVI Exposure [a]	-	0.229***	0.105***
Age (years)	-	-	-0.124***
College Education [b]	-	-	-0.090***
Married [c]	-	-	-0.091***
Household Income [d]	-	-	-0.314***
Rate of Change			
Depressive Symptoms	***	***	x
NVI Score [a]	-	x	x
Age	-	-	*
Education [b]	-	-	x
Marital Status [c]	-	-	x
Income [d]	-	-	***
Fit Indices			
Chi-Square (df)	72.5 (11)	85.9 (14)	166.2 (26)
RMSEA (95% CI)	0.04 (0.03, 0.05)	0.03 (0.03, 0.04)	0.03 (0.03, 0.04)
SRMR	0.05	0.04	0.04
CFI	0.97	0.97	0.95
TLI	0.97	0.96	0.95
AIC	333.3	211.8	-161.9

BIC	388.7	279.6	-44.9

NVI: Neighborhood Vulnerability Index, [a] Reference is Low exposure group, [b] Reference is less than 16 years completed, [c] Reference is unmarried (includes divorced, separated, never married), [d] Reference is $0-10,000 annual income , [x]p>0.05,*p<0.05, **p<0.01, ***p<0.001; RMSEA: Root Mean Square Error of Approximation; SRMR: Standardized Root Mean Square Residual; CFI: Comparative Fit Index; TLI: Tucker Lewis Index; AIC: Akaike Information Criterion; Bayesian Information Criterion.

Table 3.3: Latent – Basis Growth Curve Models for Depressive Symptoms by Race and Gender Group, ACL 1986-2012 (n=3,497)

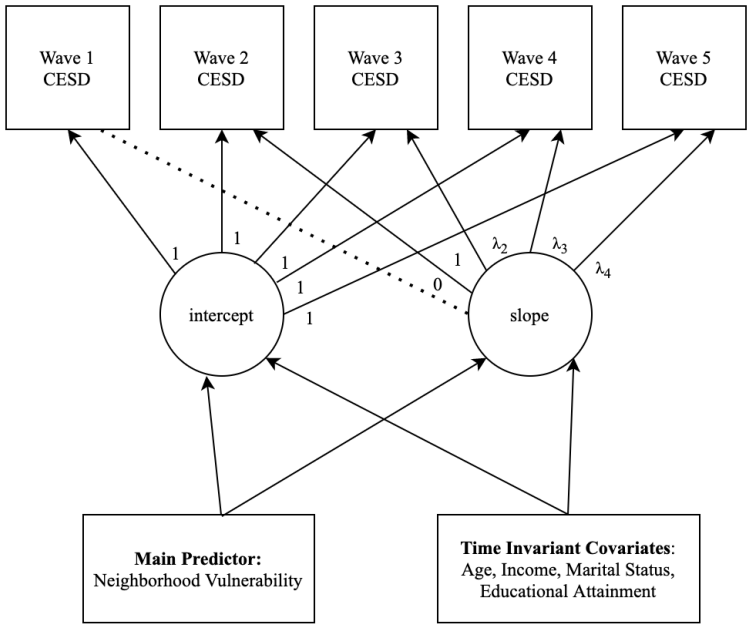
	Black Women (n=778)	Black Men (n=396)	White Women (n=1,416)	White Men (n=907)
Intercept	1.95***	1.82***	1.78***	1.70***
NVI Exposure [a]	0.010*	0.133*	0.092*	0.094*
Age	-0.164***	-0.160*	-0.122**	-0.039*
Educational Attainment [b]	-0.030	-0.131***	-0.127***	-0.054
Marital Status [c]	-0.024	-0.100*	-0.048	-0.109*
Income [d]	-0.351***	-0.243***	-0.275***	-0.278***
Rate of Change				
Depressive Symptoms	x	x	x	x
NVI Score [a]	x	x	*	x
Age	x	x	x	x
Education [b]	x	x	x	x
Marital Status [c]	x	x	x	x
Income [d]	x	x	**	x
Fit Indices				
Chi-Square (df)			197.9 (92)	
RMSEA (95% CI)			0.03 (0.02, 0.04)	
SRMR			0.05	

CFI	0.96
TLI	0.95
AIC	-544.8
BIC	-265.9

NVI: Neighborhood Vulnerability Index; [a] Reference is Low exposure group; [b] Reference is less than 16 years completed; [c] Reference is unmarried (includes divorced, separated, never married); [d] Reference is $0-10,000 annual income; ˇp>0.05,*p<0.05, **p<0.01, ***p<0.001;

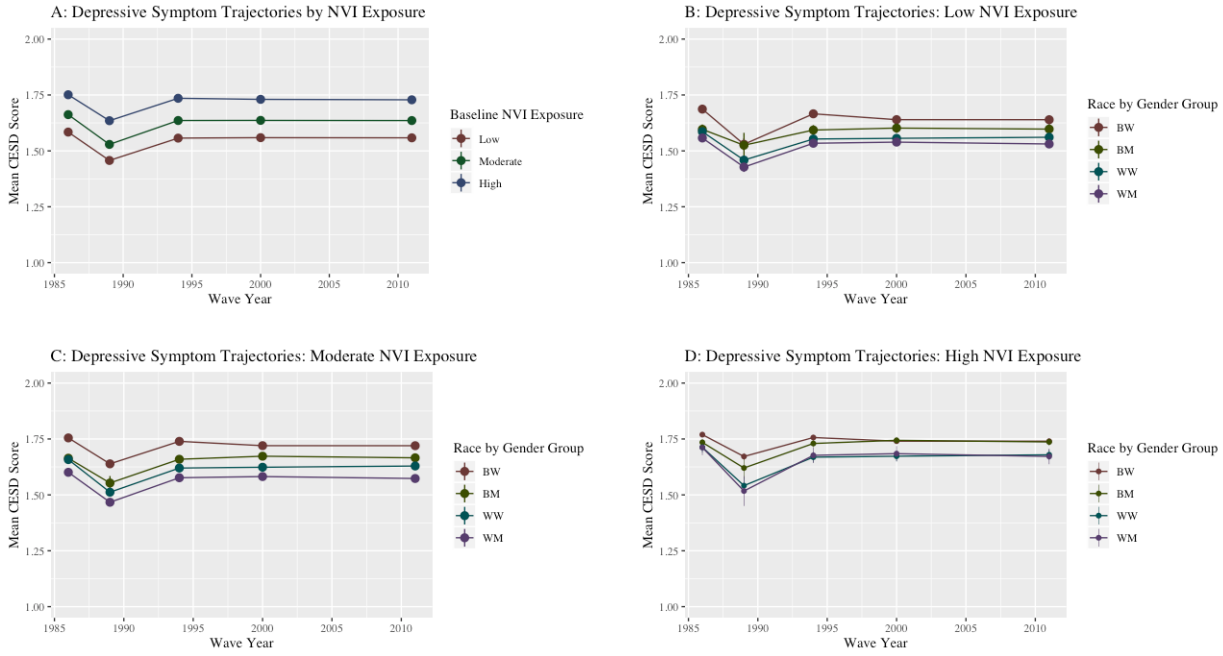
Figures

Figure 3.1: Path Diagram for Conditional Latent-Basis Curve Model



Path diagram showing repeated measures, latent growth factors, predictors, and covariates for latent basis growth curve model, where λ_t represents freely estimated loadings on the slope growth factor λ at time t.

Figure 3.2: Predicted Mean CES-D Growth Curve Trajectories by Exposure to Neighborhood Vulnerability for Race and Gender Subgroups in the American's Changing Lives Study (n=3,497), 1986-2012



Depressive symptom trajectories by Neighborhood Vulnerability Index (NVI) score based on mean CES-D values at each wave based on the multi-group latent basis growth curve model in Table 3.3. BW: Black Women, BM: Black Men, WW: White Women, WM: White Men.

Discussion

There is growing interest in structural determinants of depression outcomes. While some studies have shown significant associations between neighborhood structural conditions and depressive symptoms, most focus on only one aspect of neighborhoods; less is known about this association over time, and analyses of heterogeneity by race and gender have shown inconsistent results (D. Kim, 2008; Patel et al., 2018). Furthermore, reviews of evidence have cited the need for new measures of exposure that account for multiple aspects of neighborhood environments (Mair et al., 2008a). In this analysis, the association between structural features of neighborhoods and depressive symptoms over time and between social groups was investigated using a novel composite measure, the Neighborhood Vulnerability Index (NVI).

Created using a factor analysis of eight census tract indicators of social disadvantage and affluence, the NVI has less measurement error compared to other summed or averaged indexes and allows for a weighted contribution of each indicator to the overall score. These attributes make the NVI a robust measure to use in analyses of the association between neighborhoods and depression outcomes among U.S. adults. There are several key findings to note. First, the NVI was shown to significantly predict changes in depressive symptoms in a nationally representative sample of U.S. adults over a 26 year follow up. Compared to those who resided in

neighborhoods with low NVI scores at baseline, moderate and high NVI scores were related to higher depressive symptoms over the course of the study. Although it decreased in magnitude, this effect remained significant even after adjusting for individual level indicators of vulnerability, specifically age, educational attainment, marital status and income.

Second, there was evidence of heterogeneity by race and gender groups. In the multi-group model, the NVI predicted higher depressive symptoms at baseline and this effect remained consistent over the course of the study. However, the magnitude of this association differed between and within racial groups. Neighborhood vulnerability had a similar impact on depressive symptom trajectories for white men and women but varied markedly by gender among Black Americans. The magnitude of the association between the NVI and depressive symptoms was highest for Black men compared to Black women, white women, and white men. Unexpectedly, neighborhood vulnerability had the smallest effect on depressive symptoms for Black women.

This study builds on previous research by incorporating a composite measure of exposure to multiple neighborhood features that may affect depression. An important innovation of this analysis is the use of an exposure measure that incorporates indicators of multiple commonly used measures of neighborhood exposure such as affluence, disadvantage and social vulnerability. By quantifying these measures using model-predicted values that allow for a weighted contribution of each indicator, this measure moves us closer to measuring the impact of neighborhood exposures in a way that reflects the way we simultaneously interact with multiple aspects of neighborhood environments. In addition, investigating differences by race and gender

further gets at the complexity of how the social structuring of identity impacts the association between neighborhood environments and mental health. In residential environments we are susceptible to multiple exposures at the same time, and it is important and necessary to quantify their combined effects on mental health over time.

Although this is the first use of the NVI in an empirical analysis, these results are largely consistent with longitudinal studies of the association between structural neighborhood characteristics and depression/depressive symptoms in population-based samples. For example, multiple studies have shown positive associations between indicators of disadvantage (such as poverty (Galea et al., 2007; Yen & Kaplan, 1999), unemployment (Cutrona et al., 2005; Silver et al., 2002) and racial/ethnic composition (Bécares et al., 2014; Do et al., 2019)) and depressive symptoms both cross-sectionally and over time. In addition, previous research has also documented negative associations between indicators of neighborhood affluence (high income and high educational attainment) and depression outcomes, although this indicator is explored much less (Ludwig et al., 2008, 2013). However, there are some inconsistencies in this evidence. Some longitudinal analyses of depressive symptom trajectories showed no significant impact of neighborhood disadvantage indicators (Lee & Estrada-Martínez, 2020; Lillis, 2009), and other studies have shown insignificant associations between affluence and depression outcomes (Coley et al., 2018; Feng et al., 2019).

Empirically, gender and race have been found to be related to the neighborhoods people live in, modify the way individuals navigate their neighborhoods and the influence of neighborhood context on health outcomes (Do et al., 2008; Kravitz-Wirtz, 2016; Wen &

Kowaleski-Jones, 2012; Williams & Collins, 2001). However, the gender differences in the impact of NVI on depressive symptom trajectories observed in this analysis did not follow expected trends, which adds to the inconsistent body of previous research. Some studies have found no variation in depression by gender across neighborhoods based on exposure to structural features such as disadvantage, chronic stressors and population structure (Bohlig, 2013; Matheson et al., 2006), while other studies have shown a gendered effect of neighborhood on depressive symptoms (Bassett & Moore, 2013; Clinton, 2012; Wainwright & Surtees, 2004). Moreover, analyses of heterogeneity by race are also oftentimes inconsistent (Kelley-Moore et al., 2016; Watson et al., 2012).

Overall, the effect of neighborhood structural conditions on depressive symptoms as modified by gender and race remains unclear. In this study, we find evidence of effect modification by race and gender across time that follows an inconsistent pattern. White men and women had similar levels of NVI exposure and depressive symptoms, and results show neighborhood vulnerability influenced depressive symptoms to a similar magnitude within this group. For Black men and women, depressive symptoms were markedly different and so did exposure to NVI. Black women had the highest depressive symptoms and NVI exposure compared to all groups; however, the NVI had the lowest magnitude of impact on depressive symptom trajectories for Black women compared to all other groups and the highest magnitude of impact on depressive symptom trajectories for Black men. Notably, this finding is consistent with previous neighborhood research on the association between neighborhood structural disadvantage and the mental well-being of Black men and women. Multiple studies have found a

more severe impact of neighborhood environment on various aspects of mental health for Black men compared to Black women (Clinton, 2012; Mullings et al., 2013; Perry et al., 2015).

Several theories have been advanced explaining the seemingly higher resilience of Black women compared to Black men in high vulnerability neighborhoods. Some suggest the marginalizing effects of structural disadvantage, racial segregation and gender socialization combine to create socially supportive enclaves of Black women in disadvantaged environments (Schieman, 2005b). The low impact of neighborhood vulnerability on depressive symptoms and higher depressive symptoms observed for Black women can be explained based on what we know about their resilience and the "cost of caring," specifically the strong Black woman schema (SBW). SBW is characterized by unyielding strength, assumption of multiple roles, and caring for others (Beauboeuf-Lafontant, 2007; Settles et al., 2008). We understand this schema to be rooted in Black women's fortitude and capacity to recover from difficulties (Abrams et al., 2014; Harrington et al., 2010). While neighborhood vulnerability is associated with higher depressive symptoms over time, Black women's resilience and adaptive social cohesion may partially ameliorate its effect.

The largest impact of neighborhood advantage was observed for Black men, who have been found to be more vulnerable to neighborhood disadvantage than Black women (Schieman, 2005b). While most of the studies on the impact of neighborhood environments on Black men have focused on adolescents and emerging adults, results have consistently shown Black men have a more difficult time navigating the impact of neighborhood context on mental health (Browning et al., 2013; Hurd, Stoddard, et al., 2013; Perry et al., 2015). Based on the findings

from this study in a cohort of older adults, this disparity persists throughout the life course. The combined impact of male gender socialization (ambition, independence, leadership) and marginalization (stigmatization, limited protection, poor treatment) may cause Black men to navigate neighborhood vulnerability without as much support, leading to higher susceptibility to its negative impact on mental health (Assari et al., 2015; Assari & Caldwell, 2017; Brassel et al., 2020). Further investigation of the association between neighborhood vulnerability and depressive symptoms for race by gender groups, especially Black American men and women, is warranted to further disentangle interactions between socialization and the environment.

Strengths and limitations. Some limitations should be noted. First, the main exposure, NVI, was categorized based on the distribution of values in this sample; however, these are data driven cutoffs. Although this approach is standard in analyses using novel exposure measures with no established cutoffs in the absence of a gold standard, the categories of exposure do not always translate into significant practical interpretation (*Cut-Off Score Definition*, 2014; Streiner, 2002). For example, there are no established criteria for what characterizes low vs. high exposure. In addition, the NVI showed minor departures from race and race by gender scalar invariance in previous analyses (Battle & Clarke, 2020), so results should be interpreted with caution. Finally, we were unable to detect more than two significant impacts on the rate of change over the course of the study in both the main analyses and multi-group models; this may be due to a less than adequate sample size (due to study attrition) to detect small to moderate effects over time. The use of baseline NVI as opposed to time varying NVI may also be the reason there were no significant shifts in the rate of change, or because exposure to vulnerable

neighborhoods has a persistent impact on levels of depressive symptoms, but once exposed, does not alter trajectories of change that are already established.

This analysis also has many strengths. First, this study uses a multidimensional measure of exposure to structural vulnerability in neighborhood environments, the NVI, for the first time in an empirical analysis. The NVI combines multiple structural indicators of access to health and opportunity within neighborhood environments and more accurately reflects the way our mental and physical health is impacted by the social aspects of the built environment. Second, the use of a longitudinal design using a nationally representative cohort of U.S. adults and analyses of race and gendered effects of neighborhood context on mental health fills an important gap in neighborhood research. Studying the impact of neighborhood vulnerability on depressive distress also has implications for understanding the impact of segregation and other aspects of neighborhood risk factors on health. Furthermore, establishing the predictive ability of neighborhood indexes can be used to inform interventions designed to target the structural sources of mental health disparities.

Conclusions and Future Research. Overall, exposure to neighborhood vulnerability contributes to mental health inequities that persist over time between race and gender groups. The indicators of neighborhood vulnerability are modifiable and important to consider as we continue to design innovative approaches to reducing health disparities. Based on the differential impact of neighborhood vulnerability on depressive symptoms by race and gender, culturally competent community-based approaches to depression prevention and treatment that go beyond

the individual to intervene at the environmental level could improve the health of large groups of at-risk populations.

Future analyses should explore associations between neighborhood vulnerability and health outcomes using the NVI at other timepoints. Furthermore, accounting for other neighborhood structural factors (residential stability, service environments, etc.) could further elucidate the impact of neighborhood context on mental health outcomes. In addition, future research should investigate the mediating role of other individual and interpersonal mental health correlates (perceived discrimination, vigilance, social cohesion etc.) in this association, specifically for Black women. Finally, replication in more diverse population-based samples would further explore the utility of the NVI in predicting health outcomes.

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Chapter 4 Neighborhood Vulnerability and Depressive Symptoms: The Role of Perceived Discrimination and Vigilance

Introduction

In recent years, there has been a growing interest in studying the impact of neighborhood social context on exposure to stress and mental health outcomes, such as depression (Clarke et al., 2011; Wheaton & Clarke, 2003). Neighborhood health research broadly analyzes the impact of contextual social inequality on the stress process, conceptualizing neighborhood characteristics as indicators of spatial social stratification that affect depression outcomes (Carol S. Aneshensel, 2009; Catherine E. Ross & John Mirowsky, 2001; Chitewere et al., 2017; Pearlin, 1999). Neighborhood context is thought to influence mental health by intensifying exposure to stressors such as unemployment, poverty and violence (Joshi et al., 2017; Mendenhall et al., 2006; Pinchevsky & Wright, 2012); however, the pathway between structural neighborhood features, interpersonal stressors and their combined impact on mental health are not well understood. Most neighborhood-depression research has not measured stress exposure as a mediated pathway, and hardly any research has looked at interpersonal stressors such as discrimination and vigilance.

Previous research has shown links between structural features of neighborhoods and depressive symptoms using multiple indicators of contextual social inequality. For example,

there are established associations between neighborhood socioeconomic disadvantage, affluence, racial composition, residential stability and service environments and development of depressive symptoms (Alegría et al., 2014; English et al., 2014; Matheson et al., 2006; Silver et al., 2002). In addition, the neighborhood vulnerability index, a composite measure of exposure to eight aspects of social and economic neighborhood context, was shown to be associated with depressive symptoms both cross-sectionally and over time and to have a differential impact between race by gender groups (Battle & Clarke, 2020). Two systematic reviews have similarly documented associations between neighborhood characteristics and depressive symptoms - both conclude with a need for exploring mediating pathways between neighborhood structural features and mental health as well as effect modification by race and gender (D. Kim, 2008; Mair et al., 2008a). Subjective measures of exposure to contextual inequality, such as perceived discrimination and vigilance, can help disentangle the impact of living in a marginalized community on depression and depressive symptoms.

Everyday Discrimination, or exposure to the daily slights, hassles, and insults individuals perceive due to bias against a personal characteristic or social group membership (e.g., race, gender) is considered an important contributor to social stress (Williams et al., 1997). Exposure to discrimination, typically measured through self-reports of experiences (e.g., unfairly fired, denied a bank loan, receiving poor service, harassment, etc.) (Williams, 2016), is associated with depressive symptoms among multiple racial/ethnic groups, men and women based on previous studies and meta-analyses (Carter et al., 2019; Nadimpalli et al., 2015; Pascoe & Richman, 2009). Everyday discrimination has also been included in neighborhood research, where studies

have found associations with various neighborhood structural features. For example, Dailey et al. (2010) found that Black residents living in higher disadvantage environments perceive less exposure to discrimination, while Schulz et al. (2000) found a positive association between high neighborhood poverty and perceived discrimination. While these findings indicate a correlation between neighborhood structural conditions and mental health, there is little empirical analyses of whether the connections between neighborhood context, perceived discrimination and depressive symptoms intersect on a mediating pathway where the influence of neighborhood vulnerability on perceived discrimination influences the impact of discrimination on depressive symptoms.

There are some limitations to the use of everyday discrimination as a robust indicator of the burden of exposure to marginalizing social stress; specifically, the inclusion of other dimensions of discrimination has been suggested (Lewis et. al, 2015 Dailey et al., 2010; Himmelstein et al., 2015b). Recent research on discrimination and health indicates the significance of another dimension of social stress that occurs within interpersonal interactions and impacts mental health. Vigilance, or vigilant coping style, is broadly defined by the preparatory acts individuals engage in (such as altering appearance and speech) to prevent experiencing discrimination and prejudice (Feagin & Sikes, 1994; Nuru-Jeter et al., 2008; Shorter-Gooden, 2004). Vigilance, as a construct, is distinct from discrimination in that it is based on a combination of preparation for and prevention of potential discrimination that does not measure exposure to any particular discriminatory act. Discrimination measures exposure to a particular prejudicial encounter, such as being fired or treated with less courtesy, without

focusing on any preparatory or preventative acts. The two constructs are likely highly correlated with a bi-directional relationship, in that discrimination may predict more vigilance and vigilant coping may heighten an individual's sensitivity to perceiving discrimination.

Vigilance is discussed as a combination of identity-related anticipatory and ruminative stress that contributes to health outcomes in various racial and ethnic groups (Ahmed et al., 2007; LaVeist et al., 2014a). For example, vigilance has been linked to depressive symptoms and chronic health conditions in Black adults (Lee & Hicken, 2016). Moreover, there is emerging evidence suggesting vigilance is an important factor in the Black-white racial inequalities in sleep quality, chronic stress, and obesity (Hicken et al., 2013, 2014, 2018). There is little research on the link between vigilance and neighborhood structural features, but its role in discriminatory interpersonal interactions, relationship with social status and impact on mental health make it an important factor to consider on the mediating pathway between neighborhood structural conditions and depressive symptoms.

The mental health impact of neighborhood context, perceived discrimination, and vigilance may be conditional on social status. Different race and gender groups are exposed to different environments, with studies identifying differences in mental health outcomes between men and women of different races based on exposure to neighborhood poverty, violence and social cohesion (D. Kim, 2008). Moreover, minoritized groups, such as Black Americans and women, are more likely to report experiences with perceived discrimination compared to white Americans and men, respectively (Paradies, 2006; Paradies et al., 2015). While vigilant coping is used by all groups, it holds different meanings by race and the prolonged effect of racism-related

vigilance has been found to impact the mental health of Black American men and women ((Hicken et al., 2013, 2018; Lee & Hicken, 2016). Thus, racism and sexism likely modify the relationship between neighborhood vulnerability and depressive symptoms via the social stress experienced from discrimination and vigilance.

There are established associations between neighborhood vulnerability and depression, with less evidence clarifying the role of vigilance and discrimination in this relationship. It is also well understood that discrimination and vigilance have independent associations with the development of depressive symptoms, with some evidence suggesting effect modification by race and/or gender. It is unclear whether structural features of neighborhood environments operate through discrimination and vigilance to influence depressive symptoms. The extent to which these associations reflect a causal chain remains to be determined; thus, the primary aim of this study is to investigate the extent to which the association between neighborhood vulnerability and depressive symptoms is mediated by everyday discrimination and vigilance. Since race and gender modify exposure to neighborhood contexts discriminatory social stress and depressive symptoms, the secondary aim of this analysis is to investigate whether the magnitude of the mediating effect of vigilance and discrimination differs by race and gender. Perceived exposure to vulnerability, measured using discrimination and vigilance, is expected to partially mediate the impact of NVI on depressive symptoms. Higher neighborhood vulnerability is expected to be associated with higher exposure to vigilance and discrimination, which in turn lead to higher depressive symptoms.

Methods

Data come from the American's Changing Lives (ACL) survey (J. House et al., 2005; J. S. House et al., 1990, 1994), a stratified, multi-stage area probability sample of non-institutionalized adults age 25 and older, living in the coterminous United States, and followed over a 25-year period. Black Americans and adults over age 60 were oversampled. The first wave of the study was conducted in 1986 with 3,617 adults (68% sample response rate for individuals). Surviving respondents were re-interviewed in 1989, 1994, 2001-2002, and 2011-2012. A sixth wave of data collection is currently in the field. This analysis focuses on the 1,350 respondents who self-reported their race as Black (34%) or white (66%) at Wave 4, when the survey questions on discrimination and vigilance were asked. We exclude all respondents of other racial identifications (e.g., Asian, Native American, and Hispanic) due to small sample size, as well as all respondents missing mediator or outcome data (n = 32). The ACL data are appropriately weighted to adjust for: a) differential initial selection probabilities, b) survey non-response, and c) post-stratification adjustments to the 1986 age-race-sex-region specific Census Bureau estimates of the U.S. population. For each later wave, additional weights adjust for panel non-response using predictor variables from prior waves (Lepowski and Couper 2002). These weights make the ACL sample representative of the age, gender, and race distribution of the U.S. population in 1986. Except for differences due to post-1986 immigration and outmigration, the sample is also representative of American residents in the originally sampled age-cohorts as they aged over 25 years (J. S. House et al., 1990).

Discrimination. The Everyday Discrimination Scale (EDD) included five items. Respondents were asked, "In your day-to-day life, how often: (a) "Are you treated with less courtesy or respect than other people?" (b) "Do you receive poorer service than other people at restaurants or stores?" (c) "Do people act as if they think you are not smart?" (d) "Do people act as if they are afraid of you?" and (e) "Are you threatened or harassed?" (Williams et al. 1997). Response categories include: 1=at least once a week, 2=a few times a month, 3=a few times a year, 4=less than once a year, or 5= never. Response items were averaged after reverse coding where necessary, so that higher scores indicate more frequent perceived discrimination.

Vigilance. The vigilance scale included four items, including: "In your day-to-day life, how often do you do the following things: (a) try to prepare for possible insults from other people before leaving home?; (b) feel that you always have to be very careful about your appearance to get good service or avoid being harassed?; (c) carefully watch what you say and how you say it?; and (d) try to avoid certain social situations and places?" Each of these items were measured on a five-point scale; respondents could choose either: 1=at least once a week, 2=a few times a month, 3=a few times a year, 4=less than once a year, and 5=never. Responses were averaged after reverse coding if necessary, so that higher values represent greater vigilance.

Depressive symptoms. Depressive symptoms were assessed with a short form (11-items) of the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff 1977; Kohout, Berkman, Evans and Cornoni-Huntley 1993). For each item respondents were asked how often they experienced each symptom during the past week: 1=hardly ever, 2=some of the time, and

3=most of the time. Responses were reverse coded if necessary and averaged to produce an index of depressive symptoms ranging from 1 to 3 for each wave.

Neighborhood Vulnerability. The neighborhood vulnerability index (NVI) is a composite measure computed using a factor analysis of eight census tract indicators of social disadvantage (poverty, unemployment, public assistance, racial composition, female headed households) and affluence (income, professional employment, educational attainment). The census tracts where ACL participants lived at Wave 4 range from 20 to -36 on the NVI, with lower, more negative scores indicating less exposure to vulnerable neighborhoods.

Sociodemographic variables. Directed Acyclic Graphs (DAGs) were used to determine which sociodemographic variables met conditions to be included as potential confounders. The following covariates were included in the analysis: age, educational attainment, race and gender. Age was defined continuously in number of years. Educational attainment was measured using three categories: Less than high school (those with less than 12 years of completed schooling), High school degree or some college (participants with 12-15 years of schooling), and college degree or higher (participants with 16 or more years of education). Participants self-reported their educational attainment, race and gender at baseline.

Analysis

The direct, indirect and total effects of neighborhood vulnerability on depressive symptoms as mediated by everyday discrimination or vigilance were estimated using the product method (Baron & Kenny, 1986; VanderWeele, 2016). The product method consists of fitting two regression models, (1) where the outcome is regressed on the mediator, exposure and covariates

and (2) where the mediator is regressed on the exposure and covariates. Using EDD as a working example, this can be expressed using the following equations:

$$CES\text{-}D = c`NVI + bEDD + cov + e_1$$

$$EDD = aNVI + cov + e_2$$

where the direct effect, represented by *c`*, is the coefficient describing the relationship between NVI and CES-D controlling for the effect of EDD. The coefficient *b* represents the impact of EDD on CES-D adjusted for NVI, while *a* represents the coefficient for the relationship between NVI and EDD. The *a*, *b*, and *c* variables correspond to the paths denoted in **Figure 4.1**, where *a*b* compose the indirect effects, *cov* represents the set of covariates included and e represents the corresponding residuals in each equation. The product method assumes independent residuals, no misspecification of causal order or direction, no unmeasured confounding and no measurement error (MacKinnon et al., 2006). All models were adjusted for age, education, race and gender (with the exception of the stratified models, where the stratification variable was excluded). Stratified models by race and gender were conducted to examine differences in mediating pathways between groups. Due to small cell sizes, it was not possible to examine differences between race by gender groups.

Mediation was defined as the extent to which each mediator explained the association between neighborhood vulnerability and depressive symptoms. Mediation was assessed by the following criteria: (a) a significant total effect of the exposure on the outcome unadjusted for the mediator, (b) the mediator is independently associated with the exposure and outcome, (c) the indirect effect, or product of the *a* and *b* paths, is significant, and (d) the effect of the exposure on

the outcome is attenuated and/or no longer significant after adjusting for the mediator (Baron & Kenny, 1986). Evidence of mediation was also based on the proportion of the total association explained after adjusting for the potential mediator. Although there is no specific threshold for percent change in coefficients that determines mediation, the conventional assessment of a 15% or greater change in beta coefficient was considered evidence of mediation, and a 30% change or greater was considered suggestive of strong mediation, given all other conditions were met (Baron & Kenny, 1986; Holmbeck, 1997; Hoyle & Kenny, 1999; Pollitt et al., 2005). All analyses were conducted using robust maximum likelihood estimation with R's lavaan package (Rosseel, 2011).

Results

Means (±standard error) and prevalence (%) for covariates included in the models are shown in **Table 4.1**. On average, ACL participants experienced everyday discrimination a few times a year (mean 3.14±0.01) and engaged in vigilant coping less than once a year (mean 2.18±0.03). All groups reported a similar level of exposure to both discrimination and vigilance, with Black Americans reporting slightly more vigilance than whites and men reporting lower perceived exposure to everyday discrimination compared to women. The average NVI score for the sample was -5.71(±0.2); indicating that participants had relatively low levels of neighborhood vulnerability.

Discrimination. Results of the main analysis are shown in **Table 4.2**. In the discrimination model, neighborhood vulnerability was positively associated with depressive symptoms controlling for age, race, gender and educational attainment (β_{total}= 0.122, $p<0.05$).

Adjustment for discrimination had no impact on the association between neighborhood vulnerability and depressive symptoms and the indirect effect of discrimination was small and not statistically significant ($\beta_{indirect}$= 0.001, p>0.05), suggesting that discrimination does not mediate the association between neighborhood vulnerability and depressive symptoms in this sample.

The discrimination mediation model was stratified by race and gender to ascertain whether there are differences between groups (**Table 4.3**). Race stratified models showed a significant positive association between neighborhood vulnerability and discrimination for white Americans (β_{total}= 0.10, p<0.05). Following the inclusion of discrimination, the initial association between neighborhood vulnerability and depressive symptoms remained unchanged and the indirect effects were not significant (β= 0.003, p>0.05), suggesting discrimination does not mediate the association between neighborhood vulnerability and depressive symptoms in this sample. For Black Americans, there was a negative association between neighborhood vulnerability and depressive symptoms that persisted after controlling for discrimination (β_{direct}= -0.040); however, this finding did not reach statistical significance (p>0.05).

Gender stratified discrimination models showed no significant direct, indirect or total effects between neighborhood vulnerability and depressive symptoms for men (**Table 4.3**). Among women, the association between neighborhood vulnerability and depressive symptoms was positive and statistically significant (β_{total}= 0.079, p=0.04). There was a negligible difference in the point estimate after adjusting for discrimination and both the direct and indirect effect

estimates were not significant, suggesting discrimination does not mediate the association between neighborhood vulnerability and depressive symptoms among women.

Vigilance. In the main vigilance models, neighborhood vulnerability was positively associated with depressive symptoms (β_{total}= 0.122, p<0.05). After mediator adjustment, the association was attenuated by 35% (β_{direct}= 0.098, p<0.05); suggesting vigilance partially mediates the association between NVI and depressive symptoms; however, the indirect effects were only marginally significant (β= 0.024, p=0.05).

In the stratified models, vigilance was positively associated with depressive symptoms across groups (p<0.01). The inclusion of vigilance attenuated the association between neighborhood vulnerability and depressive symptoms among Black (400%) and white (21%) Americans. The indirect effect was not significant in the model for Black Americans; however, the indirect effect was marginally significant among white Americans (p<0.10). The direct and total effect estimates were also significant for white Americans (β_{direct}= 0.081, β_{total}= 0.102, p<0.05); suggesting vigilance partially mediates the association between neighborhood vulnerability and depressive symptoms for this group.

In the gender models, adjustment for vigilance attenuated the association between neighborhood vulnerability and depressive symptoms among women (17.5%) and men (37%). There were significant direct and total effects for women (β_{direct}= 0.066, β_{total}= 0.080, p<0.05); but insufficient evidence of mediation as the indirect effect estimate did not reach statistical significance (p>0.05). No significant direct, indirect or total effects were observed among men,

suggesting vigilance does not significantly mediate the association between neighborhood vulnerability and depressive symptoms in men in this sample.

Tables

Table 4.1: Sample Characteristics a, American's Changing Lives Study, Wave 4 (n=1,350)

Variable	Mean ± SE or Prevalence (%)				
	Black (n = 362)	White (n=988)	Women (n=854)	Men (n=496)	All Groups (n=1,350)
Neighborhood Vulnerability Index	-0.84 ±0.32	-7.33 ±0.32	-5.24±0.33	-6.48±0.45	-5.71±0.27
Age (years)	61.38±0.72	62.68±0.49	63.89±0.52	59.66±0.52	62.33±0.41
Everyday Discrimination Scale Score	3.13±0.03	3.15±0.02	3.18±0.02	3.08±0.03	3.14±0.01
Vigilance Scale Score	2.53±0.07	2.06±0.03	2.17±0.04	2.20±0.05	2.18±0.03
Educational Attainment					
College Degree or More	10.5	21.4	14.3	25.6	18.4
High School	50.6	59.7	59.7	53.6	57.3
Less Than High School	38.9	51.7	26.3	20.8	24.2
CES-D Score	1.68±0.01	1.58±0.02	1.63±0.01	1.58±0.01	1.61±0.01

a. Mean ± standard error (SE) or prevalence (%) of baseline covariates are reported. CES-D: Center for Epidemiologic Studies-Depression (CES-D) scale.

Table 4.2: Mediation of the Relationship between Neighborhood Vulnerability and Depressive Symptoms, Americans' Changing Lives, Wave 4 (n=1,350)

			Estimate	SE	P
Everyday Discrimination		a	0.016	0.002	0.675
		b	0.058	0.016	0.197
	Direct	c`	0.122	0.001	**0.003**
	Indirect	a*b	0.001	0.000	0.695
	Total	c	0.122	0.001	**0.003**
	R-square	Discrimination	0.040	-	-
		Depressive Symptoms	0.070	-	-
			Estimate	SE	P
Vigilance		a	0.091	0.006	**0.032**
		b	0.263	0.008	**0.000**
	Direct	c`	0.098	0.001	**0.015**
	Indirect	a*b	0.024	0.000	0.053
	Total	c	0.122	0.001	**0.003**
	R-square	Vigilance	0.053	-	-
		Depressive Symptoms	0.136	-	-

Point estimates for the direct, indirect and total effects of neighborhood vulnerability on depressive symptoms based on models in Figure 4.1. All models were adjusted for race, gender, age and educational attainment. SE = Standard Error; R-square = Effect size estimate. All estimates are standardized. Bold: $p<0.05$.

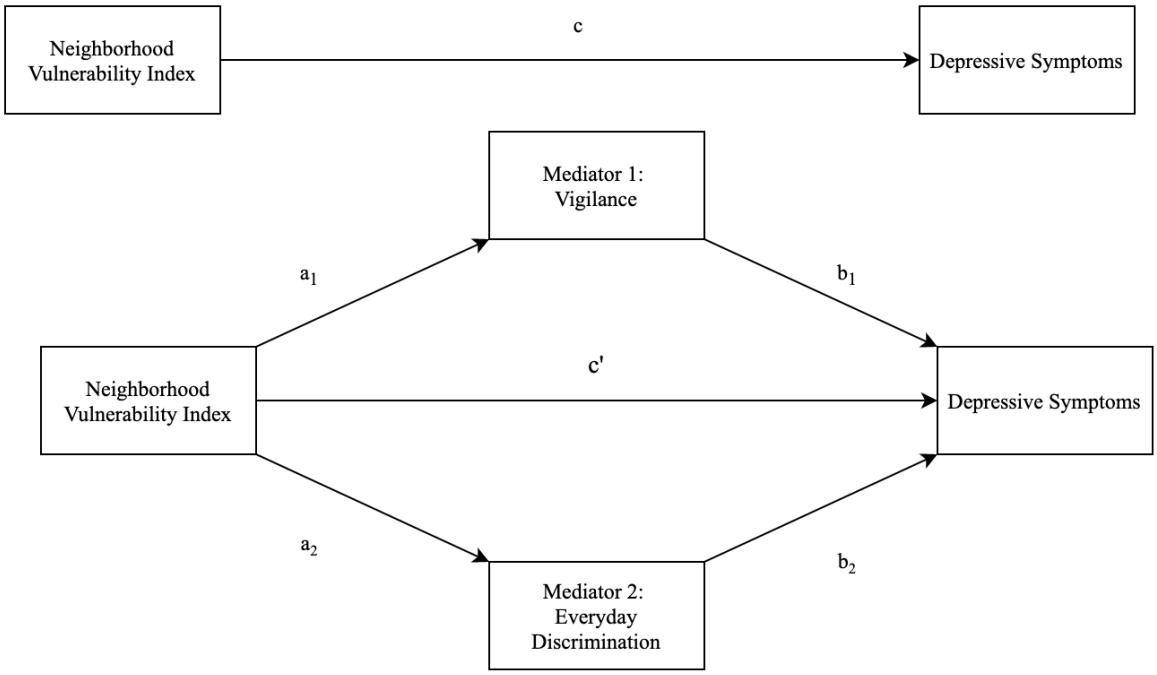
Table 4.3: Mediation of the Relationship between Neighborhood Vulnerability and Depressive Symptoms, Differences by Race and Gender. Americans' Changing Lives Study, Wave 4 (2001)

			Black^ (n=362)	White^ (n=988)	Women^^ (n=854)	Men^^ (n=496)
Discrimination		a	0.017	0.044	0.031	0.035
		b	0.080	0.065	0.113	0.029
	Direct	c`	-0.040	0.100**	0.076^{+}	0.065
	Indirect	a*b	0.001	0.003	0.003	0.001
	Total	c	-0.039	0.102**	0.079*	0.066
	R-Square	Discrimination	0.081	0.029	0.022	0.032
		Depressive Symptoms	0.035	0.044	0.084	0.072
Vigilance		a	0.035	0.076^{+}	0.047	0.100^{+}
		b	0.279**	0.288**	0.297**	0.252**
	Direct	c`	-0.012	0.081*	0.066^{+}	0.041
	Indirect	a*b	0.010	0.022^{+}	0.014	0.025
	Total	c	-0.002	0.102**	0.080*	0.066
	R-Square	Vigilance	0.008	0.040	0.060	0.084
		Depressive Symptoms	0.122	0.120	0.155	0.129

Direct, indirect and total effect estimates from single mediation models. $^{+}$p<0.10,* p<0.05, **p<0.01. All models adjusted for age and educational attainment. ^Model adjusted for gender. ^^Model adjusted for race.

Figures

Figure 4.1: Path Diagram of Single Mediation Models



Path diagrams for single mediation models. a_1: coefficient describing the effect of NVI on vigilance; b_1: coefficient describing the effect of vigilance on depressive symptoms; a_2: coefficient describing the effect of NVI on discrimination; b_2: coefficient describing the relationship between discrimination and depressive symptoms; c: coefficient describing the total effect of NVI on depressive symptoms; c`: coefficient describing the direct effect of NVI on depressive symptoms, controlling for each mediator

Discussion

Using a large sample of aging Americans, this study examined the extent to which discrimination and vigilant coping style mediate the association between neighborhood vulnerability and depressive symptoms for Black and white adults. Overall, residence in a socially and economically vulnerable neighborhood was positively associated with depressive symptoms, which is consistent with existing literature (Alegría et al., 2014; Bassett & Moore, 2013; Bolstad et al., 2020). This analysis found no evidence that perceived discrimination is the mechanism by which neighborhood vulnerability is associated with depressive symptoms; however, we found partial evidence that a vigilant coping style may mediate the association between residence in a vulnerable neighborhood and depressive symptoms.

Discrimination. The lack of an indirect effect of discrimination in the association between neighborhood vulnerability and depressive symptoms may be partially due to neighborhood vulnerability not having a significant effect on exposure to discrimination in the full sample. This is somewhat consistent with previous research that identified negative associations between neighborhood disadvantage and reports of racial discrimination among Black adults and no association among whites (Dailey et al., 2010) and is likely due to the strong correlation between residential segregation and neighborhood disadvantage, and the decreased likelihood of experiencing interpersonal discrimination in a racially segregated neighborhood (English et al., 2014; Hurd, Sellers, et al., 2013; Williams & Collins, 2001). However, discrimination was also not directly associated with depressive symptoms in the main or stratified models, which is inconsistent with previous research showing a positive association

between neighborhood racial discrimination and depression outcomes among Black Americans (English et al., 2014; Russell et al., 2018).

There was also no evidence of mediation by discrimination when models were stratified by race or gender, but results showed an interesting pattern of effect modification. In the race stratified models, neighborhood vulnerability was positively associated with depressive symptoms among white Americans and negatively associated with depressive symptoms among Black Americans, though these results were not significant. Consistent with this finding, other analyses have found neighborhood racial composition and neighborhood disadvantage have an inverse association with depressive symptoms among Black Americans (Dailey et al., 2010; Hurd et al., 2013; Lee et al., 2018). Since the NVI includes racial composition and disadvantage indicators and racial segregation impacts disadvantage this pattern of results is not surprising.

In the gender stratified models, neighborhood vulnerability was positively associated with depressive symptoms for both groups but to a slightly higher magnitude among women. This finding adds to a body of research that has inconsistently shown a significant difference in the effect of neighborhood structural features on depressive symptoms between men and women. For example, Matheson et al. (2006) and Clinton (2012) found no evidence of a differential impact of chronic neighborhood stressors on depressive symptoms between men and women, while Bassett and Moore (2013) reported a positive association between neighborhood disadvantage and depressive symptoms for women and no association for men. Moreover, Latkin and Curry (2003) showed a prospective association between neighborhood conditions and higher depressive symptoms that was partially attenuated for men while another study found indicators

of neighborhood vulnerability increase the risk of depressive symptoms for both groups, though effect modifiers differ (Mullings et al., 2013). The effect of neighborhood context on depressive symptoms by gender remains inconclusive; however, results indicate a positive association for men and women with a small difference in magnitude.

Vigilance. There was a significant positive association between neighborhood vulnerability and vigilant coping. In addition, vigilance was strongly associated with depressive symptoms and the combined effects of neighborhood vulnerability and vigilance accounted for 12-15% of the variation in depressive symptoms. In the full sample, mediator adjustment attenuated the association between neighborhood vulnerability and depressive symptoms by 35%, indicating some evidence of strong mediation.

In the stratified models, there was also evidence of effect modification across race and gender groups. Neighborhood vulnerability was negatively associated with depressive symptoms among Black Americans while there was a positive association for white Americans, men and women. This pattern is inconsistent with previous studies showing a positive association between neighborhood context and depressive symptoms among men, women, Black Americans and whites (Himmelstein et al., 2015b; Watson-Singleton et al., 2019). The indirect effect of vigilance was marginally significant for white Americans and men and did not reach significance for any other groups, indicating a need for further inquiry. Adjustment for vigilance resulted in a >30% change in the association between neighborhood vulnerability and depressive symptoms for all groups, with a 500% change the point estimate for Black Americans. Though the indirect effect of vigilance on depressive symptoms did not reach significance, these findings are

consistent with previous analyses showing a major role of vigilance in narrowing Black advantage regarding depression compared to whites (LaVeist et al., 2014a). Vigilance is seldom used in neighborhood studies, so contextualization of these findings is limited, but the theories that exist on stress processes within neighborhood contexts are consistent with the findings of this analysis. Hill and Maimon previously described the mediating role of stress in the association between neighborhood context and mental health outcomes, specifically citing the significance of subjective experiences and social processes (2013). Whether the association between neighborhood vulnerability and depressive symptoms partially operates through vigilance remains unclear, but the marginally significant estimates suggest an indirect effect. This should be further investigated in other nationally representative population-based samples.

These findings illustrate the pervasive reach of neighborhood vulnerability and its capacity to influence mental health regardless of individual perception. While perception is an important variable to consider for mental health outcomes, it is limited in its ability to filter the impact of navigating the stressors associated with prolonged exposure to neighborhood vulnerability. Our understanding of neighborhood context and its direct link to individual outcomes, specifically depressive symptoms, should be used to inform mental health interventions that seek to influence improvements in population health. This is especially relevant as we grapple with the long-term mental health impacts of the coronavirus pandemic. It will be important to focus mental health interventions in communities who were already at increased risk of depressive symptoms, especially as they seek to recover from being the hardest

hit in terms of mortality, economic downturn (lost jobs, closed businesses) and long-term isolation.

Strengths and Limitations. This analysis has many strengths. First, the use of a population-based sample allows for generalization to the 1986 U.S. population as they have aged to 2001. Furthermore, the use of older adults to study the mental health impact of neighborhood environments adds to a body of evidence that has primarily focused on adolescents and emerging adults. Second, the Neighborhood Vulnerability Index is a novel measure of exposure to social context and mental health risks. Linking this measure to mental health outcomes provides a new exposure metric for future inquiry. Furthermore, a significant association between NVI and depressive symptoms observed in Chapter 3 was replicated here at a single timepoint, demonstrating the utility of this measure for future studies. Third, the pattern of race and gender effect modification is supported by multiple social theories about the impact of socio-structural context on mental health between social groups, and this analysis helps us to better understand the nuances of the impact of exposure to neighborhood vulnerability on well-being.

This analysis has some limitations. First, results may be under (or over) estimated based on the socioeconomic indicators of the analytic sample relative to the baseline ACL sample. It is likely the remaining participants in the fourth wave of the ACL study represent those who were exposed to less neighborhood vulnerability, were more stable, and therefore less likely to be lost to follow up due to disease morbidity and mortality compared to the general population. While the weights in the ACL dataset adjust for differential selection probabilities and some attrition, they may not fully account for selective mortality and loss to follow up. Selective mortality of

the most vulnerable participants at baseline would bias results towards the null and dilute the impact of both mediators.

Second, cross-sectional analyses are always limited in their ability to infer causality. This is especially relevant based on the potential for reverse causation when using mediation analysis. Temporality is unclear since the exposure, mediators and outcome were all measured simultaneously. However, the NVI was previously shown to have a longitudinal association with depressive symptoms (Battle and Clarke, 2020) and the spacing between ACL waves make it a less than ideal sample to use for longitudinal mediation analysis since the larger the gap between each measure, the greater the potential for reverse causation and time varying confounding (Bind et al., 2016; MacKinnon et al., 2006). Third, the possibility of residual confounding by individual level variables may partially violate the assumptions of this analysis. However, this is a common limitation of studies of neighborhood effects and this issue was addressed by controlling for a variety of individual level variables using directed acyclic graphs as a guide since there is no consensus in the extant literature on what the main confounders are (Mair et al., 2008a).

Conclusion and Future Research. In summary, the results of this study point to the importance of neighborhood vulnerability for depressive symptoms, regardless of perceptions of interpersonal stress. Future analyses should use more diverse population-based samples that include those who live in the most vulnerable census tracts to further investigate the impact of neighborhood vulnerability on depressive symptoms and perhaps clarify where other racial/ethnic and gender groups lie on the spectrum of effect modification. In addition, longitudinal analyses can address temporality constraints using a cohort sample with more

frequent follow up. Finally, vigilance appears to be more sensitive to race and gender-based effects of navigating inequality at the individual level and should be looked into as a strong variable linking structural conditions to mental health outcomes.

The Neighborhood Vulnerability Index is a measure of exposure to structural advantages and disadvantages that may not operate on mental health through perception. The direct association between NVI and depressive symptoms provides evidence that interventions aimed at reducing mental health risks in large groups of the American population should target the overarching contextual risk factors to improve on their impact and scope. This would also create community contexts in which individual level interventions would be more effective.

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Chapter 5 Conclusion

Summary and Implications of Main Findings

Depressive symptoms are common among U.S. adults and a predictor of adverse social, economic and physical health outcomes (Anxiety and Depression Association of America, 2016). The relationship between race, gender and mental health is complex; depression impacts all racial, gender and socioeconomic groups in different ways (R. K. Bailey et al., 2019b). Over the past few decades, public health has explored structural context, namely the neighborhood environment, as a risk factor for developing depressive symptoms (A. V. Diez Roux & Mair, 2010; D. Kim, 2008). Studies examining the relationship between neighborhood contextual features and depressive symptoms have inconsistently found an association between neighborhoods and depressive symptoms, which is partially due to the difficulty in capturing the multidimensionality of neighborhood exposures (A. V. Diez Roux, 2016; Mair et al., 2008b). Moreover, there is a need for exploring effect modification by race and gender and mediating pathways of neighborhood stress processes (Elliott, 2000). By addressing these gaps, we can identify large groups of adults at risk of poor mental health trajectories and develop neighborhood-based strategies to address socio-structural risk factors as a potential avenue to improve the mental health of the U.S. adult population.

Neighborhood environments are critical in maintaining mental health, educational attainment, disease prevention and generally contribute to well-being at any age (Braveman et al., 2011). There are stark inequities in the neighborhood contexts of U.S. adults due to racial and income segregation, differences in policy and governance, and other factors that determine neighborhood selection and quality (Popescu et al., 2018; Reardon & Bischoff, 2011). Therefore, there are likely inequities in how they impact mental health over time. Several measures of neighborhood context are often used in empirical analyses, such as poverty, unemployment, racial composition and income, but they do not fully capture the complexity of these inequities in neighborhood exposures. They primarily focus on a single dimension of neighborhoods, such as affluence, disadvantage, and poverty, which are likely to underestimate neighborhood effects on mental health. Additionally, this approach neglects the multidimensional nature of neighborhood context; thus, the impact of neighborhoods on mental health outcomes such as depressive symptoms remains misunderstood.

This dissertation developed a composite measure of neighborhood vulnerability to conduct a fuller and more nuanced assessment of neighborhood effects on depressive symptoms. This dissertation also assessed the utility of the composite measure in establishing an empirical link between neighborhood conditions and mental health, identifying which race and gender groups are at risk of poor depressive symptom trajectories as they age, and understanding the mediating role of discrimination and vigilance as sources of contextual stress. Thus, the overall contribution of this dissertation was to (1) develop a composite measure of multidimensional exposure to neighborhood vulnerability; (2) describe differences in exposure to neighborhood

vulnerability between race by gender groups; (3) determine the cross-sectional and longitudinal associations between neighborhood vulnerability and depressive symptoms, (4) examine the role of perception-based indicators of vulnerability -- perceived discrimination and vigilance --as mediators of the association between neighborhood vulnerability and depressive symptoms; and (5) investigate heterogeneity in neighborhood effects by race and gender.

In Chapter 2, the Neighborhood Vulnerability Index (NVI) was created using eight census tract indicators of neighborhood context. The NVI was assessed for three levels of race, gender, race by gender and time invariance -- findings suggest this measure most accurately captures gender differences in neighborhood context with less precision between race and race by gender groups. Consistent with other neighborhood or area level indexes, the NVI was not time-invariant (Berg et al., 2020; Miles et al., 2016). Overall, neighborhood vulnerability appeared to decline over the course of a 33 year follow up with the sharpest decline among white adults. Chapter 2 documented stark inequities in exposure to vulnerability in the neighborhood environment between race by gender groups. Black Americans lived in the most vulnerable census tracts, with Black women being exposed to higher levels of neighborhood vulnerability than Black men, white men and white women. Taken together, these findings illustrate the longstanding impacts of a combination of racism, sexism and classism in the U.S. population, specifically how social status systematically sorts large groups of American adults into different neighborhoods in ways that may have long-term implications for their mental health. The relatively high vulnerability of Black adult's census tracts reflects structural racism and classism,

and the differences in vulnerability by both gender and race reflects the intersecting impact of sexism on neighborhood quality.

The NVI illustrates inequities in exposure to mental health risks in the neighborhood environment and serves as a tool to assess whether there are cross-sectional and longitudinal links to depressive symptoms at the individual level. Chapter 3 builds on Chapter 2 by investigating the relationship between the NVI and depressive symptoms at baseline and over time. This study found a significant association between NVI and depressive symptoms, where the NVI significantly predicted depressive symptoms at all timepoints for Black and white men and women. For all groups, there was a positive association between neighborhood vulnerability and depressive symptoms at baseline, and the rate of change did not significantly shift over the course of the 33 year follow up.

Over time, there were distinct depressive symptom trajectories for each race by gender group. Neighborhood vulnerability had a similar impact on depressive symptoms for white men and women, the strongest association with depressive symptoms for Black men and the weakest association with depressive symptoms for Black women. In low and moderate vulnerability neighborhoods, the impact of both race and gender was clearly demonstrated. The gendered effect of neighborhood context on depressive symptom trajectories seemed to fade in high vulnerability environments, leaving race as the most influential factor for depressive symptom trajectories.

Neighborhood effects on depressive symptom trajectories were shown to vary by race and gender and be especially heterogeneous between Black men and women. For Black women,

there was a small effect of neighborhood vulnerability on depressive symptoms, an observation supported by previous research and aligns with theories that Black women are uniquely exposed to and navigate contextual vulnerability (Abrams et al., 2014; Beauboeuf-Lafontant, 2009; Crenshaw, 1989; Hooks, 2015). Furthermore, they appear to exclusively benefit from protective factors that buffer its harmful effects. On the other hand, Black men's mental health was shown to be the most vulnerable to neighborhood context, with the combination of racist marginalization and challenges of masculinity emerging as potential explanations (Brassel et al., 2020; Brown, 2017; Hale et al., 2019; Schieman, 2005b).

These results are an important contribution to the literature on the association between neighborhoods and depressive symptoms. The findings of previous research are mixed but results from this analysis support the body of work that has shown a direct link between indicators of neighborhood context and depressive symptoms, with higher vulnerability being predictive of more depressive symptoms. Results also suggest race plays a major role in depressive symptom trajectories among those who reside in our most vulnerable neighborhoods, which aligns with what we know about the impacts of racial segregation on neighborhood divestment and health outcomes (Do et al., 2019; Landrine & Corral, 2009; Massey et al., 1987; Popescu et al., 2018).

Chapter 4 built on previous chapters by investigating discrimination and vigilance as potential mediators in the association between neighborhood vulnerability and depressive symptoms. The results of Chapter 3 were partially replicated, where neighborhood vulnerability was once again found to have a positive cross-sectional association with depressive symptoms

that was heterogeneous by race and gender. There was a positive association between neighborhood vulnerability and depressive symptoms among both men and women, which adds to the mixed results on effect modification by gender. Between race groups, neighborhood vulnerability was negatively associated with depressive symptoms for Black adults and had the opposite effect on white adults. The Black sample at wave four was primarily composed of Black women; thus, the negative association may be explained by the selective survival of the least vulnerable Black women and protective factors that exist within this group.

There was no significant evidence of mediation by discrimination in the full sample and this finding was consistent after stratification by race and gender. There was evidence suggestive of strong partial mediation by vigilance and effect modification between race and gender groups. In the full sample, neighborhood vulnerability predicted more vigilant coping and depressive symptoms. Accounting for vigilance explained 30% of the association between neighborhood vulnerability and depressive symptoms which is suggestive of strong mediation; however, the total and indirect effects were only marginally significant, warranting further investigation.

This finding was consistent after race and gender stratification, and there were stark differences in the magnitude of mediation by vigilance on the pathway between neighborhood vulnerability and depressive symptoms. Adjustment for vigilance attenuated the association between neighborhood vulnerability and depressive symptoms by 15-33% for whites, men and women. Notably, adjustment for vigilance resulted in a 400% change in the point estimate for Black adults. Consistent with the analyses in the full sample, many of the direct and indirect

effects were insignificant or marginally significant for each group. However, the large change in point estimate for Black adults indicates a noteworthy role of vigilance for this group and is consistent with previous research that has attributed a portion of the disparity in depression outcomes between Black and white adults to vigilance and the effects of navigating racism (Barnes et al., 2013; LaVeist et al., 2014a). Overall, an association between vigilance and depressive symptoms is well established, but these results contribute to a growing body of analyses exploring the relationship between vigilance and neighborhood context. Marginally significant results that lack previous empirical support limit the ability to draw any firm conclusions but do show a consequential role of vigilance that should be further explored.

Strengths and Limitations

While this dissertation makes a significant contribution to our understanding of neighborhood context and depressive symptoms among U.S. adults, it has limitations that warrant discussion. Census tracts, in addition to several other spatial scales of measurement, are often used in studies of neighborhood context and health without a strong consensus as to which is the most precise (Messer, 2007; Mujahid et al., 2007). Results of this analysis may be sensitive to the use of census tracts as opposed to some other measure of neighborhood, but previous analyses have shown no significant differences in neighborhood effects by neighborhood definition based on comparisons between a one-kilometer buffer, block group, census tract, and ZIP code (Berkowitz et al., 2015; Krieger et al., 2002; Sampson et al., 2002).

In neighborhood studies, the influence of neighborhood selection is often acknowledged as a potential source of bias. In this study, it is possible the influence of neighborhood

vulnerability on depressive symptoms is due to differential selection into more vulnerable neighborhoods based on race, gender and socioeconomic status (Dohrenwend et. al, 1992). It is possible the those who are more depressed as a result of early life exposures may select into more vulnerable neighborhoods. The influence of social selection on study results cannot be ruled out, and future analyses should explore the effect of differential selection on mental health outcomes between groups.

Additionally, the ACL waves are unevenly spaced, with five waves of data collected at three-to-ten-year intervals. This aspect of the study design may be insufficient to detect the complex relationship between neighborhood vulnerability and mental health, specifically any small shifts in the rate of change between waves, making Chapter 3 results susceptible to underestimation and bias due to insufficient data. In addition, the ten-year interval between waves four and five restricted the ability to do a longitudinal mediation analysis in Chapter 4, limiting the interpretation of results.

Finally, the Neighborhood Vulnerability Index was not time-invariant. This may be due to differential item functioning over time or the natural shifts in context that current data and methods are unable to account for. While this limitation is common to spatial indexes, it partially undermines the utility of the measure and the ability to assess the cumulative impact of neighborhood context on depressive symptoms and other outcomes. This limitation remains a challenge for neighborhood studies.

This dissertation has several strengths, however. First, the results presented in this dissertation utilized data from the American's Changing Lives Study. The ACL study is the

longest ongoing nationally representative longitudinal study of U.S. adults aged 25 years and older. Therefore, the research findings generated from this study can be generalized to the 1986 population of U.S. adults who were aged 50 years and older in Chapter 3 and 39 years and older in Chapter 4 since the study is nationally representative with weighted responses. This is a particularly important strength since previous research examining neighborhoods and mental health have relied on smaller studies with a shorter follow up of less than 10 years. Furthermore, the use of a prospective study design in Chapter 3, where Neighborhood Vulnerability was measured at baseline and depressive symptoms at subsequent waves, removes potential bias due to reverse causation.

Second, exposure to neighborhood context was uniquely conceptualized in Chapter 2 for use in all subsequent chapters. A multidimensional measure such as the Neighborhood Vulnerability Index computed using a structural equation model -- as opposed to using single indicators, a group of indicators, summing indicators or averaging indicators -- better reflects the multifaceted nature of neighborhood environments that individuals navigate. Accounting for exposure to neighborhood context using a method that weighs the contribution of each indicator to compute an overall score was novel in itself and using a longitudinal dataset with a long follow up to understand the impact of neighborhood vulnerability on mental health throughout adulthood was also innovative.

Third, Chapter 4 provides one of the first analyses to explore mediation by discrimination and vigilance on the stress process, specifically between neighborhood vulnerability and depressive symptoms. Studies typically begin with discrimination or vigilance as the primary

exposure and look at outcomes without consideration for contextual influences that predict these subjective experiences. The incorporation of place in this pathway contextualizes the association between vigilance, discrimination and depressive symptoms, expanding the focus on individuals to the subjective experiences we respond to as we navigate daily life. Not only does neighborhood context illustrate how context influences exposure to social stress, but it may also be an indicator of how we navigate the world at large and has implications for exposure to discrimination and vigilance beyond the census tract. For example, residents of the most vulnerable neighborhoods may be subconsciously aware of how socioeconomic disadvantage modifies interpersonal treatment and may be more likely to use vigilance as a way to cope and shield themselves from its harmful impacts. Future neighborhood studies should explore the role of additional mediators and the influence of vigilance and discrimination on the mental health of other marginalized socioeconomic, racial and gender groups.

Conclusion and Future Directions

This dissertation builds on previous work that has shown neighborhoods to be an important risk factor for depression in adulthood. The collective findings of this dissertation also inform the path forward in the study of depression etiology in multiple ways. First, creating a composite score for neighborhood vulnerability provides a new tool that strengthens the ability to quantify structural context in a way that does not rely on individual perception. Using measures such as the NVI as a model, epidemiologists can further refine our definition and conceptualization of exposure to contextual inequity and more precisely assess its impact. Future measures of structural vulnerability that build on the NVI should incorporate political aspects of

vulnerability by measuring the differential impact of past and present political discourse and decisions that influence health outcomes. Second, linking this score to an individual-level outcome provides evidence of a direct pathway between structural conditions and depression outcomes, shifting the narrative about disparities beyond individual skills, perception and abilities. Future analyses should continue to explore the direct and indirect pathways between social context and health, as context has the power to shift outcomes in a way individual effort often cannot. Studying individuals outside of their socio-structural context results in inaccurate conclusions about the abilities of individuals to self-determine their mental health trajectories without interventions at the systemic level.

Third, exploring mediating pathways via social stress from discrimination and vigilance inform future directions in studying the impact of marginalizing social systems on mental health and how their effects differ between race and gender groups. We observed differences between Black and white U.S. adults that provide some information about the social patterning of depression disparities. Among Black adults, we uncovered a pattern of neighborhood effects that warrants further investigation. Black women's response to misogynoir has been to generate sociocultural protective factors they appear to exclusively benefit from. However, Black women still had the highest depressive symptoms of any group, so this analysis is limited in its ability to inform our understanding of their risk factors for depression. Neighborhood exposures may not be the most relevant predictors, but other aspects of the social environment such as socialization social schemas and interpersonal interactions could lead to a deeper understanding.

Moving forward, research on neighborhoods and mental health should do three main things to strengthen causal inference, improve upon measures and gain new insights for intervention strategies to address racial and gender inequities in depression. First, epidemiology should continue neighborhood-based surveillance efforts and longitudinally collect observational data at evenly spaced intervals. This approach will supply additional information on the residential histories of U.S. adults, allowing for the assessment of cumulative disadvantage on mental health. Second, factors such as disadvantage and affluence are undeniably key dimensions of neighborhood effects on health, but researchers should further disentangle how their effects are mediated by social stress processes such as vigilance that may be more directly relevant. Third, effect modification by race and gender as well as variation by other demographic subgroups (age, ethnicity, migratory status) will further inform how oppressive social systems undergird depression disparities and impact etiologic risk factors by group. Depression impacts all socioeconomic classes, genders and racial groups with differences in onset, severity and chronicity that indicate the need to construct multiple conceptualizations of causal pathways and etiology.

This dissertation highlights the complexity of relationships between place, personhood and mental health. In sum, health disparities are not solely created by individual shortcomings, they are also the result of harmful social structures - the policies, systems, environments that lie outside of the control of any single person. In addition, race and gender are not inherently linked to any particular trait or behavior; it is the meaning and social treatment attached to these identities that undermine the ability to maintain mental health. Thus, we should continue to

explore the way we think about depression etiology among different race and gender groups to explain differences in prevalence and expand this approach to other health inequities. In conclusion, depression is an illness of place and power and the result of marginalization at the structural level that interacts with the social environment to predict poor mental health outcomes.

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