

Research Article

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Structural equation modeling of mental health in gentrifying neighborhoods in Austin, Texas

<https://doi.org/10.1515/openhe-2021-0002>

received October 4, 2020; accepted February 24, 2021

Abstract: Having poor mental health can be life-threatening, and problems tied to it are prevalent in communities across the United States (US). The city of Austin is one of the ten cities in the US undergoing rapid urban gentrification; however, there is insufficient empirical evidence on the impact of this process on residents' health. Consequently, this study explored the concept of weathering and life course perspective using data of 331 residents recruited from two regions endemic with gentrification to assess the health impacts of gentrification. We used a triangulation method including univariate, bivariate correlation, and multiple linear regression implemented through the structural equation model to examine the complex pathways to three health outcomes—measured stress, self-rated mental health, and depression symptoms. Bivariate Pearson's correlation indicated a significant positive association between gentrification score and mental health symptoms and stress. However, the direct association between gentrification and depression disappeared in the causal/path model. In support of the weathering hypothesis, this study found that stress score was directly related to the adulthood depression score. Therefore, this research builds on the accumulating evidence of environmental stress and mental health in the US's rapidly changing physical and sociocultural environment. Hence, implementing and guaranteeing social equity of resources will improve residents' health and reduce the cost of health care spending at both the household level and the city government level.

Keywords: gentrification, environmental stressor, mental health, depression, weathering hypothesis

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1 Introduction

The literature has highlighted the impact of a rapidly changing environment on general health, including mental health. Having poor mental health can be life-threatening, and problems tied to it are prevalent in communities across the United States (US). The Centers for Disease Control and Prevention (CDC) estimates that more than 50 percent of Americans are diagnosed with a mental illness or disorder at some point in their lifetime [1]. Based on empirical research, CDC rated mental health illness (MHI) such as depression, the third most common cause of hospitalization in the US among adults aged 18–44 years old, and adults living with serious mental illness die on average 25 years earlier compared to those without MHI [1]. Depression is defined by its symptoms: depressed mood (feeling blue), feelings of helplessness and hopelessness, feelings of guilt, worthlessness, loss of appetite, loss of sleep, and psychomotor retardation [2–4]. Some of the risk factors include female sex, divorced or separated living situation, low socioeconomic status, poor social support, recent adverse and unexpected life events (e.g., death, homelessness, or eviction), severe medical illness with functional impairment, and chronic diseases. Moreover, accumulating evidence suggests significant links between neighborhood stressors and mental illness symptoms such as anxiety and depression but with mixed results [4–12]. This present study examines the report of mental health among residents in gentrifying neighborhoods identified by existing studies [13,14] to add to the existing literature on the impacts of gentrification on health.

Gentrification, broadly defined, is a process that reverses the decline and disinvestment in the inner-city and the return of capital into neighborhoods leading to sociospatial rearrangement of the inner-city landscapes [15–17]. The definition of gentrification adopted in this study aligns with those that have been used widely by scholars, which is the movement of the higher-income population into lower-income neighborhoods, thus increasing property values, tax, and rents leading to the voluntary and involuntary displacement of longtime res-

idents (LTRs) [18–24]. Scholars like Neil Smith described gentrification as “a systematic, comprehensive policy for city building,” which connotes inequality in many research arena [25]. On the other hand, urban gentrification advocates argue that gentrification increases housing stock, restoration of neighborhood quality, dissolution of poverty rate, new businesses and investors’ attraction, and tax revenues for municipal government. Conversely, gentrification is associated with the physical and cultural displacement of vulnerable residents, including the elderly and lower-income groups, leading to or intensifying homelessness, landlord harassment, chronic health conditions, and psychological distress [20,26].

The rest of the paper examines a brief history of urban renewal in Austin, followed by the conceptualization of health in the gentrifying neighborhood. The ‘Data and methods’ section presents the data source analyzed, and the findings are presented in the ‘Results’ section. The penultimate and the ultimate sections discussed the findings and concluded with a summary of the findings.

2 Background

2.1 A brief examination of urban renewal in Austin

East Austin, Texas, is a minority neighborhood that originally housed African American and Hispanic communities following the 1928 zoning policy. Due to the institutionalized segregation, the black and Hispanic neighborhoods, for long, were neglected and less developed, which led to urban decay or blight [27,28]. Following World War II, African Americans were pushed out of suburbs by racial covenants and redlining “as the federal government subsidized white out-migration to racially exclusive suburbs,” notably in 1949 [29]. In 1954, the Austin City Council started exploring urban renewal by creating the Greater East Austin Development Committee (GEADC). Initially, the idea was to study the needs of the East Austin community and the housing conditions in an area defined by East 19th Street (Martin Luther King Boulevard), Airport Boulevard, Springdale Road, the Colorado River (Lady Bird Lake), and East Avenue/I-35 (Figure 1). The GEADC birthed the Urban Renewal Program’s idea, whose primary aim was to improve the built environment (BE) in general [30]. As a result, Austin Urban Renewal Department (AURD) was created. Urban renewal projects dramatically altered the Eastside landscape during the 1960s. For a neighborhood to be qualified for renewal, the

AURD had to declare half of the structures as “dilapidated beyond a reasonable rehabilitation” [28,31]. After facing financial constraints to accomplish some of the projects in 1977, the agency’s central function was narrowed to housing rehabilitation for low-income residents through grants and loans on a case by case basis, according to the available information.

Fast forward to 1996, the Austin Revitalization Authority (ARA) initiated the Central East Austin Master Plan (CEAMP) targeted at redeveloping the 11th and 12th Street Corridors (henceforth, project area). The project area comprises neighborhoods with buildings classified as blighting structural conditions, vacant land, and tax delinquency (Appendix Figures 1 and 2). Alongside, a Community Redevelopment Plan (CRP) for the target project area was commissioned. The city of Austin then passed a resolution in support of the CEAMP project. Thus, the target area was declared urban renewal areas, and the CRP was translated into the East 11th and 12th Streets Urban Renewal Plan (URP). Through CEAMP, detailed land use and zoning studies were recommended for other areas outside the project area. The CEAMP provided a framework for developing the Central East Austin Neighborhood Plan (CEANP) later on. The CEANP, as presented in Table 1, aimed to create an environment that is supposed to protect the opportunities and assets for the benefit of all residents, including the traditional and recent residents of these neighborhoods [31]. However, things did not go as expected, the traditional residents, instead of reaping the improved neighborhoods’ outcome, are being uprooted [13,32], and many were displaced due to increased property tax and rent [33,34]. The project area’s discussion is meaningful because it is pivotal for East and Southeast Austin’s gentrification process. According to the key informant interview (KII) we conducted, we learned that the project area contributed to today’s gentrification in East and Southeast Austin. In the word of the community leader, “gentrification spread like wildfire from Central Austin” (McCarver February 25, 2020; personal communication).

2.2 Poverty, blight, and urban renewal

Urban decay in the Eastside of Austin could be traced to the endemic poverty situation in the area compared to the rest of the city. The poverty rate in the region increased from 37.5% in 1970 to 52% in 1990 [28]. Following the implementation of urban renewal programs that targeted East Austin’s core—Central East Austin in Figure 1, the demographic landscape shifted considerably. Between

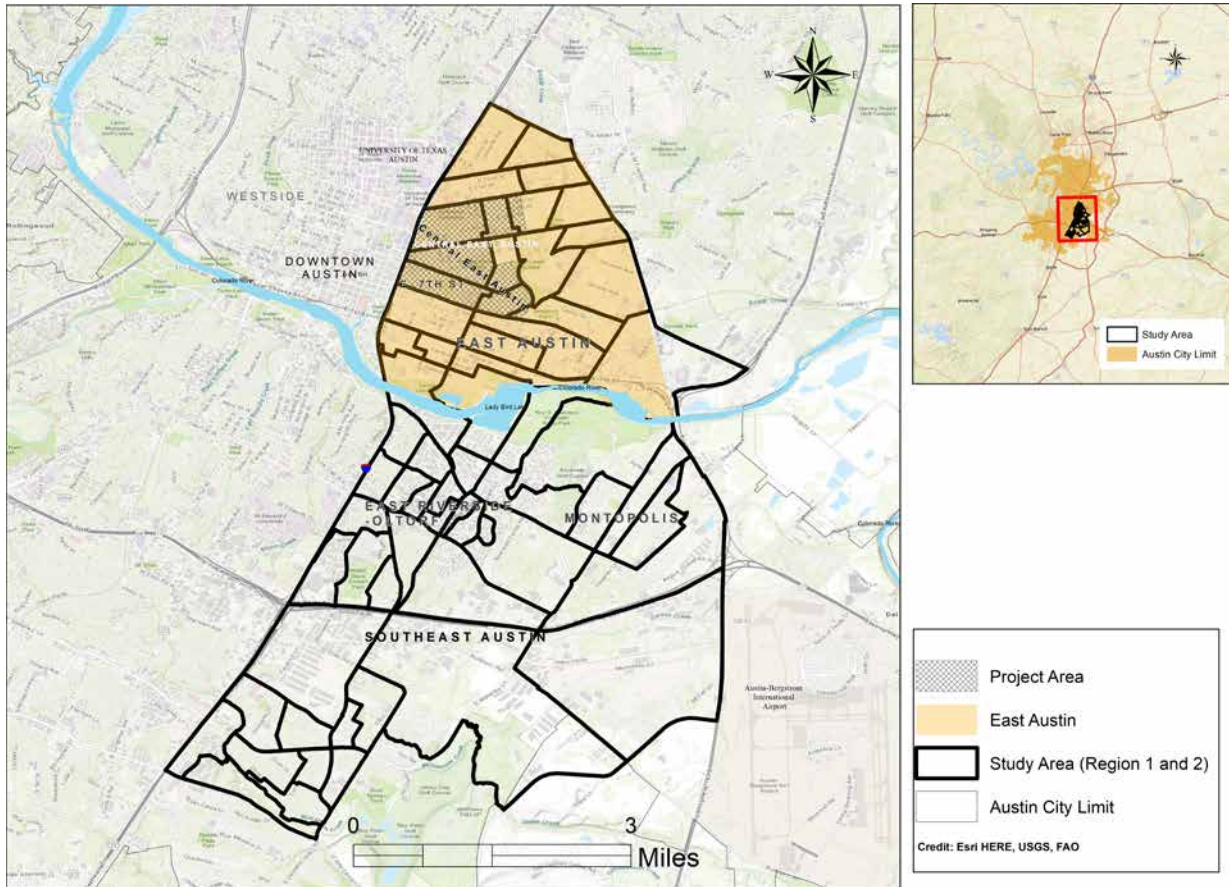


Figure 1: Map showing the project area, study area covering East/Southeast Austin, and an inset map showing Austin city limit.

1970 and 1978, a particular neighborhood (Census Tract 8), which housed 97% minority, had lost 1,976 residents and 446 families, representing a 14.8% decline for both categories [31]. Figure 2 shows the demographic change in Austin between 1990 and 2018. It is evident that the percent black population declined drastically between 1990 and 2010 and peaked slightly in 2018 by less than half percent (0.4%). Notably, in 2010, Austin attained a majority-minority status.

Combined with the historic preservation, which started in 2004, the improvements to infrastructure and streetscape on East 11th Street and the construction of community parking lots in the target project area have accelerated housing and demographic shifts. These shifts were evident in the targeted project areas and diffused to the adjoining communities in East Austin and Southeast Austin neighborhoods like Riverside and Montopolis [13,35]. Population decline, then a resurgence of largely white, higher-income residents as the urban renewal policies improved physical conditions of East/Southeast Austin. This transition pushed out many longtime residents, and those who remain are struggling financially, and as this study shows, with their mental health as well.

In recent times, the physical and demographic change in East Austin neighborhoods has precipitated public outcries and violent protests by anti-gentrification groups [36–39].

Previous studies that interviewed “those who left” [33] and “those who stayed” [34] showed that increased tax forced longtime residents out of their long-lived

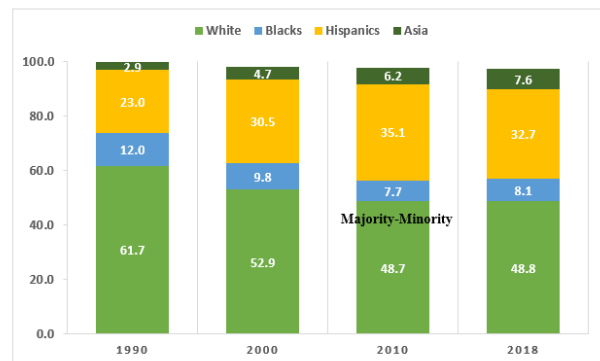


Figure 2: Percent change in racial/ethnic composition in Austin (Data Source: US Census Bureau, Decennial Census Total Population, 2018 American Community Survey Population Estimate).

Table 1: Central East Austin Neighborhood Plan Goals, 1999

s/n	Proposed neighborhood plan
1	Preserve, restore, and recognize historic resources and other unique neighborhood features.
2	Create housing that is affordable, accessible, and attractive to a diverse range of people.
3	Promote new development for a mix of uses that respects and enhances the residential neighborhoods of Central East Austin.
4	Promote opportunities to leverage positive impacts and encourage compatibility from civic investments.
5	Create a safe and attractive neighborhood where daily needs can be met by walking, cycling, or transit.
6	Improve bicycle, pedestrian, and transit access within Central East Austin and to the rest of Austin.
7	Respect the historical, ethnic, and cultural character of the neighborhoods of Central East Austin.
8	Enhance and enliven the streetscape.
9	Ensure compatibility and encourage a complementary relationship between adjacent land uses.

Note: Adapted from the CEANP report, December 2001

community to neighboring towns (e.g., Manor, Pflugerville) and currently threatens the stayers who are mostly low-income earners, widow/widowers, elderly, and low-income earners. However, how the process of urban renewal affects residents' health in this locale has been overlooked. Consequently, this study applied weathering hypothesis [40,41] to examine the impact of urban renewal programs that had generated several debates on gentrification in East Austin, Texas, to assess residents' health impact. This study is essential for two reasons: first, for intervention policies, and second, to respond to the need for continued research on the impact of urban renewal and development policies on health [40].

2.3 Conceptualizing health in the changing environment

Gentrification, deprivation, segregation, and low socioeconomic position are known sources of environmental stressors [42,43]. In health inequality research, material deprivation and psychosocial mechanisms are used to explain this phenomenon. From the material deprivation viewpoint, scholars have argued that an individual's health tends to worsen in the absence of family and community resources (such as access to income, housing, or affordable health care) in addition to structural inequality [44]. On the other hand, psychosocial interpretation of health inequalities "ascribes the existence of health inequalities to the direct or indirect effects of stress stemming from either being lower on the socioeconomic hierarchy or living under conditions of relative socioeconomic disadvantage." [45] The socioeconomic disparity has been argued to be a significant source of stress and a risk factor

for health. Similarly, the erosion of social cohesion and social capital has been cited as an additional mechanism underlying the relation between socioeconomic disparity and health outcomes. The following paragraph examined the weathering hypothesis and life course perspective to explain the link between gentrification and health outcomes in rapidly changing environments in East and Southeast Austin, Texas.

The weathering thesis posits that repeated exposure to stressor without any intervention—medical or non-medical—deteriorates health [40,46]. Weathering hypothesis was interpreted as the cumulative impact of exposure to, and high-effort coping with, subjective and objective stressors, that is, with psychosocial, economic, and environmental stress [44]. The concept has been applied in urban research, particularly in urban housing and displacement [41,44,47]. Physiologically, environmental stress can trigger stress hormones [48]—cortisol, epinephrine, and norepinephrine—which can damage blood vessels and arteries, leading to elevated blood pressure (BP). Abnormal BP increases the risk of heart attacks, stroke, and sudden death [49,50], while excess cortisol increases obesity, hypertension, and hyperglycemia. Accumulating evidence suggests significant links between neighborhood stressors and mental illness symptoms such as anxiety and depression [4–12]. What is more is that the intensity of exposure, proximity to exposure, duration of exposure, and frequency of stressors determine the severity of health outcomes. It has been documented that the duration of exposure to these environmental stressors increases the risk for chronic health conditions, namely cardiovascular disease, asthma, metabolic disorder, cancer, depression, extreme mood change, and isolation [4,51]. During the long weathering process,

the body is automatically prepared for pre-disease states [52–55]. Dysregulation in metabolism, mental functioning, autoimmune response, and the cardiopulmonary system can secondarily cause anxiety, change in body mass index, and bodily accumulated fat or visceral fat [53,56].

Curry, Latkin, and Davey-Rothwell [7], in their study in Maryland, US, employed pathway analysis to investigate the impact of neighborhood effect on residents' psychological distress. The study by Tran et al. [57] in California indicated that living in a gentrified and upscaled neighborhood was associated with an increased likelihood of severe psychological distress relative to living in a low-income and not gentrified neighborhood. Venzala et al. [4] found that environmental chronic mild stress (CMS) induced depressive-like profiles, including anhedonia, helplessness, and memory impairment. In their study, Conway, Rutter, and Brown [6] showed that environmental stressors were associated with depression and panic disorder. In a case-control study, Brummett et al. [5] examined the link between environmental stress and symptoms of depression among the stressor group and the non-stressor group. The study found that environmental stress was significantly associated with depression scores among the stressor group for both female and male participants than the non-stressor groups. However, there remain many opportunities for more studies to disentangle the mixed results available on the impact of gentrification and health [58,59].

In the social science research literature, several studies have also applied life course perspective to understand stress, mental health, social relationships (e.g., social capital, social cohesion, social networking), and chronic health conditions [57,60–65]. Life course effect refers to how health status at any given age reflects the current condition and the “embodiment of prior living circumstances,” including previous neighborhood [45]. According to Kawachi, Subramanian, Almeida-Filho [45], the life course perspective has three dimensions: latent, pathway, and cumulative effects. The *latent effect* is when the early-life environment (e.g., born and raised in the social and economically deprived environment) affects adult health regardless of intervening experience; *pathway effect* occurs when the early life environment sets individuals onto life trajectories (such as exposure to traumatic situations) that, in turn, affect health status over time. Lastly, the *cumulative effect* is related to the intensity and duration of exposure to unfavorable environments that adversely affect health status, according to a dose-response. Tran et al. [57] used respondent age, marital status, and parental status as proxies for life cycle status to study gentrification and mental health illness in

California. Furthermore, extant literature suggests that the health of people who witnessed chronic stress earlier in childhood is worse compared to those who were exposed to stress later in life [3,56,66].

Scholars including Anguelovski et al. [67]; Gibbons and Barton [68]; Dragan, Ellen, and Glied [69]; and Izenberg, Mujahid, and Yen [70] have investigated the link between gentrification and health in the US. However, these studies have shown mixed results. For example, Izenberg and colleagues [70] in California, after adjusting for covariates in their model, found that individuals living in gentrifying neighborhoods did not have significantly poor/fair self-rated health (SRH) compared to those not living in a gentrifying neighborhood. However, they reported that living in a non-gentrifiable neighborhood was associated with reduced odds of fair or poor SRH. The study also found higher odds of poor health among blacks, an association not found among other racial/ethnic groups, which is in line with other findings [71].

Earlier, Gibbons, Barton, and Brault's [71] study indicated that residents of neighborhoods experiencing gentrification reported overall better physical health outcomes than those living in neighborhoods that had not experienced gentrification, irrespective of the stage of gentrification. Studies that investigated children's health in New York showed that the experience of gentrification has no effects on children's diagnoses of asthma or obesity when children are assessed at ages 9–11, but that it was associated with moderate increases in diagnoses of anxiety or depression [69]. A study that focused on the older population based on validated questionnaires indicated that older adults in gentrifying neighborhoods are more likely to experience symptoms of anxiety and depression [10,11]. The study also reported that the symptoms tend to decrease over time in neighborhoods experiencing increases in social cohesion and increased for adults experiencing adverse neighborhood changes. Despite the growing evidence between changing environment and health, limited research exists on whether the perception of gentrification has a direct or indirect relationship with mental health conditions (e.g., depression) using a complex model. Hence, we tested three research hypotheses visualized in Figure 3.

Hypothesis:

1. Residents' perceived gentrification and sociodemographic characteristics are significant predictors of stress and mental health symptoms.
2. Historical childhood health is associated with self-rated mental health, stress, and depression.

- Neighborhood resources such as access to socio-economic support, attraction, interaction, and cohesion are associated with self-rated health, stress, and depression.

3 Data and methods

3.1 Study area

This study focused on residents living in gentrifying neighborhoods in East and Southeast Austin, Texas. Six zip codes fall within the areas delineated for this study. Based on the American Community Survey data between 2009 and 2017, most of the neighborhoods in the Eastside of Austin have gentrified while Southeast Austin is rapidly gentrifying. Our survey design delineated Austin's city into four regions, regions 1 and 2 in East Austin and Southeast Austin, formed the study area (Figure 1). A quantitative structured questionnaire was then used to collect data in June 2020 through the Facebook campaign tool. Out of the 1,338 survey link clicks, only 331 respondents finally took the survey, which formed our sample size. To ensure that the sample size is well-represented of the underlying population characterized by race, we computed the population's sampling weight (Appendix Table 1). Another weight was also computed to adjust for the differences in the gender subgroups.

3.2 Measure

We used both validated and self-developed questionnaires in this study. Questions related to mental health, self-rated health, and stress were based on validated questionnaires. On the other hand, we developed our questionnaires on the residents' perception of neighborhood change to determine the index of gentrification and access to socio-economic support in this study.

3.2.1 Measured depression and stress

Seven items designed to measure depression symptoms from the standardized scale for measuring the emotional state of Depression, Anxiety, and Stress Scale (DASS-21) were adapted in this study. The outcome variable was depression measured by the depression scale and assessed dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia, and inertia. The stress scale assessed difficulty relaxing, nervous arousal, and being easily upset/agitated, irritable/over-reactive, and impatient, triggered by biosocial factors. Scores for depression and stress were calculated by summing the scores for the relevant items [72]. The derived scores were then multiplied by 2 to obtain the final score. Scores for depression and stress were calculated by summing the scores for the relevant items [72].

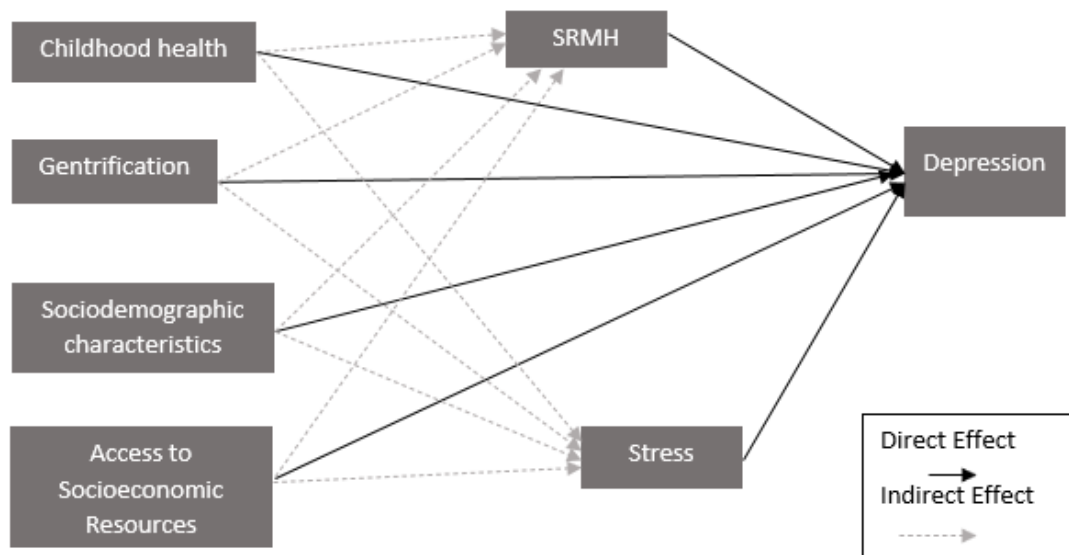


Figure 3: Hypothetical pathways to depression. Note: SRMH is self-rated mental health; the ASR index is the access to socioeconomic resources. Sociodemographic characteristics include neighborhood attachment, interaction, cohesion, duration of residence, age, education, and household status.

3.2.2 Self-rated health

Each respondent was asked to rate his/her health on a 10-point Visually Analog Scale (VAS): “On a scale of 1–10, ‘1’ being the lowest and ‘10’ being the highest, rate your overall health, physical health, mental health, health while growing up and parents; health while growing up.” Following Tran et al. [57] approach, we used the last two questions as proxies for historical health on respondents’ current health and as life cycle status.

3.2.3 Perception of gentrification

The perception of gentrification score (PGS) was developed based on some known impacts of urban renewal on property and residents. It has been documented that gentrification is likely to lead to the physical, cultural, and economic overturn, leading to increasing rent, property tax, homelessness, residential displacement, and possibly increase spending on groceries and utility bills [26]. The response to each of the five items was assessed based on the 5-Point Likert Scale (Extremely unlikely to Extremely likely). The five items were aggregated to form a gentrification index with a moderate Cronbach’s alpha of 0.678. Our PGS is similar to the Neighborhood and Gentrification Scale recently developed by DeVlyder et al. [73].

3.2.4 Measure of neighborhood tie and social cohesion

This study adopted Buckner’s [74] Neighborhood Cohesion Instrument (NCI) to measure neighborhood ties and social cohesion. The NCI has three dimensions: attraction to the neighborhood, neighboring/interaction, and psychological sense of community (PSC). Each of the dimensions has 10, 15, and 15 items in the original instrument, respectively. Attraction to the neighborhood is defined as the eagerness to remain a resident in the neighborhood, and it can be used to assess residents’ attachment to a particular neighborhood. Neighboring, instead, measures the degree of interaction within the neighborhood. The third-dimension measures shared emotional connection that people may experience toward others in their community. These three dimensions of NCI can be used to weather the effects of gentrification among longtime residents. In this study, high scores were an indication that individuals had a strong sense of cohesion.

3.2.5 Access to socioeconomic support

We constructed access to socioeconomic resources (ASR) indicator from a set of eight items related to social and financial access. The items assessed individuals’ access to healthy food, health care services, employment, housing, child/adult school enrollment, mortgage/financing with a low rate, car financing/loan, and a bank loan at a low rate. The responses were coded on a 5-Point Likert Scale: 1 = Extremely difficult and 5 = Extremely easy and summed up to develop the ASR index. Before constructing the index, we tested for internal consistency and reliability for the eight items, which yielded an acceptable Cronbach’s alpha of 0.866.

3.2.6 Covariates of health outcomes

Other continuous variables included in the study are the respondents’ age, the number of years spent in school, the number of people residing in the household, and the duration of residence in a neighborhood. These are essential factors to be considered because they may be directly or indirectly contributing to mental health outcomes and stress.

3.3 Analytical procedure

The data were interpreted based on univariate descriptive, bivariate correlation, and multiple regression analyses. We employed a t-test to determine the difference between regions 1 (East Austin) and region 2 (Southeast). Based on logic and prior empirical evidence, we developed the causal model to assess the pathway to depression. We used the univariate and multivariate analyses to examine the linearity and normality of all the variables. Hence, a structural equation model was developed in JMP® v15 to examine the complex factors for predicting depression among residents in gentrifying neighborhoods. The best model or model goodness-of-fit index (GFI) was determined based on some standard parameters such as the low value of Root Mean Square Error of approximation (RMSEA), the highest comparative fit index (CFI > 0.95), and the lowest value of corrected Akaike Information Criteria (AICc) in cases of multiple models [75,76]. The model’s CFI value closed to the perfect model (CFI = 1) was finally selected. Besides, the Macro Process was used to test variable interactions and determine the direct and indirect effects of predictors on depression, as recommended by a recent study on gentrification and health [58]. Lastly, we

computed the 95% confidence interval (CI) and standard error (se) of the effect based on a non-parametric 5000 bootstrapped estimation [77,78].

4 Results

4.1 Descriptive results

Table 2 presents the descriptive and bivariate correlation analyses in the study area. The average age of the respondents was 49 years. The mean scores of gentrification, depression, measured stress, and self-rated mental health were 2.98, 23.95, and 29.5, and 7.5, respectively. More women than men participated in the study ($n = 222$, 69.8%). Overall, a larger proportion of the respondents were married 146 (45.5%), 74 (23.1%) were identified as being widowed/divorced/separated, and 101 (31.5%) of the sample were not married or single. More than half of the respondents self-identified as white ($n = 181$, 56.7%), few were black ($n = 23$, 7.2%), 59 (18.5%) were Hispanics/Latino, 46 (14.4%) were Asian, and only ten (3.1%) were identified as other race/ethnicity. About one-third (36%) had lived in the study area for more than ten years, and 264 (91%) were aware of neighborhood change (gentrification). The majority of the respondents (73.2%) did not plan to move out of their neighborhood anytime soon, 20% were not sure, and only 7% declared they wanted to move. Among those who said they were aware of the changing neighborhood, 40.3% said that change in their neighborhood threatens them.

Gentrification score was positively associated with depression score, stress score, and neighborhood attraction but was negatively associated with self-rated mental health, socioeconomic support, and childhood health (Table 2). The correlation supports the first hypothesis of an association between gentrification and the three health outcomes—depression score, stress score, and self-rated mental health.

4.1.1 Variation by region

Table 2 also shows that the study area differs by region. For example, respondents from East Austin were younger compared to respondents from Southeast Austin. The ground score of depression was 24 points and did not vary by region—East Austin and Southeast Austin. Gentrification scores vary between the two regions ($p < 0.05$), and

the mean score was higher in Southeast Austin. The stress score did not vary between the two regions, and the total mean score was 29.5 points but slightly higher in Southeast Austin. East Austin had a higher mean score of access to socio-economic resources than Southeast Austin. The mean score of neighborhood cohesion, attraction, and interaction was lower in Southeast Austin than in East Austin.

Table 2 further presents the correlation between depression and other independent variables. All variables but cohesion and attraction were significantly associated with depression. Meanwhile, in East Austin, three variables were not significantly associated with depression, while four variables were not statistically associated with depression in Southeast Austin. This indicates that factors contributing to depression in the two regions vary. However, perception of gentrification was positively and significantly associated with depression in the total sample ($r = 0.33$, $p < 0.001$), in East Austin ($r = 0.30$, $p < 0.001$), and Southeast Austin ($r = 0.35$, $p < 0.001$). The last column in Table 2 shows the result of the *t*-test, which indicates the significant variation by region for the perception of gentrification, stress, interaction, attraction, childhood health, and self-rated mental health.

4.1.2 Difference between longtime and recent residents

Based on analysis of variance, Table 3 indicates that the mean scores of perceived gentrification, depression, and stress were not statistically and significantly different between longtime and recent residents but stress scores vary significantly. Longtime residents are more likely to feel stressed ($MD = 2.52$, $p = 0.047$) compared to recent residents.

4.2 Multivariate regression analysis

Perceived gentrification score was positively related to depression in a simple bivariate linear regression ($B = 0.453$, $p < 0.01$, 95% CI 0.168–0.738) in model 1 (Table 4); however, its association disappeared in the multiple linear regression in model 2. Only ASR, neighboring, SRMH, and measured stress were significantly associated with depression (Table 4). However, because there are complex pathways to health outcomes such as depression, we examined all the 12 variables specified to predict the end-point outcome (i.e., depression) in the SEM.

Table 2: Mean scores, correlation, and t-test results for depression and predictors by region

	Total Mean (r)	East Austin Mean (r)	Southeast Austin Mean (r)	T-test ^a (sig.)
Depression	23.95	23.22	24.71	ns
Gentrification (PGS)	2.98 (0.329***)	2.86 (0.300***)	3.10 (0.353***)	*
Stress	29.5 (0.523***)	29.43 (0.517***)	30.05 (0.530***)	ns
Cohesion	20.92 (-0.068)	21.36 (-0.023)	20.43 (-0.133)	ns
Interaction	16.71 (-0.148*)	17.27 (-0.236***)	16.05 (-0.003)	**
Attraction	15.20 (-0.104)	16.01 (0.033)	13.96 (-0.257***)	***
Socioeconomic resources (ASR)	26.75 (-0.313***)	28.67 (-0.225***)	25.21 (-0.406***)	***
Age (years)	48.8 (-0.201***)	46 (-0.189*)	48.61 (-0.228*)	ns
Duration of residence	11.59 (-0.137*)	11.19 (0.183)	10.06 (-0.171)	ns
Childhood health	6.46 (-0.278**)	8.72 (-0.318**)	8.19 (-0.219*)	*
Self-rated mental health	7.5 (-0.723**)	7.70 (-0.685**)	7.24 (-0.765)	*

*** p < 0.001; ** p < 0.01; * p < 0.05; ns is not significant

Values in the () is the correlation coefficient of association between depression and other factors

^a Equal variance not assumed

Table 3: Mean difference of gentrification, stress, depression, mental health by residence status

	t-test ^a	df	MD	Std. Error (MD)	95% CI (MD)	
					Lower	Upper
Gentrification	-1.539	283	-0.154	0.100	-0.350	0.043
Stress Score	1.993*	258	2.515	1.262	0.030	4.999
Depression Score	1.000	247	1.371	1.371	-1.329	4.072
SRMH	-0.188	264	-0.043	0.231	-0.498	0.411

* p < 0.05; MD mean difference between the longtime and new residents. CI (MD) is the confidence interval for the mean difference. Note: residence status was coded as longtime residents (1) and recent residents (0).

^a Equal variance assumed

4.2.1 Pathway model of mental health

The causal model was tested in the JMP Pro program using a maximum likelihood (ML) structural equation model. Note that the RMSEA statistic measures the average remaining error per individual in the data where a good fit model is indicated by smaller RMSEA values, while the CFI compares the poorest model with the hypothesized model and assesses fit. RMSEA values < 0.05 and CFI values of at least 0.95 indicate a good model fit. Table 5 presents the parameters used in selecting the best model. Model 1 was a better choice compared to others in the table because of the low RMSEA (0.049) and comparative fit index (CFI = 0.953), revised goodness-of-fit (RGFI =

0.981), Tucker-Lewis index (TLI = 0.930), and the adjusted revised GFI (AGFI = 0.962). It is important to mention that the structural model produced seven endogenous¹ variables with associated R²: Depression (R² = 44.77%), SRMH (R² = 21.147%), stress (R² = 17.04%), childhood health (R² = 1.80%), PGS (R² = 23.19%), cohesion (R² = 1.54%), and ASR (R² = 4.96%). Note that depression is the end-point variable in the SEM model.

Figure 4 shows the pathway of the predictors of depression. As seen in Table 5, stress and self-rated mental

¹ Endogenous variables are variables in a statistical model that are determined by their relationships with other variables within the model. They are synonymous with a dependent variable.

Table 4: Multivariate linear regression for depression

			t	Sig.	95% CI		
Model 1	B	Std. Error			Lower Bound	Upper Bound	VIF
(Constant)	15.309	2.318	6.603	0.000	10.742	19.875	
gentrification	0.453	0.145	3.131	0.002	0.168	0.738	1
Model 2							
(Constant)	33.805	5.406	6.253	0.000	23.155	44.456	
gentrification	0.11	0.117	0.941	0.348	-0.121	0.341	1.375
Duration	-0.044	0.034	-1.271	0.205	-0.112	0.024	1.863
Age	-0.022	0.043	-0.5	0.618	-0.107	0.064	1.767
YrSCHL	-0.127	0.096	-1.324	0.187	-0.316	0.062	1.137
ASR	0.125	0.059	2.124	0.035	0.009	0.241	1.523
Stress	0.434	0.082	5.282	0.000	0.272	0.595	1.811
Cohesion	-0.65	0.462	-1.405	0.161	-1.56	0.261	1.231
Attraction	-0.527	0.454	-1.16	0.247	-1.422	0.368	1.152
Neighboring	-0.91	0.429	-2.124	0.035	-1.755	-0.066	1.062
Household member	0.139	0.305	0.456	0.649	-0.462	0.74	1.212
SRMH	-2.721	0.332	-8.205	0.000	-3.375	-2.068	1.838
Childhood Health	-0.189	0.283	-0.667	0.505	-0.746	0.369	1.429

SRMH self-rated mental health; ASR access to socioeconomic resources; YrSCH number of years in school.

health (SRMH) are directly linked to depression. Contrary to the hypothesized association, the perceived gentrification score, ASR, neighborhood cohesion, attraction, and neighborhood interaction had no direct association with depression (Table 6). Five variables, including the perception of gentrification, a total year spent in school (TrSCHL), historical childhood health, age, and ASR, were directly linked to self-rated mental health and stress scores. Attraction and ASR were significantly associated with gentrification, while total years spent in school, neighborhood attraction, and interaction were associated with ASR in the causal model. Age was a significant determinant of neighborhood cohesion (Table 6).

Further, the interactions between gentrification, stress, and SRMH were tested in Macro Process [77,78]. The interaction between gentrification and stress was not significant, but the interaction between SRMH and gentrification was significant ($p = 0.008$). The total effect explained by the model was 0.472. The distribution of the effect indirectly via stress was 0.133 (Bootstrap se = 0.45, 95% CI 0.05–0.23); via SRMH was 0.237 (Bootstrap se = 0.077; 95% CI 0.101–0.401); and through stress and SRMH was 0.101 (Bootstrap se = 0.031; 95% CI 0.046–0.168). In addition, the indirect effect of gentrification via child-

hood health on adulthood depression was 41% (IE = 0.410, Bootstrap se = 0.022, 95 CI 0.046–0.911).

5 Discussion

This study examined the direct and indirect pathways to depression in a sample of two communities undergoing gentrification in Austin, Texas. The theoretical formulation developed in this study revealed a causal association of depression. Two theoretical perceptions guided this study—weathering hypothesis and life course perspective. Based on all the parameters used to measure the model's goodness-of-fit, all the variables included in the model specified a correct model. Hence, the findings of the specific relationships uncovered in the study warrant discussion.

The bivariate analysis showed that perceived gentrification (or neighborhood change) was positively and significantly associated with depression before introducing the causal analysis. This, in part, confirms the first hypothesis and is supported by the work of Tran et al. [57] in California; living in gentrified neighborhoods was significantly associated with an increased likelihood of severe psychologi-

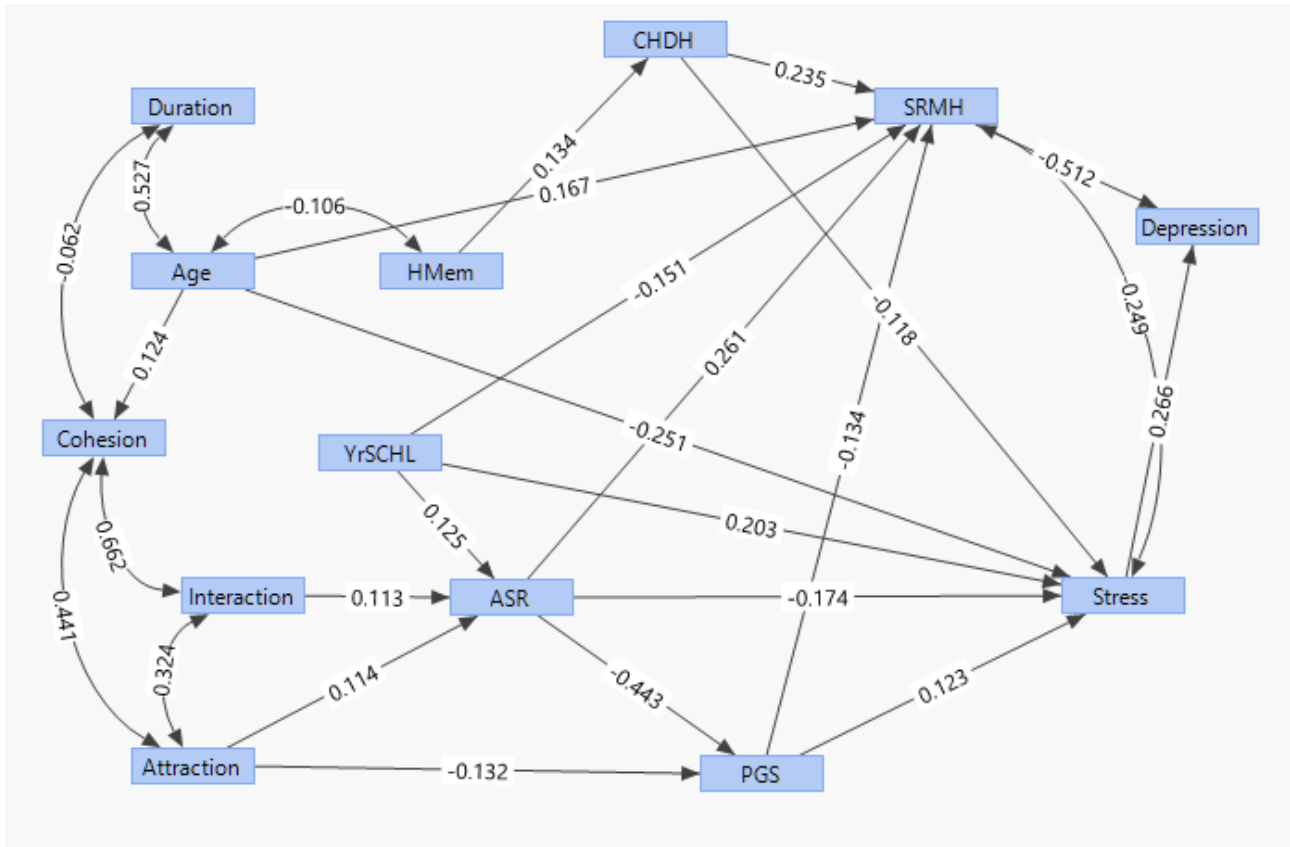


Figure 4: Final model and structural pathways to depression through self-rated mental health and stress. Note that the standardized coefficients are presented in the figure. Legend: PGS perceived gentrification score, ASR access to socioeconomic resources, CHDH self-rated childhood health, YrSCHL total number of years in school, HMem number of household members, and duration is years of residence in a neighborhood.

cal distress among adult residents. Here, the positive association indicates that as the perception of gentrification increases, the report of depression increases. However, the relationship disappeared when measured stress and self-rated mental health were introduced in the model, suggesting a spurious relationship between gentrification and depression. This study showed that the relationship between gentrification and health outcomes depends on the context in which the relationship is being studied. As shown in this study, gentrification was directly associated with health outcomes in a simple model, whereas its effect disappeared in a complex model.

Our study uncovered several other relationships in the pathway/structural model. We found a direct relationship between perceived gentrification, historical perception of childhood health, age, access to social and economic supports, the number of years spent in school, and measured stress as an endogenous variable. The result on gentrification and stress indicated that as residents perceived physical and sociodemographic shifts in their neighborhoods, their stress level significantly increased and aligned with other studies [10,12,79]. The hypothesis based on the

direct association between gentrification and depression was not supported. The failure to find a direct effect of perceived gentrification on adulthood depression may arise due to the more comprehensive modeling of predictors in the current study. We also found support for the second hypothesis; perceived gentrification was associated with access to socioeconomic resources. Judging from the dimension of the relationship between gentrification and ASR, it can be inferred that increasing access to social and economic resources could reduce the negative perception of gentrification. Community resources—in various forms such as social capital, health care resources, and healthy food—is an ideal that has been promoted in several other research that examined the impact of the changing neighborhood on health [58,80–82]. However, the perception of the changing neighborhood on health could also be interpreted that residents may perceive those changes as beneficial even in changing neighborhoods. Consequently, residents’ gentrification ratings as a negative outcome of an urban renewal policy may be influenced due to access to social and economic resources. However, this assumption

Table 5: Structural equation model diagnostic indices for the best model selection

Parameter	Model 1 ^a	Model 2	Model 3	Model 4
	Index	Index	Index	Index
-2 Log Likelihood	26,225.522	26,229.097	26,220.902	26,220.899
AICc	26,349.349	26,350.108	26,359.122	26,365.024
BIC	26,527.232	26,525.005	26,551.623	26,563.223
ChiSquare	94.022	97.597	89.402	89.399
DF	52.000	53.000	47.000	45.000
Prob>ChiSq	0.000	0.000	0.000	0.000
CFI	0.953	0.950	0.953	0.950
TLI	0.930	0.927	0.921	0.914
NFI	0.903	0.900	0.908	0.908
Revised GFI	0.981	0.980	0.981	0.980
Revised AGFI	0.962	0.960	0.957	0.953
RMSEA	0.049	0.050	0.052	0.055
Lower 90%	0.033	0.034	0.035	0.038
Upper 90%	0.065	0.066	0.069	0.071
RMR	3.818	3.988	2.028	2.028
SRMR	0.058	0.059	0.053	0.053

^a Preferred model

may not be the same for those who bear the brunt of the changing environment's effect.

As expected, residents who reported better childhood health significantly had a lower score of measured stress in adulthood (H2), supporting the life course effect on chronic health [60,63]. This study found that adulthood stress tended to decrease by a factor of 0.56, in line with other studies that found significant associations between childhood health and adverse health outcomes in adulthood [45,66,83–85]. Hence, this study contributes to research that has documented the accumulated effect of adverse childhood experiences on adulthood health. On the other hand, the number of years spent in school increased stress by a factor of 0.45. This means that advanced degrees contribute to increased stress. Likewise, this study also found that the level of stress tends to reduce with increasing age. The plausible explanation for this observed relationship is that stress coping skills among the study population increase with age, probably due to past life experiences, and conformed with previous findings [86,87].

In support of the third hypothesis (H3), improved access to social and economic supports significantly reduced stress as a risk factor for depression. Studies had indicated that social supports buffer all kinds of

stress toward improving health and well-being [88–91]. Following a recent systemic review of the impacts of gentrification on health [58], we found the mediating effect of access to socioeconomic resources in the association between gentrification and health. In the context of this study findings, access to socioeconomic support for residents in the gentrifying neighborhoods will, to a greater extent, reduce stress, which, in turn, will reduce depression. This finding reiterates the need to continuously provide welfare support to longtime residents who are most affected by gentrification. The most viable support would be in the form of reduced property tax for longtime homeowners who are probably retired, unemployed, disabled, or with limited income to cope with the rapidly changing environment. It has also been recommended for renters that rent-ceiling is a viable strategy for low-income earners in gentrifying neighborhoods.

Like the factors related to stress as a risk factor for depression, those factors were also directly associated with self-rated mental health but with a different dimension of association. Gentrification was inversely associated with self-rated health, meaning that as perceive gentrification increased, self-rated mental health decreased. Participants might perceive gentrification as a malicious process posing stress to them through several outcomes

Table 6: Regression coefficients of the determinant of depression and other exogenous variables

Regressions		Estimate (β)	Std. Error	Wald Z	Prob.> Z
Depression	←SRMH	-2.599***	0.227	-11.452	<.0001
	←Stress	0.281***	0.048	5.897	<.0001
SRMH	←YrSCHL	-0.069**	0.022	-3.071	0.002
	←Childhood	0.234***	0.049	4.742	<.0001
	←PGS	-0.063*	0.026	-2.423	0.015
	←Age	0.022**	0.007	3.381	0.001
	←ASR	0.071***	0.015	4.694	<.0001
	←Stress	0.279*	0.129	2.160	0.031
Stress	←Childhood	-0.564*	0.243	-2.317	0.021
	←YrSCHL	0.445***	0.111	4.014	<.0001
	←ASR	-0.228**	0.075	-3.042	0.002
	←Age	-0.159***	0.032	-4.951	<.0001
PGS	←Attraction	-0.042**	0.015	-2.717	0.007
	←ASR	-0.256***	0.028	-9.101	<.0001
Childhood	←HMem	0.186*	0.076	2.465	0.014
ASR	←YrSCHL	0.209*	0.090	2.333	0.020
	←Attraction	0.062*	0.031	2.006	0.045
	←Interaction	0.112*	0.056	1.990	0.047
Cohesion	←Age	0.084*	0.027	3.152	0.002

*** p < 0.001; ** p < 0.01; * p < 0.05; R = 0.47; β standardized beta coefficient

such as increased property tax and fear of displacement. This study aligns with the existing evidence of the association between neighborhood change and self-rated mental health [8,9,70,92]. However, it deviates from a Canadian study [93]. According to the US Centers for Disease Control and Prevention, residents' mental and physical health in a gentrifying neighborhood is worse than those living in non-gentrifying neighborhoods [92]. In the current study, the direct impact of gentrification on health remains inconclusive.

Neighborhood investment, no doubt, brings new amenities such as big stores into the neighborhoods; however, research has indicated that most of these benefits related to gentrification are less likely to be enjoyable by longtime low-income residents [57]. Aside from loss in socio-cultural networking and increase rent and tax, these factors may unknowingly interact to elevate stress that can, in turn, contribute to mental health among low-income residents. In the current study, the direct impact of gentrification on health remains inconclusive.

This study's limitations include its cross-sectional design that examined depression at a point in time, making

it difficult to establish causation. Hence, readers should apply caution when interpreting the results. Second, the current study did not control other stress sources and the latent period effect of gentrification, which might also confound the observed associations. The effect of gentrification, taken at a single point in time, maybe concealed during this study because, as an environmental stressor, this effect needs to be studied and followed over a more extended period. Hence, longitudinal data is necessary to control historical exposure to stress from various sources such as living environment, work, and familial or marital relationships. Nevertheless, this study's findings contribute to the growing knowledge of gentrification on mental health in the United States.

6 Conclusion

This study found a significant association between gentrification and symptoms of mental health and stress. However, we found no direct association between per-

ceived gentrification and depression among residents living in gentrifying neighborhoods in our complex model. Our study also indicates that stress was directly related to depression among residents in gentrifying neighborhoods in East and Southeast Austin. These findings build on the current evidence on environmental stress and mental health. It also supports the weathering hypothesis. Therefore, it is essential to buffer stress sources by improving access to social and economic resources, particularly for residents in gentrifying neighborhoods.

Many scholars and policymakers believed that introducing the affluent population in low-income neighborhoods improves the physical environment of disinvested neighborhoods. However, gentrification may not necessarily improve access to community resources if the social status of low-income minority residents is not improved to match that of the gentry. This study indicates that stress from the changing environments may increase poor mental health considering other life stress sources from a relationship and work not covered in this study. Gentrification plays a passive role, while stress plays an active role in contributing to residents' mental health status in this study. For gentrification's benefits to be fully realized, factors causing stress such as displacement and increasing property tax should be addressed, particularly for low-income earners with a fixed income.

Funding information: This study acknowledges the funding support by the Department of Geography, Texas State University, through the Detlefsen Geography Scholarship and Doctoral Research Support Fellowship by Graduate College, Texas State University.

Conflict of interest: The authors state no conflict of interest.

Informed consent: Informed consent has been obtained from all individuals included in this study.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

Data availability statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix

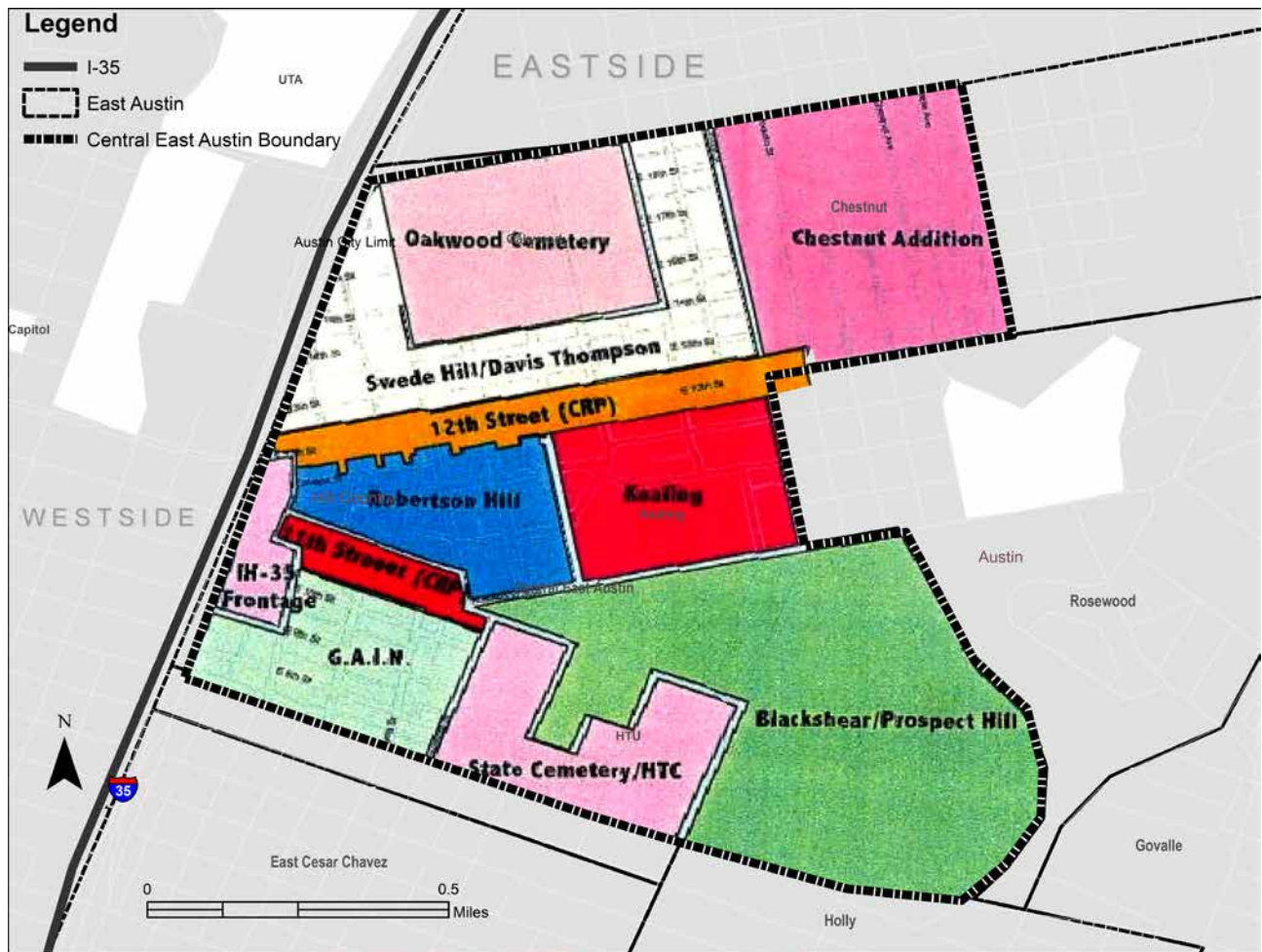


Figure 1: Project areas in 11th and 12th Street (Central East Austin Renewal Program).

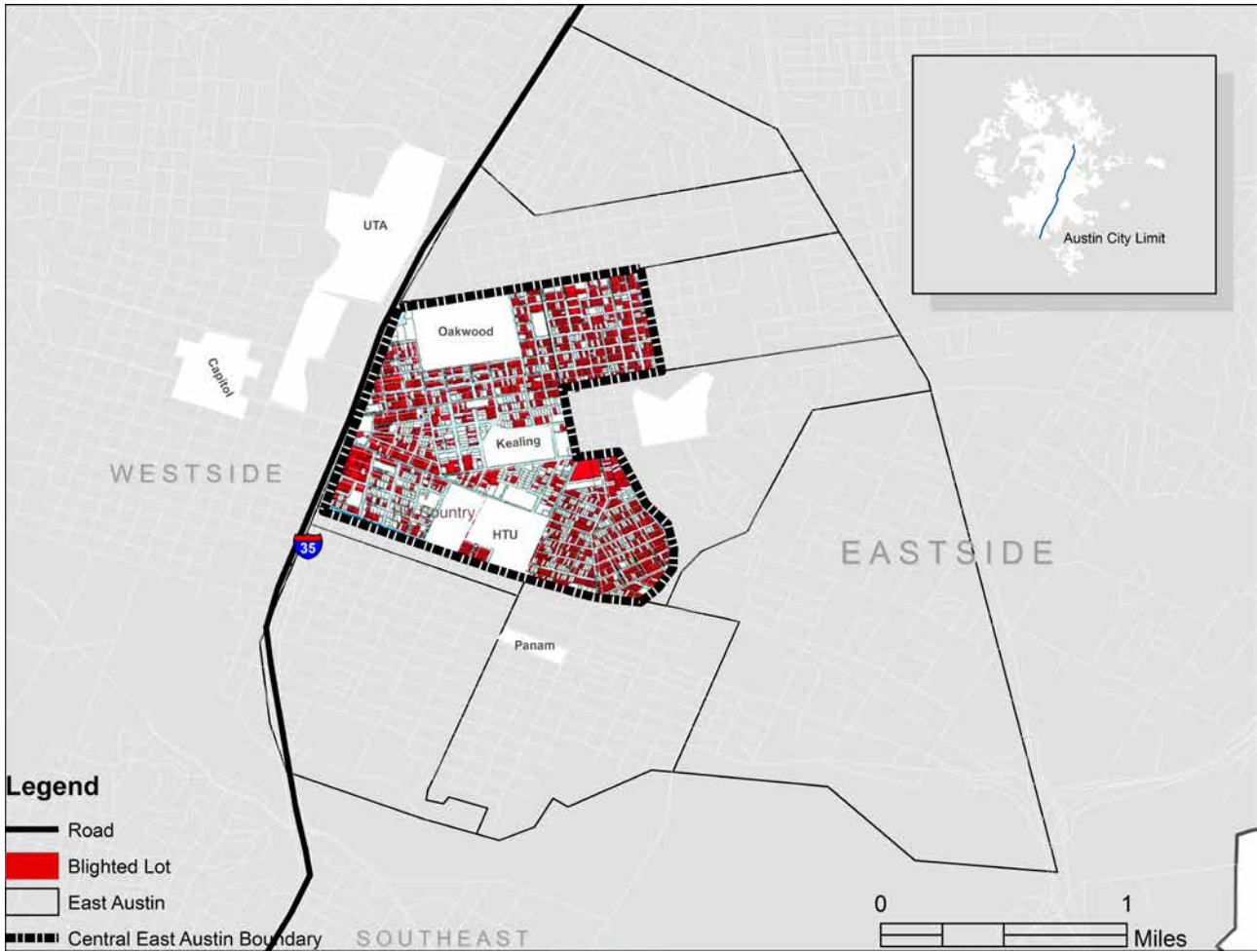


Figure 2: Blighted lots in Central East Austin, Texas.

Table 1: Determination of sample weight by race/ethnicity

	East Austin					Southeast Austin			Ground Total	Race/Ethnicity *	Sample	Weight
Race / Ethnicity	78702	78721	78723	78722	Total	78741	78744	Total	Row Total	(%)	(%)	
Asian	415	184	575	195	1369	293	2435	2,728	4,097	2.37	14.1	0.17
Black	2034	3749	6233	973	12989	3676	5479	9,155	22,144	12.81	7	1.83
White	7455	2379	11600	1036	22470	7565	14100	21,665	44,135	25.53	56.3	0.45
Hispanics	11300	5574	13600	4728	35202	35100	28700	63,800	99,002	57.27	18.7	3.06
Others (mixed)	440	267	504	360	1571	585	1334	1,919	34,90	2.02	3.1	0.65
					73,601			9,926	172,868	100		

* This represents the percentage of race/ethnicity in the study area by zip code.