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RESEARCH ARTICLE

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Impact of gentrification on adult mental health

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Abstract

Objective: To estimate the net effect of living in a gentrified neighborhood on probability of having serious psychological distress.

Data Sources: We pooled 5 years of secondary data from the California Health Interview Survey (2011-2015) and focused on southern California residents.

Study Design: We compared adults (n = 43 815) living in low-income and gentrified, low-income and not gentrified, middle- to high-income and upscaled, and middle- to high-income and not upscaled neighborhoods. We performed a probit regression to test whether living in a gentrified neighborhood increased residents' probabilities of having serious psychological distress in the past year and stratified analyses by neighborhood tenure, homeownership status, and low-income status. Instrumental variables estimation and propensity scores were applied to reduce bias arising from residential selection and simultaneity. An endogenous treatment effects model was also applied in sensitivity analyses.

Data Collection/Extraction Methods: Adults who completed the survey on their own and lived in urban neighborhoods with 500 or more residents were selected for analyses. Survey respondents who scored 13 and above on the Kessler 6 were categorized as having serious psychological distress in the past year. We used eight neighborhood change measures to classify respondents' neighborhoods.

Principal Findings: Living in a gentrified and upscaled neighborhood was associated with increased likelihood of serious psychological distress relative to living in a low-income and not gentrified neighborhood. The average treatment effect was 0.0141 (standard error = 0.007), which indicates that the prevalence of serious psychological distress would have been 1.4 percentage points less if none of the respondents lived in gentrified neighborhoods. Gentrification appears to have a negative impact on the mental health of renters, low-income residents, and long-term residents. This effect was not observed among homeowners, higher-income residents, and recent residents.

Conclusions: Gentrification levies mental health costs on financially vulnerable community members and can worsen mental health inequities.

KEYWORDS

gentrification, mental health, psychological, residence characteristics, social determinants of health, stress

1 | INTRODUCTION

Gentrification is a process marked by accelerated physical restructuring, rapid economic growth, and shifts in the social and cultural characteristics of neighborhoods. At worst, gentrification can disrupt the social cohesion of a neighborhood, provoke feelings of cultural displacement, and sever social networks, thereby weakening individuals' protective factors for mental illness.[1-4] Residents must also contend with rising living costs and substantial changes in their material circumstances.[1,5] At best, residents of gentrifying neighborhoods potentially benefit from improved housing quality, higher property values for home and commercial owners, better neighborhood amenities, richer retail and built environments, and possibly higher levels of collective efficacy.[6-8] Although the benefits and harms of gentrification have been well documented, debates on whether gentrification is "bad" or "good" for residents and communities are highly contested. The public health consequences of gentrification are not well understood.

The literature on gentrification and health has expanded in recent years. Gentrification or the rapid neighborhood upscaling of historically under-resourced neighborhoods has been linked to greater risk for preterm birth among non-Hispanic Blacks, but was associated with lower risk for preterm birth among non-Hispanic Whites.[9] Although research on the relationship between gentrification and self-reported health has produced mixed results,[10-13] living in a gentrifying neighborhood has been linked to poorer self-reported health for Black residents.[10,11] In a recent study of 500 cities, researchers found that gentrification was positively and significantly associated with better neighborhood health.[14] Gentrification did not appear to impact self-reported health for cities overall.[14] Finally, in-depth interviews showed that high rents fueled by gentrification exacerbated food insecurity and hunger for people with low incomes and people living with HIV.[15]

Fewer studies have examined the relationship between gentrification and mental health. Using a representative sample of Medicare beneficiaries, researchers found that economically vulnerable and higher-income adults living in gentrifying neighborhoods had greater levels of depression and anxiety than older adults living in middle- to high-income neighborhoods.[13] Higher-income older adults in gentrifying neighborhoods also reported poorer mental health than their counterparts in low-income neighborhoods.[13] In cohort studies, low-income children who lived in gentrified New York City neighborhoods had higher prevalence of anxiety or depression compared to children who lived in other neighborhoods,[16] and displaced residents of gentrifying neighborhoods had greater risks for emergency department visits, hospitalizations, and mental health-related visits than residents who remained.[17]

Many studies to date have not fully explored selection biases that are inherent when examining neighborhoods and individual health. Using detailed respondent and residential information available in a large, continuous population-based survey in California, we sought to understand the causal effect of gentrification on adult residents' mental health and identify residents most impacted. We focused on neighborhoods in southern California, a region that has received increasing attention due to its diversity and rapidly changing neighborhoods.[18-21] Southern California has a wide range of neighborhoods that encompass urban and suburban areas, communities with high concentrations of residents who share a racial or ethnic identity, as well as integrated neighborhoods. Housing markets and home prices also quickly rebounded from the Great Recession in some areas of southern California, while other communities did not. We classified neighborhoods based on the pace of upscaling experienced between 2010 and 2015, and compared adult residents' likelihood of serious psychological distress across neighborhood change categories. We also recognized the challenges of measuring neighborhood effects and applied instrumental variables estimation and propensity score analyses to address nonrandom residential mobility and simultaneity, the possibility that gentrification and residents' mental health simultaneously affected one another.

What This Study Adds

- There is growing evidence that gentrification disparately affects the health of different populations.
- Our study applied quasi-experimental designs to identify the causal impact of gentrification on adult mental health.
- We found that adults who lived in gentrified neighborhoods had increased risks for serious psychological distress compared to those in not gentrified, low-income neighborhoods.
- Longtime and economically vulnerable residents were disproportionately impacted.

2 | METHODS

2.1 | Data sources

The California Health Interview Survey (CHIS) is the largest state health survey in the nation. Each year, more than 20 000 households participate in CHIS and share information about their health, environment, and behaviors. Cross-sectional data from CHIS 2011, 2012, 2013, 2014, and 2015 were pooled. The initial sample had 104 209 adult respondents aged 18 and over, 45 917 of whom lived in six select southern California counties: Ventura, Los Angeles, Orange, San Bernardino, Riverside, and San Diego. Responses from interviewees who completed the survey by proxy, resided in rural census tracts, or lived in tracts with fewer than 500 residents were excluded. Data used to classify neighborhood change came from the 2006-2010 American Community Survey, 2011-2015 American Community Survey, and 2010 and 2015 Home Mortgage Disclosure Act (HMDA) aggregate reports. Census tract-level variables from these sources were merged

with CHIS responses using the census tract Federal Information Processing Standards (FIPS) codes of respondents' residences. 44 905 of 45 652 (98 percent) CHIS observations were successfully merged with neighborhood-level variables.

Instrumental and exclusion restriction variables were extracted from the US Census, American Community Survey, California Department of Education, National Center for Education Statistics, School Attendance Boundary Survey, and California Department of Transportation. These neighborhood-level variables were also merged with CHIS responses (90 percent) using census tract FIPS codes. The analytic dataset had 43 815 adult respondents.

2.2 | Measures

Serious psychological distress (SPD) in the past year was the outcome of interest. SPD was assessed using the Kessler 6, a 6-item assessment tool designed to estimate the prevalence of adults with nonspecific psychological distress.[22] Respondents were asked to reflect on the worst month in the past year and indicate how often they felt nervous, hopeless, restless or fidgety, worthless, that everything was an effort, and so depressed that nothing can cheer them up. Responses were converted to scores, and respondents with scores of 13 and above (range 0-24) were categorized as having SPD in the past year.[23]

The key independent variable was a neighborhood-level variable that categorized census tracts into four typologies: "Low-income and gentrified," "Low-income and not gentrified," "Middle- to high-income and upscaled," or "Middle- to high-income and not upscaled." For brevity, neighborhood change categories will respectively be referred to as "gentrified," "not gentrified," "upscaled," and "not upscaled." These neighborhood change categories were developed based on eight indicators representing neighborhood physical structuring, economic growth, and cultural shifts between 2006-2010 and 2011-2015. Indicators included changes in the following: dollar amount of improvement loans per capita, median household income, median home value, mean dollar amount for home loans, median rent, percent of households with incomes above 200 percent FPL, percent of adults aged 25+ with a college degree, and percent of non-Hispanic White residents.

Strategies for identifying gentrified neighborhood are numerous and wide-ranging. Researchers have commonly used a threshold strategy in which neighborhood changes in housing prices and household incomes, for example, are compared to set thresholds.[10,20,24,25] Other quantitative strategies involve ranking neighborhood change indicators[9,26] and the use of principal component analysis (PCA).[17,27,28] We recognize that different strategies for developing a gentrification variable, when used as an independent variable, can produce conflicting results.[29,30] We used PCA because while the results are empirically driven, the selection of neighborhood change indicators was grounded in theory and because PCA allows neighborhood change indicators to have different weights on the metric for upscaling. This was critical for capturing the upscaling and gentrification phenomena, which varied from county to county.

We conducted principal component analysis to summarize neighborhood change measures and binned PCA scores into groups using a clustering approach.[31] All PCAs were stratified by county to situate neighborhoods within their respective regional contexts, and census tracts in the group with the greatest PCA scores were considered "upscaled." Gentrification is a process that impacts low-income neighborhoods.[6,24] Because this phenomenon is conditioned by neighborhood income at the start of the observation period, the processes of upscaling in low-income and higher-income neighborhoods are distinct and may have differential health effects. We distinguished historically low-income neighborhoods from middle- to high-income neighborhoods and defined census tracts with median incomes below 80 percent of their respective counties' median household incomes at the start of the study period as "low-income." Upscaled, low-income census tracts were classified as "gentrified." Low-income tracts that were not upscaled were considered "not gentrified," and middle- to high-income census tracts (median household incomes ≥ 80 percent of county median) that upscaled and did not experience upscaling were categorized as "upscaled" and "not upscaled," respectively.

Length of time at current address served as an exposure measure. Long-term residents were classified as those who had lived in their neighborhoods for at least 15 years. Residents who had lived in their neighborhoods for fewer than 6 years were categorized as recent residents, and residents who had lived at their current addresses for 6-14 years were categorized as average tenure residents.

Covariates measured socioeconomic position and other factors that predict both our key independent variable and health. These covariates included demographic factors, socioeconomic status, financial stressors, social support, health status, and neighborhood stressors.

2.2.1 | Moderators and subgroups

We hypothesized that any effect of gentrification on mental health would be moderated by residents' attachment and therefore length of time in the neighborhood, their homeownership status, and household income (<200 percent federal poverty level vs ≥200 percent federal poverty level).

2.2.2 | Residential selection and exclusion restriction variables

We used respondent age, marital status, and parental status as proxies for life cycle status, included employment status, education, and household income variables as measures of socioeconomic status, and used respondent homeownership status as a

TABLE 1 Characteristics of adults aged 18 and over living in southern California Counties by neighborhood type,[a] n = 43 815

	Low-income and gentrified n = 3036	Low-income and not gentrified n = 9210	Middle- to high-income and upscaled n = 8849	Middle- to high-income and not upscaled n = 22 720
Outcome: Likely had serious psychological distress in the past year	9.1	9.0	5.7	6.0
Tenure in neighborhood				
1-5 y (recent resident)	43.2	46.3	32.0	32.9
6-14 y	25.8	24.9	23.7	24.6
15+ y (long-term resident)	31.0	28.8	44.3	42.5
Gender				
Female	59.5	59.9	58.4	57.8
Male	40.5	40.1	41.6	42.2
Age category				
18-25	9.7	11.1	6.3	7.6
26-45	23.8	25.2	19.2	19.3
46-64	31.5	33.6	36.7	36.9
65+	35.0	30.2	37.7	36.2
Nativity				
Born outside United States	41.1	42.8	23.7	25.9
Born in United States	58.9	57.2	76.3	74.1
English proficiency				
Speaks only English or speaks English very well or well	75.4	72.3	93.1	90.4
Speaks English not well or not at all	24.6	27.7	6.9	9.6
Race/Ethnicity				
Latinx/Hispanic	38.9	45	16.6	21.4
Non-Hispanic White	36.5	31.7	65	59.4
Non-Hispanic Black	9.6	10.1	5.1	5.5
Non-Hispanic Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, two or more race	14.9	13.1	13.4	13.8
Has Bachelor's Degree or Higher	29.5	21.8	51.9	43.6
Household income				
1st quartile	39.1	44.7	14.8	18.7
2nd and 3rd quartiles	48.0	45.7	50.7	52.4
4th quartile	12.9	9.6	34.6	28.9
Homeownership status				
Rent or other arrangements	59.5	60.4	29.6	30.7
Own home	40.5	39.6	70.4	69.3
Employment status				
Employed or not looking for work	93.1	92.1	95.9	94.9
Unemployed	6.9	7.9	4.1	5.1
Insurance status				
Currently uninsured or uninsured any time	20.0	23.0	10.5	12.6
Insured all year	80.0	77.0	89.5	87.4
Marital status				
Married/living with partner	42.0	45.5	55.5	54.8
Widowed/separated/divorced	32.4	30.0	27.2	27.3

(Continues)

TABLE 1 (Continued)

	Low-income and gentrified n = 3036	Low-income and not gentrified n = 9210	Middle- to high-income and upscaled n = 8849	Middle- to high-income and not upscaled n = 22 720
Never married	25.6	24.5	17.3	17.9
Reported fair or poor health	29.0	33.8	16.1	19.5
Chronic conditions				
No reported conditions	67.8	67.7	71.0	69.5
Asthma, diabetes, and/or heart disease	32.2	32.3	29.0	30.5
Current smoker	12.2	13.4	9.0	9.7
Social Capital Score				
2	1.2	2.1	0.5	0.7
3	2.7	2.6	0.9	1.1
4	12.1	13.7	4.6	5.7
5	16.5	18.5	9.9	10.9
6	46.6	45.1	52.3	51.8
7	12.4	10.7	15.4	14.7
8	8.5	7.4	16.3	15.2
Feels safe in the neighborhood all or most of the time	82.4	78.2	94.6	93.0
Children in household	21.1	26.2	20.8	21.7

[a]All differences (χ^2) between respondents in low-income vs middle- to high-income neighborhoods were statistically significant ($P < .05$).

Sources: California Health Interview Survey 2011, 2012, 2013, 2014, and 2015; American Community Survey 2006-2010 and 2011-2015; and Home Mortgage Disclosure Act Aggregate Data 2010 and 2015.

proxy for moving costs. Social capital was assessed using responses to questions about neighbors' willingness to help one another and whether neighbors can be trusted. Perception of safety was included as a predictor of residential selection because safety concerns contribute to stress and can influence residential location decisions.

To account for racially/ethnically motivated and restricted migration, we used respondent race/ethnicity, immigrant status, and English proficiency. Exclusion restriction variables, which we assumed predicted residential location but did not affect SPD, included percent of non-Hispanic White residents, census tract median household income, which was categorized into three categories (ie, first quartile, second and third quartiles, and fourth quartile), the interaction between percent of non-Hispanic White residents in respondents' neighborhoods and respondent race/ethnicity, and the interaction between median household income and respondent household income.

2.2.3 | Instrumental variables

Candidate instrumental variables were hypothesized to predict the likelihood that respondents' neighborhoods gentrified between 2010 and 2015, but were expected to not predict respondents' likelihoods for SPD. These instruments included census tract's distance in miles to the nearest rail station, miles to nearest high-income neighborhood, difference in mean similar school rank and mean overall rank for all public elementary schools in a census tract, the interaction between whether respondents had children in the household and difference in school ranks, and the proportion of renters in a tract.

2.3 | Analyses

Descriptive analyses summarized all variables by neighborhood change category. We applied several approaches to estimate the relationship between living in a gentrified neighborhood and likelihood of serious psychological distress. The first approach was a probit model that included respondents in low- and middle- to high-income neighborhoods. Middle- to high-income or "non-gentrifiable" neighborhoods were often included in previous gentrification studies.[10-12,14,25] Model misspecification, multicollinearity, calibration, and predictive accuracy were assessed using the Tukey and Pregibon link test, variance inflation factors, receiver operating characteristic curve, and Hosmer-Lemeshow goodness-of-fit test. Moderation of the impact of gentrification on mental health was examined through stratified analyses by neighborhood tenure, homeownership status, and low-income status.

In an effort to address nonrandom residential selection and potential simultaneity between living in a gentrified neighborhood and experiencing serious psychological distress, we employed an

TABLE 2 Effect of neighborhood type on past year serious psychological distress[a] by tenure in neighborhood, homeownership status, and household income, adults aged 18 and over living in southern California Counties

	Tenure in neighborhood		Homeownership status		Household income	
Neighborhood Type—ref: low-income and not gentrified	**Recent residents n = 15 884**	**Long-term residents n = 17 165**	**Renters or other arrangements n = 16 961**	**Homeowners n = 26 854**	**Income < 200% FPL n = 14 840**	**Income 200% FPL+ n = 28 975**
Low-income and gentrified	−0.015 (0.061)	0.235** (0.081)	0.110* (0.049)	0.045 (0.080)	0.134** (0.050)	0.021 (0.067)
Middle- to high-income and upscaled	0.045 (0.049)	0.130* (0.063)	0.094* (0.046)	0.079 (0.051)	0.115* (0.050)	0.049 (0.047)
Middle- to high-income and not upscaled	0.015 (0.039)	0.110 (0.054)	0.037 (0.034)	0.078 (0.045)	0.047 (0.035)	0.043 (0.041)

[a]Coefficients and robust standard errors (in parentheses) estimated from stratified probit models. Covariates in these models included respondent age, gender, race/ethnicity, marital status, education, tenure in the neighborhood, income, homeownership status, insurance status, English proficiency, overall health, chronic conditions, smoking status, perceived safety in the neighborhood, presence of children, Social Capita Score, and year fixed effects. Robust standard errors were estimated to adjust for clustering in census tracts.

**$P < .01$.

*$P < .05$.

Sources: California Health Interview Survey 2011, 2012, 2013, 2014, and 2015; American Community Survey 2006-2010 and 2011-2015; and Home Mortgage Disclosure Act Aggregate Data 2010 and 2015

instrumental variable (IV) strategy by performing seemingly unrelated bivariate probit regression analysis on a subset of respondents who lived in low-income neighborhoods (n = 12 067). IV estimation was preferred, but in the case that the correlation coefficient was not statistically significantly different from zero, we conducted propensity score analyses by employing inverse-probability treatment weighting to balance respondents in gentrified and not gentrified neighborhoods on observed characteristics. An endogenous treatment effects model was applied in sensitivity analyses to explore unobserved heterogeneity between people in gentrified and not gentrified neighborhoods.

For all models, cluster-robust standard errors were estimated to adjust for intragroup correlation at the census tract level. Average marginal effects or average treatment effects were calculated. All analyses were conducted using Stata 14.

3 | RESULTS

Roughly a quarter (28 percent) of respondents in our sample lived in low-income neighborhoods. Approximately 7 percent of respondents lived in low-income neighborhoods that underwent gentrification between 2010 and 2015; 21 percent lived in low-income census tracts that did not. One-fifth (20 percent) of respondents lived in middle- to high-income neighborhoods that experienced upscaling, and half of respondents (52 percent) lived in middle- to high-income neighborhoods that did not experience upscaling.

Seven percent of adults living in southern California between 2011 and 2015 likely had serious psychological distress (SPD) in the past year. The fraction of respondents with SPD was greater among respondents living in low-income neighborhoods (9 percent) compared to residents of middle- to high-income neighborhoods (6 percent) (Table 1).

On average, living in a gentrified neighborhood increased respondents' likelihood of SPD ($b = 0.01$; $P = .02$) relative to living in a low-income and not gentrified neighborhood (the reference category; see Table S1). This translated to an average 1.1 percentage point increase in SPD for living in a gentrified neighborhood ($P = .02$). Living in a middle- to high-income neighborhood, upscaled or not, also increased respondents' likelihood of SPD relative to living in a not gentrified neighborhood. Regression diagnostics suggested that the probit model was not mis-specified and that the model predicted SPD with acceptable discrimination.

Stratified probit regression results are presented in Table 2. For adults who recently moved to their neighborhoods, neighborhood change category did not have an effect on their likelihood of having SPD. Living in a gentrified ($b = 0.23$; $P = <0.01$) or middle- to high-income and upscaled ($b = 0.13$; $P = .04$) neighborhood, relative to living in a not gentrified neighborhood, did increase likelihood of SPD for long-term residents. On average, living in gentrified neighborhoods, as opposed to living in low-income and not gentrified neighborhoods, increased likelihood of SPD by 2

percentage points ($P < .01$) for long-term residents. Renters and respondents with lower household incomes living in gentrified or upscaled neighborhoods had greater probabilities for SPD relative to similar adults living in low-income and not gentrified neighborhoods. Neighborhood change did not influence likelihood of SPD among respondents who owned their homes or had higher household incomes.

Table 3 presents seemingly unrelated bivariate probit regression results. In the first stage regression, both instruments, neighborhood's distance from nearest high-income neighborhood and difference in similar and overall school rank, were associated with whether a respondent's neighborhood was gentrified. Instruments also met the exclusion restriction criterion (data not shown). The association between living in a gentrified neighborhood and SPD in second-stage regression results (Table 3) was positive but not statistically significant. A Wald test suggested that rho was zero, indicating no endogeneity.

As seen in Table 4, individual characteristics such as race/ethnicity, educational attainment, and household income were linked to whether respondents lived in gentrified neighborhoods. Estimation with inverse-probability treatment weights generated an average treatment effect of 1.4 percentage points, and the effect was statistically significant ($P < .05$). Endogenous treatment effect results in sensitivity analysis (Table S2) suggested no unobserved heterogeneity between treatment groups supporting the use of propensity scores.

4 | DISCUSSION

After testing for endogeneity and balancing respondents on characteristics that affect residential selection and serious psychological distress, we estimated that on average, the prevalence of serious psychological distress would have been 1.4 percentage points less if none of the respondents lived in gentrified neighborhoods. Although a 1 percentage point difference appears to be small, this average marginal effect is roughly equivalent to a 13 percent increase in SPD among adult southern California residents. Gentrification appears to have a negative impact on the mental health of renters, low-income residents, and long-term residents.

Insights on the pathways through which living in gentrified neighborhoods contributes to poorer mental health can be gleaned from stratified analysis results. Gentrified neighborhoods negatively impacted select groups of residents and not others. Among recent residents, people who had lived in their neighborhoods for fewer than 6 years, living in a gentrified neighborhood did not negatively impact their risks for SPD. Several reasons might explain this null effect. The first is insufficient exposure to rapid neighborhood change.[32] Recent residents might have not yet developed attachments to their new communities and were therefore less susceptible to stressors associated with gentrification.[33] Selective in-migration to gentrified neighborhoods is another factor to consider. People who move to gentrifying neighborhoods tend to have higher incomes and more education than current residents.[24,34,35] In turn, recent residents may benefit more from gentrification than longtime residents with lower incomes.[7,12,36]

In contrast, residents who had lived in their communities for 15 or more years and experienced gentrification had greater risk for SPD in the past year compared to similar long-term residents of neighborhoods that did not gentrify. Longtime residents have reported loss of community and feeling that they did not belong as a result of gentrification.[1,6,37] Long-term residents are also more likely to experience cultural displacement or the replacement of their norms and values.[1,33,38,39] Similarly, residents can experience "symbolic displacement" or feelings of isolation and dislocation as their neighborhoods transform.[40,41] For longtime residents of gentrified neighborhoods, the distress associated with feeling left behind, pushed out, and/or replaced might have outweighed positive changes in the neighborhood and increased their risk for mental distress.

Residing in a gentrified neighborhood also negatively impacted the mental health of adults with low incomes and renters but did not affect homeowners and people with higher incomes. This finding suggests that gentrification influences mental health through heightened financial pressures associated with higher living costs. As home values and rents rapidly appreciate in gentrifying neighborhoods, residents with low incomes and renters in non-rent-controlled housing units may be more vulnerable to the mental health effects of unaffordable housing compared to homeowners.[42-44]

In addition to greater financial stressors, low-income and long-term residents may feel excluded from and alienated by the changes in their neighborhoods. Investments in gentrifying neighborhoods offer residents expanded food and retail options.[4] However, new retail in gentrifying neighborhoods often caters to recent residents with higher education and incomes and may be inaccessible to residents with low incomes.[7,36,45] Finally, as gentrified neighborhoods become less affordable and "friendly" to longtime residents, renters and low-income residents must contend with fears of displacement, which contribute to stress.[3,4]

The effects of gentrification or upscaling on SPD were greatest among long-term residents. As mentioned earlier, these residents are at greater risk of experiencing loss of connectivity and cultural displacement as their communities gentrified, and although not all long-term residents have low incomes, any cumulative increases in household income were likely outpaced by rising costs in their neighborhoods. Fear of displacement likely carried a heavy toll on longtime residents' mental health.

4.1 | Limitations

This study focused on the mental health effects of gentrification on the current residents of gentrified neighborhoods. Not represented in our study are former residents who moved away. Based on our findings, we posit that former residents, particularly renters and people with low

TABLE 3 instrumental variables estimation—seemingly unrelated bivariate probit results, adults aged 18 and over living in low-income neighborhoods, n = 12 067

	Coefficient	Standard error[a]	*P*-value
Stage 1—Dependent variable: neighborhood gentrified			
Instrument: Distance to nearest high-income neighborhood	−0.095	0.029	<.01
Instrument: Difference in mean similar and overall school rank scores x Presence of children in household			
Children not in household	−0.004	0.022	.88
Children in household	0.052	0.026	.05
Children in household (ref: no children in household)	−0.191	0.052	<.01
Tenure in neighborhood—ref: 6-14 y			
1-5 y (recent resident)	−0.054	0.036	.13
15+ y (long-term resident)	0.009	0.041	.84
Male (ref: female)	0.002	0.029	.95
Age category—ref: 46-64			
18-25	−0.043	0.057	.45
26-45	0.061	0.040	.13
65+	0.058	0.048	.22
Born in United States (ref: born outside United States)	−0.052	0.046	.26
Speaks English not well or not at all (ref: speaks only English or speaks English very well or well)	0.004	0.047	.93
Race/Ethnicity—ref: non-Hispanic White			
Latinx/Hispanic	−0.073	0.062	.24
Non-Hispanic Black	−0.091	0.091	.31
Non-Hispanic Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, two or more race	−0.019	0.077	.81
Has bachelor's degree or higher (ref: less than BA/BS)	0.141	0.037	<.01
Household Income—ref: 2nd and 3rd quartiles			
1st quartile	−0.051	0.032	.12
4th quartile	0.088	0.050	.08
Own home (ref: rent or other arrangements)	−0.092	0.046	.05
Unemployed (ref: employed or not looking)	−0.022	0.056	.69
Insured all year (ref: currently uninsured or uninsured any time)	0.042	0.035	.23
Marital status—ref: married/living with partner			
Widowed/separated/divorced	0.054	0.035	.13
Never married	0.081	0.041	.05
Fair or poor health (ref: excellent, very good, or good health)	−0.104	0.029	<.01
Asthma, diabetes, and/or heart disease (ref: no reported conditions)	−0.002	0.030	.94
Current smoker (ref: nonsmoker)	−0.010	0.040	.81
Social Capita Score	0.020	0.013	.13
Feels safe in the neighborhood all or most of the time (ref: feels safe some or none of the time)	0.082	0.037	.03
Survey Year—ref: 2011			
2012	0.041	0.047	.38
2013	−0.012	0.042	.77
2014	0.018	0.047	.71
2015	−0.023	0.047	.62
Constant	−0.627	0.120	<.01

(Continues)

TABLE 3 (Continued)

	Coefficient	Standard error[a]	*P*-value
Stage 2—Dependent variable: serious psychological distress in past year			
Neighborhood gentrified	0.336	1.513	.82
Tenure in neighborhood—ref: 6-14 y			
1-5 y (recent resident)	0.107	0.049	.03
15+ years (long-term resident)	0.009	0.052	.87
Male (ref: female)	−0.134	0.038	<.01
Age category—ref: 46-64			
18-25	0.184	0.066	.01
26-45	0.094	0.061	.13
65+	−0.439	0.053	<.01
Born in United States (ref: born outside United States)	0.093	0.060	.12
Speaks English not well or not at all (ref: speaks only English or speaks English very well or well)	−0.037	0.058	.52
Race/Ethnicity—ref: non-Hispanic White			
Latinx/Hispanic	−0.076	0.067	.25
Non-Hispanic Black	−0.154	0.075	.04
Non-Hispanic Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, two or more race	−0.102	0.068	.13
Has bachelor's degree or higher (ref: less than BA/BS)	0.015	0.089	.87
Household Income—ref: 2nd and 3rd quartiles			
1st quartile	0.163	0.045	<.01
4th quartile	−0.129	0.083	.12
Own home (ref: rent or other arrangements)	−0.126	0.074	.09
Unemployed (ref: employed or not looking)	0.164	0.060	.01
Insured all year (ref: currently uninsured or uninsured any time)	0.061	0.050	.23
Marital status—ref: married/living with partner			
Widowed/separated/divorced	0.220	0.061	<.01
Never married	0.109	0.070	.12
Fair or poor health (ref: excellent, very good, or good health)	0.619	0.038	<.01
Asthma, diabetes, and/or heart disease (ref: no reported conditions)	0.201	0.040	<.01
Current smoker (ref: nonsmoker)	0.386	0.047	<.01
Social Capita Score	−0.059	0.015	<.01
Feels safe in the neighborhood all or most of the time (ref: feels safe some or none of the time)	−0.168	0.050	<.01
Children in household (ref: no children in household)	−0.126	0.065	.05
Survey Year—ref: 2011			
2012	−0.028	0.058	.63
2013	0.042	0.054	.44
2014	−0.047	0.061	.44
2015	0.055	0.053	.31
Constant	−1.461	0.279	<.01
Rho[b]	−0.146	0.873	

[a]Robust standard errors were estimated to adjust for clustering in census tracts.

[b]Wald test of rho = 0; $\chi(1) = 0.0271$; *P*-value = .87.

Sources: California Health Interview Survey 2011, 2012, 2013, 2014, and 2015; American Community Survey 2006-2010 and 2011-2015; Home Mortgage Disclosure Act Aggregate Data 2010 and 2015; Census 2000 and 2010; California Department of Education 2010; National Center for Education Statistics School Attendance Boundary Survey 2010-2011 and 2013-2014; and California Department of Transportation.

TABLE 4 Propensity score and inverse-probability treatment weighting results for past year serious psychological distress, adults aged 18 and over living in low-income neighborhoods, n = 12 246

Treatment effect estimation with inverse-probability weights	Estimate	Standard error[a]	*P*-value
Average treatment effect (neighborhood gentrified vs not gentrified)	0.0141	0.007	.03
Potential outcome mean	0.088	0.003	<.01
Propensity Score Model (Probit)	**Coefficient**	**Standard error[a]**	***P*-value**
% Non-Hispanic White residents in 2010	0.011	0.001	<.01
Respondent Race/Ethnicity × % Non-Hispanic White Residents (ref: non-Hispanic White)			
Latinx/Hispanic	−0.004	0.001	.01
Black	−0.014	0.003	<.01
Asian and others	−0.010	0.002	<.01
Median household income in 2010	−1.06E−05	1.94E−06	<.01
Respondent household income × median household income (ref: 2nd and 3rd quartiles)			
1st quartile	−1.34E−05	2.82E−06	<.01
4th quartile	−2.97E−06	4.25E−06	.49
Tenure in neighborhood—ref: 6-14 y			
1-5 y (recent resident)	−0.072	0.033	.03
15+ years (long-term resident)	0.061	0.035	.08
Male (ref: female)	0.003	0.027	.90
Age category—ref: 46-64			
18-25	−0.004	0.054	.94
26-45	0.072	0.039	.07
65+	−0.006	0.035	.87
Born in United States (ref: born outside United States)	−0.078	0.039	.04
Speaks English not well or not at all (ref: speaks only English or speaks English very well or well)	0.007	0.043	.87
Race/Ethnicity—ref: non-Hispanic White			
Latinx/Hispanic	0.208	0.059	<.01
Non-Hispanic Black	0.348	0.068	<.01
Non-Hispanic Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, two or more race	0.405	0.071	<.01
Has bachelor's degree or higher (ref: less than BA/BS)	0.163	0.032	<.01
Household income—ref: 2nd and 3rd quartiles			
1st quartile	0.455	0.117	<.01
4th quartile	0.221	0.189	.24
Own home (ref: rent or other arrangements)	−0.122	0.032	<.01
Unemployed (ref: employed or not looking)	−0.030	0.050	.54
Insured all year (ref: currently uninsured or uninsured any time)	0.034	0.034	.33
Marital status—ref: married/living with partner			
Widowed/separated/divorced	0.050	0.033	.13
Never married	0.082	0.038	.03
Fair or poor health (ref: excellent, very good, or good health)	−0.087	0.030	<.01
Asthma, diabetes, and/or heart disease (ref: no reported conditions)	0.004	0.029	.89
Current smoker (ref: nonsmoker)	−0.028	0.039	.47
Social Capita Score	0.009	0.011	.43
Feels safe in the neighborhood all or most of the time (ref: feels safe some or none of the time)	0.083	0.035	.02
Children in household (ref: no children in household)	−0.099	0.039	.01

(Continues)

TABLE 3 (Continued)

Propensity Score Model (Probit)	Coefficient	Standard error[a]	*P*-value
Survey Year—ref: 2011			
2012	0.066	0.038	.08
2013	0.014	0.039	.73
2014	0.039	0.042	.35
2015	−0.020	0.039	.62
Constant	−0.696	0.130	<.01

[a]Robust standard errors were estimated to adjust for clustering in census tracts.

Sources: California Health Interview Survey 2011, 2012, 2013, 2014, and 2015; American Community Survey 2006-2010 and 2011-2015; Home Mortgage Disclosure Act Aggregate Data 2010 and 2015; and Census 2000 and 2010.

incomes, contending with unsustainable and rapidly increasing living costs, had limited options but to leave their communities. In doing so, these displaced residents would likely experience "root shock," disruption in their social networks, unexpected moving expenses, and other stressors that negatively impacted their mental health.[46] In addition, vulnerable residents who moved out of gentrifying neighborhoods had greater risk of downward mobility and moving to "economically worse-off neighborhood(s)."[25] It is less clear whether homeowners in gentrifying neighborhoods, who potentially benefit from greater increases in home values, fare better or worse from moving.

Instrumental variables estimation was applied to address endogeneity arising from nonrandom migration and simultaneity. Although the R^2 in the first stage model was approximately 0.02, Wald tests for rho from both IV results and sensitivity analyses indicated that conditional on the other covariates in the model, residing in a gentrified neighborhood, was not endogenous. We retain some uncertainty about the quality of our instruments, but do believe that balancing across observed residential selection variables adequately reduced bias from selective in-migration into gentrified neighborhoods. Without panel data, we were unable to adjust for selective out-migration and observe displacement from gentrified neighborhoods, but, using statistical adjustments and the rich data offered in CHIS, were able to minimize residential selection bias to estimate the effect of gentrification on residents' mental health.

5 | PUBLIC HEALTH IMPLICATIONS

This study offers evidence that gentrification has a mental health cost on current residents and that longtime residents, renters, and people with low incomes carry much of the burden.[47,48] This has implications for population health and health inequities. By elevating levels of mental health distress of population groups who are already disproportionately exposed to stressors such as discrimination and threats to financial security and safety, gentrification can exacerbate mental health inequities.[49,50]

Numerous local and statewide efforts have been launched to stop gentrification and prevent the displacement of community members.[51] Cities have debated and adopted antidisplacement policies to create new affordable housing units, preserve existing affordable housing, protect existing tenants, and build the assets of residents with low incomes.[52] Although much of the latest campaigns have focused on rent regulation, our study highlights the potential importance of community ownership and neighborhood preservation. Longtime residents of gentrified neighborhoods were most affected by upscaling, despite being able to stay in their communities. Separate from affordability, legislators, planners, and developers should weigh the cultural costs and potential mental health impacts of their proposals. Residents should continue to build community power to challenge and transform unwanted investments to projects that meet with wishes of the community.[53,54]

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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