

**Gentrification, housing insecurity, and Preterm Birth among Black women and birthing people in the San Francisco Bay Area**

Working Paper

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## ABSTRACT

**Background:** Despite medical and technological advances, the preterm birth (PTB) rate among infants born to Black American women is 55% higher than infants born to white women. Exploratory scholarship suggests that living in gentrifying neighborhoods may increase risk of PTB for Black women. However, no published studies to date outline the pathways linking gentrification and PTB.

**Purpose:** The purpose of this study is to assess the relationship between gentrification, housing insecurity and PTB among Black women in the San Francisco Bay Area. The aims are (1) to determine if gentrification stage is associated with preterm birth among Black women; (2) to determine if the association is mediated by housing insecurity.

**Methods:** The study uses a cross-sectional design to assess the association between living in a census tract undergoing different stages of gentrification and preterm birth. The sample is drawn from vital statistics records from all births in California from the years The birth certificate data is linked to hospital discharge data (2013-2017). The sample (n=18,327) is restricted to singleton births to Black birthing people occurring in the 9 counties that constitute the San Francisco Bay Area. The exposure measure is neighborhood displacement typology developed by the Urban Displacement Project (UDP) at UC Berkeley. The UDP typology uses census and other publicly available data to categorize census tracts into various stages of gentrification and exclusion. Multilevel logistic regression was used to examine the association between gentrification and preterm birth. Mediation analysis was used to assess the role of housing insecurity in the association.

**Results:** Residence in low-income neighborhoods with advanced gentrification is associated with *lower* odds of preterm birth (aOR= 0.818, 95% CI: 0.642,1.042). This relationship was not mediated by prenatal care. There was, however, a partial suppression effect with housing insecurity, such that the relationship between advanced gentrification and odds of preterm birth was stronger holding housing security constant.

**Conclusions:** These findings should not be used as an endorsement of gentrification to improve infant health. Instead, they should be considered in light of other studies of neighborhood exclusion and health. To improve preterm birth among Black women and birthing people, jurisdictions prioritize ensure that individuals' ability remain in neighborhoods that are becoming more expensive and exclusive.

Key terms: preterm birth; perinatal health; gentrification; neighborhood effects; housing insecurity, racism

**Word count:** 7,719

## INTRODUCTION

In the United States, Black women are more likely to deliver their infants early compared to their white counterparts. This pattern has persisted amidst overall downward trends in preterm birth between 2007 and 2014 and the more recent upward trends between the years 2014 and 2019 (Martin, 2019). In California, the Black-white disparity largely mirrors national trends. Black women are 30% more likely to deliver preterm infants than white women (March of Dimes, n.d.). The most recent data on racial disparities in predictors of preterm birth in California shows that a greater proportion of Black women live in impoverished neighborhoods (52% vs 21%) and experience food insecurity (20.1% vs 11.4%) during pregnancy (California Department of Public Health, 2018). This is coupled with lower rates of health insurance coverage pre-pregnancy. These disparities are not explained by behavioral factors. Rates of smoking were comparable between Black and white women and Black women were less likely to alcohol use during pregnancy (6.1% vs. 15.3%).

This persistent racial disparity is significant because preterm birth is an important indicator for infant, child, adult health outcomes. Most immediately, preterm birth is a leading cause of neonatal (within 28 days of birth) infant (within the first year) mortality. Of the approximately 22,000 infants who die before their first birthday on an annual basis, 70% are born preterm (Lorenz et al., 2016). Preterm birth is also a leading cause of child mortality, death before age 5 (Howson et al., 2013). Thus, experts see the prevention of preterm birth as a significant intervention in infant and child mortality.

Substantial evidence suggests that neighborhood-level racial and economic inequality is associated with racial inequities in preterm birth (Anthopoulos et al., 2011; Bell et al., 2006; Britton & Shin, 2013; Kramer et al., 2010a; Kramer & Hogue, 2009; Nyarko & Wehby, 2012). These studies typically use ecologic designs to demonstrate that neighborhood inequality can explain some of the disparity in preterm birth between Black and white women. A growing

body of literature also demonstrates that unequal neighborhoods are associated with preterm birth risk among Black women irrespective of their white counterparts (Chambers et al., 2019; Krieger et al., 2017; Shrimali et al., 2020). These studies typically use a multilevel design whereby individuals are nested in neighborhoods characterized by some level of material deprivation.

The majority of studies designed to assess the effect of neighborhood-level segregation on infant health neglect to examine who or what is perpetrating the action. This practice of treating neighborhoods as containers, rather than dynamic place-based systems, fails to capture both the processes that sort people into places and how these processes influence birth outcomes. A notable exception in perinatal epidemiology is the work of Dara Mendez and colleagues on mortgage discrimination and preterm birth (Mendez et al., 2014). Using data from the Home Mortgage Disclosure Act (HMDA) database, they assess whether redlining was associated with preterm birth. They found that Black women who lived in neighborhoods characterized by *greater* mortgage discrimination against Black households were at *lower* risk of delivering early. At first glance, this finding may be surprising but conceptually it makes sense. Black households were systematically—but not totally—excluded from these neighborhoods; thus, those who were able to bypass that exclusion, may have benefitted from the resources available to other residents. Neighborhoods where Black people were *more* likely to get loans, on the other hand, may have had fewer health-promoting resources. Furthermore, predatory lending practices are known to target neighborhoods with greater proportions of Black households (Rugh & Massey, 2010; Taylor, 2019).

To better understand how place impacts preterm birth, scholars must take better care to understand *processes*, rather than just indicators, of exclusion. In other words, we need to know more about segregation as a verb rather than just a noun. As Mendez's work shows, increased access mortgages for Black households, *per se*, may not be as beneficial for health as expected if they are concentrated in 'unhealthy' neighborhoods. The underlying question, then, shifts from

“how does where you live affect your life chances, and thus, your health?” to “how do structural factors affect where you live *and* your health?” Traditional neighborhood effects research often fails to measure the structural factors that determine how and why people end up in particular neighborhoods (Slater, 2013).

The hyper focus on the causal impact of the neighborhood itself is lacking because the neighborhood is a *result of* political economic factors. Racially and economically segregated neighborhoods are created through processes of racialized spatial exclusion. Thus, little can be learned about how racism impacts health by studying concentrated poverty or segregation in isolation (Riley, 2018). Instead, it is important to study how *processes* of neighborhood investment and disinvestment, inclusion and exclusion impact health. As Slater asserts, it is not a clustering of poor people (who are assumed to make poor choices) that causes a neighborhood decline, it is that disinvestment makes "declining neighborhoods" more affordable for both poor people and hazardous industry (Slater, 2013). Uneven geographic development, then, may cause the concentration of poverty *and* unhealthy social environments.

Gentrification is a neighborhood-level process characterized by capital investment, increased housing costs and an increase in middle-class white residents. Gentrification presents a puzzle for public health researchers. On the one hand, housing activists and tenant organizers consider gentrification a form of urban colonialism. On the other hand, academic researchers often characterize gentrification as “neighborhood upgrading” and suggest the influx of capital investment could increase access to health promoting resources. Thus, some scholars suggest that there could be health benefits to living in gentrifying or gentrified neighborhoods for some populations (Schnake-Mahl et al., 2020; Steinmetz-Wood et al., 2017).

To our knowledge, only two studies explicitly examine the relationship between gentrification and preterm birth in the U.S. The only peer-reviewed published study was conducted in New York City and found that high levels of gentrification were associated with slightly higher odds of preterm birth among Black women (Huynh & Maroko, 2014a). For white

women, however, residence in a high gentrification area was associated with slightly reduced odds of preterm birth.

The second study explicitly measuring gentrification and preterm birth is an unpublished master's thesis (Zlotorzynska, 2014). In bivariate analyses, this study found that there was an inverse relationship between gentrification level and preterm birth such that high gentrification was associated with lower rates of preterm birth. In multivariate analyses, there was no association in the overall sample. Race-stratified models showed that compared to living in a low gentrification neighborhood, living in a neighborhood characterized by medium or high gentrification was *protective* for white women. This study was unique in that the models were run on two different cohorts (2000-2003 and 2004-2007) to test the hypothesis that *more advanced* gentrification will have different effects. The author, indeed, found that for white women, advanced gentrification was even more protective.

Three additional studies have examined neighborhood processes that are similar to gentrification without explicitly measuring it. In all three studies, the authors were interested in examining whether changes in neighborhood socioeconomic or racial composition was associated with birth outcomes. The first (Margerison-Zilko et al., 2015), sought to examine whether longitudinal measures of neighborhood poverty in California were associated with preterm birth. The authors found that compared to residence in long-term low poverty neighborhoods, residence in neighborhoods that experienced early and late poverty decreases was associated with preterm birth among the full sample of Black, white and Hispanic women. Second, Cubbin and colleagues (2020) sought to build on neighborhood change and gentrification research but they measured only population-based changes. Residence in neighborhoods with decreasing poverty (comparing to long term low poverty neighborhoods) was associated with slightly higher odds of preterm birth among the full sample of Black and white women.

Finally, the same authors performed a similar analyses but based on neighborhood racial trajectories (Kim et al., 2020). They sought to understand whether changes in racial demographics of neighborhoods measured by racial composition at three time points, was associated with preterm birth. For this study there are potentially three trajectories that could be proxies for gentrification: [1] Latinx neighborhoods losing Latinx people [2] Black neighborhoods losing Black people and [3] any neighborhoods gaining white people. Among these neighborhoods, loss of Black population was not associated with increased odds of preterm birth. Additionally, they found that the Black-white disparity in preterm birth is the smallest in neighborhoods that have “steady low” white trajectories. In these neighborhoods, the odds of delivering preterm is 34% higher for Black women compared to white women. In neighborhoods with increasing white trajectories however, the Black-white disparity increases to 55%. This could be a function of worse outcomes among white women who live in “low white” neighborhoods (i.e., there is a protective effect of segregation for white women). It could also suggest that there is something about neighborhoods becoming whiter that is associated with preterm birth among Black women.

These studies found that neighborhood trajectories that may be linked with gentrification are associated with slightly higher odds of preterm birth. All three suggest, however, that other neighborhood trajectories may have more significant effects on preterm birth. This may be because the measures do not include other key components of gentrification that may indicate neighborhood level exclusion or displacement pressures such as increasing housing costs. Nevertheless, these studies suggest that socioeconomic “upgrading” in neighborhoods may have implications for birth outcomes among certain populations.

Taken together, the literature examining the relationship between gentrification (and similar processes) and preterm birth suggests that, for Black birthing people, gentrification may be a harmful neighborhood exposure. However, there are two important gaps in the literature. First, the previous measures of gentrification, treat gentrification as a one-time neighborhood

change and therefore do not capture the nuances of the processes. These commonly used measures of gentrification fail to capture how it is a dynamic, staged process. Both of the studies that examine gentrification explicitly use a measure that may misclassify neighborhoods as not *gentrifying* if they have already been *gentrified*. The popular Freeman measure (Freeman, 2005) disregards, for example, neighborhoods that have undergone gentrification in a previous time period. The measure effectively treats neighborhoods that may have become increasingly exclusionary since *gentrifying* (or experience *über* gentrification) as irrelevant to the study of gentrification. Thus, we cannot better understand how late-stage gentrification is related to birth outcomes using the Freeman measure. To address this gap, a more robust measure of gentrification that can highlight differences across neighborhoods experiencing gentrification at different stages should be considered (Mujahid et al., 2019).

Secondly, there are no studies that examine *why* gentrification is associated with preterm birth. Previous research does not assess any potential mediators that can help explain why advanced gentrification might impact PTB among Black birthing parents. So far, studies have only explored associations between gentrification and preterm birth. This limitation prevents scholars or policymakers from understanding the various ways that neighborhood change can potentially influence health. Research does suggest, however that housing insecurity and prenatal care may be important pathways that could link gentrification and preterm birth. A 2019 study used propensity score matching to assess the effect of housing instability on preterm birth (Pantell et al., 2019). The authors found that women with housing instability designated on hospital discharge records had higher odds of preterm birth compared to presumably stably housed women (Pantell et al., 2019). Another study suggests that Black women in neighborhoods with low deprivation, which could be a proxy for a gentrified neighborhood, are more likely to have no or delayed prenatal care (Cubbin et al., 2008). Other studies suggest that housing unaffordability is a barrier to healthcare utilization (Reid et al.,



2008). These data suggest that studies explicitly measuring gentrification and health outcomes should go beyond finding associations and seek to test mediators to explain associations.

The purpose of this study is to assess the relationship between gentrification, housing insecurity and PTB among Black women in the San Francisco Bay Area. The aims are (1) to determine if gentrification stage is associated with preterm birth among Black women; (2) to determine if the association is mediated by housing insecurity or prenatal care. In this study, I will use a robust measure of gentrification that differentiates between 4 stages of exclusion across two types of neighborhoods: low-income and moderate-to-high income neighborhoods.

## METHODS

### Setting

The setting for this study is the San Francisco Bay Area which is an ideal region to study preterm birth among Black women and the processes of advanced gentrification. Preterm birth rates among Black women in the Bay Area varies across the 9 counties but are consistently higher than those of other racial groups (California Preterm Birth Initiative, 2020). The 9-county region is undergoing a third wave of gentrification referred to as Tech 2.0. The region is ideal to study the impact of gentrification for four main reasons. First, there is no scholarly or public debate as to whether gentrification is ongoing in the region. The Bay Area is characterized by both a large in-migration of upper-class workers and “creatives,” forced displacement (i.e., out-migration) of working class, especially Black workers. According to one estimate, 83,000 Black residents have migrated out of the inner region of the Bay between 2000 and 2014 (Samara, 2016). The rising housing costs in the Bay are also consistent with typical understandings of gentrification in a U.S. context. Second, the patterns of resegregation happening in the Bay Area are similar to other regions in the country. Third, the Bay Area is ideal because housing justice activists, organizations and scholars in the Bay have produced a wealth of data that has

not been developed at the same scale in other areas of the country. These data sources have been underutilized in public health research. Finally, the Bay Area, despite massive Black displacement, still has a sizable number of Black people. Twenty-six percent of the Black people (approximately 600,000) in the state live in the 9 counties that make up the Bay Area (U.S. Census Bureau, 2019).

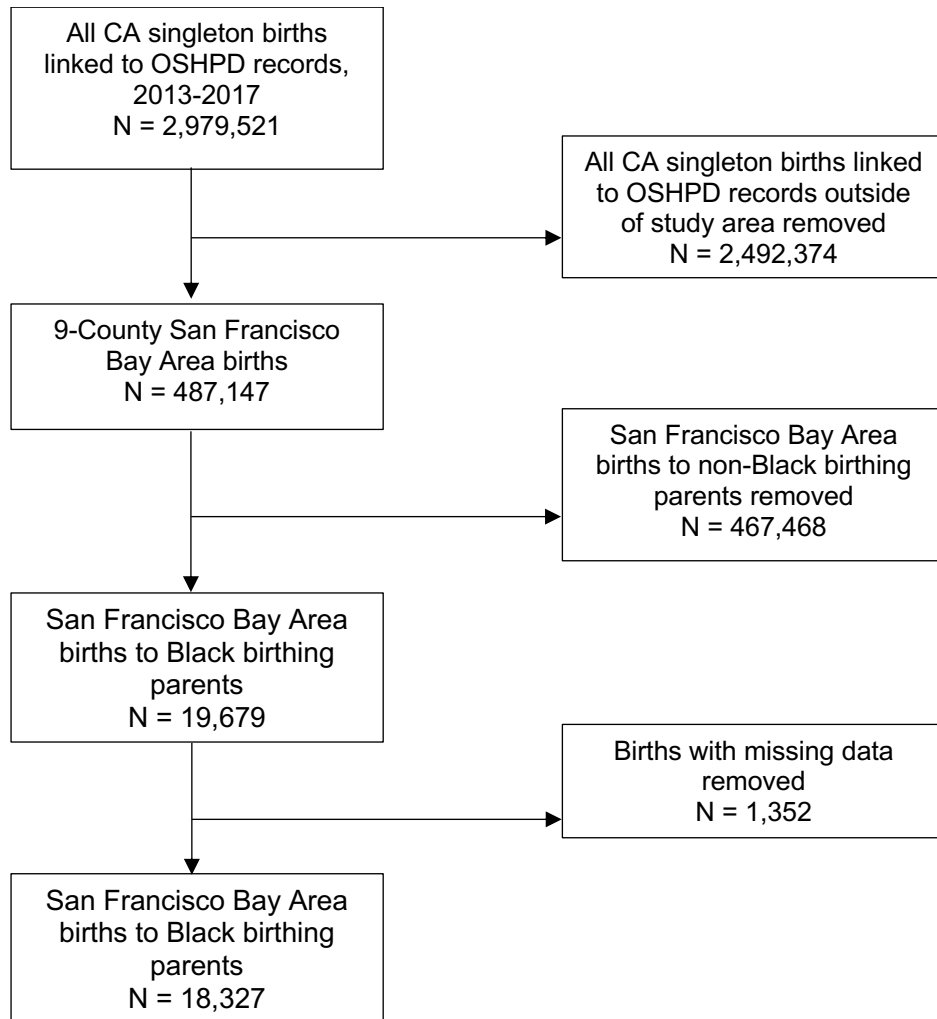
#### Data Preparation

*Outcome data.* Outcome data is provided by SOMI. The preterm delivery variable has been cleaned by prior investigators as have the covariates. The census tract variables were assessed in ArcGIS to ensure that each of the census tracts falls within the appropriate census place (i.e., city, town, or unincorporated place).

*Exposure data linkage.* Exposure data is provided by the Urban Displacement Project. The exposure variable was linked to birth record data via the many to one `merge` command in STATA. Gentrification is a dynamic process. Thus, the exposure data varies depending on the year. Deliveries between January 1, 2014 and December 31, 2015 were linked to the 2013 exposure variable. Deliveries between January 1, 2016 and December 31, 2017 were linked to the 2015 variable.

*Sample derivation.* The sample is drawn from all women who have given birth between the years 2013-2017 residing in the 9 counties within the San Francisco Bay Area who have Black/African American as at least one of their racial categories on their infant's birth certificate. The sample excludes women whose deliveries were not recorded by state records. The sample additionally excludes women who gave birth to multiple (i.e., twins, triplets, etc.) and infants with congenital anomalies because of their increased likelihood to deliver prior to 37 weeks' gestation. The sample size is N=18,327.

**Figure 1.**  
Sample Derivation Flow Chart



*Note.* Author received dataset with multiple births (i.e., twins, triplets, etc.) and births with infant congenital anomalies removed.

## Measures

*Outcome.* Preterm birth is a binary variable < 37 weeks' gestation (0=no, 1=yes). This is obtained from the birth records from a hierarchy of sources: high quality clinical estimates from ultrasounds, obstetrician estimates from birth record and last menstrual period from birth record.

*Predictor.* For this study, we used three specifications of gentrification stage. The first is a categorical variable with eight categories. The second is limited to low-income tracts and will

be an ordinal variable with four categories (0=not losing LI households, 1=at risk of displacement, 2=undergoing displacement, 3=advanced gentrification). And the third is limited to moderate-to-high income (MHI) tracts with four categories (0=not losing LI households, 1=at risk of displacement, 2=undergoing displacement, 3=advanced exclusion).

*Mediator.* Housing insecurity is a binary variable derived from hospital discharge data (0=no insecurity reported, 1=housing insecure). The International Statistical Classification of Diseases and Related Health Problems (ICD) Social determinants of health screening tool includes two specific items related to housing insecurity (Torres et al., 2017). Based on the years of the data, we used both ICD-9 and ICD-10 codes for “problems related to housing and economic circumstances” (ICD codes CDC 2020). Individuals with ICD-9 codes V600 “lack of housing” or code V601 “inadequate housing” or V6089 “Other specified housing or economic circumstances” on their hospital record were categorized as housing insecure. Individuals with ICD-10 codes Z59.0 “homelessness,” Z59.1 “inadequate housing,” or Z59.8 “other problems related to housing and economic circumstances” will be categorized as housing insecure.

*Control variables.* We included a set of control variables that are known to influence preterm delivery. *Maternal age* is age at delivery. *History of preterm birth* and *history of small for gestational age* are binary variables included on the birth certificate. *Insurance payor* is a categorical variable (private, public, none). *Maternal birthplace* is a binary variable (born in USA or not). *Maternal education* will be measured as a proxy for socioeconomic status and is determined by mother’s highest level of education. Categories include: less than high school, High school or equivalent, some college, bachelor’s degree, master’s degree, doctorate or professional degree. *Smoking* is a binary variable that indicates if an individual smoked at any point during the pregnancy. Though parity (birth order) is treated as a confounder in many studies on preterm birth, it may not meet the standard for a true confounder: (1) associated with the exposure, (2) associated with the outcome among the unexposed and (3) not on the causal

pathway (Hernán et al., 2002). We did not control for parity because we conceptualize it as being on the causal path between gentrification and preterm birth. We additionally controlled for county-level health expenditures. We calculated the annual county per capita health spending by averaging 2 years of data for each birth (year of delivery and year prior to delivery). Data for this variable is provided publicly by the California Department of Health Care Services (DHCS) (California Department of Health Care Services, n.d.).

### Analytic Strategy

First, we described demographic, health care and neighborhood characteristics of the sample including age, education, marital status, insurance status, prenatal care, housing stability and gentrification stage. We calculated the number and percent of *preterm births* as well as the mean and SD for *weeks' gestation* (continuous). Second, we evaluated the unadjusted relationship between the exposure (gentrification stage) and the outcome (preterm birth) by cross-tabulating these variables.

After conducting bivariate analysis, we prepared the data for multivariate analysis. The first step in this process was to calculate the intraclass correlation coefficient (ICC) to estimate the amount of variation in preterm birth between vs. within census tracts. An ICC value of zero suggests a one-level logistic regression analysis is appropriate. An ICC greater than zero indicates that there is variation between census tracts, which suggests a multilevel analysis is needed.

The intraclass correlation coefficient with the clustering at the census tract was 0.004 indicating a little variation in preterm birth across census tracts. Due to the small census tract ICC, we recalculated the ICC with clustering at the hospital-level. Conceptually, this allows us to account for similarities among individuals who are delivering at the same hospitals who may be more similar than those living in the same neighborhoods. The hospital ICC was .066 indicating

that there is more variation in preterm birth between hospitals than between neighborhoods; therefore, we conducted multilevel models with `hospital_id` as the clustering variable.

We used multilevel logistic regression to estimate the statistical relationship between *gentrification stage* and *preterm birth*. Odds ratios (ORs) and 95% confidence intervals will compare women living in census tracts with advanced gentrification to those living in neighborhoods at low risk of gentrification. Multilevel logistic regression is a common model used to assess area-level associations with preterm birth (Collins et al., 2015; DeFranco et al., 2008; Jahn et al., 2020; Messer et al., 2010; Nkansah-Amankra et al., 2010). A one-level logistic regression could be used but it would violate the assumption of independence of the residuals (Peugh, 2010). To determine which model was superior, we compared the 3 models: (1) single level, (2) multi-level clustered at the census tract, and (3) multi-level clustered at the hospital by comparing the AIC and BIC. I did not compare using likelihood ratio test because the models are not nested. In comparing the AIC & BIC amongst the models, the 3rd model (clustering at the hospital) had the lowest AIC and BIC indicating its superiority (Table available upon request).

To test whether housing insecurity mediated the relationship between gentrification and preterm birth, we used a mediation analysis technique described by Buis (2010). The method, which is adapted from Erikson et al. (2005), uses a counterfactual approach to compute direct and indirect effects in a logistic regression model. Specifically, this method (`ldecomp` in STATA) computes the direct effect by comparing the predicted probabilities of preterm birth across categories of neighborhood types, holding the probability of housing insecurity constant. The indirect effect is then estimated by comparing the predicted probabilities of preterm birth within one neighborhood type with the probabilities of preterm birth for the same group but assuming that the probabilities of housing insecurity are those of another neighborhood type. Data was managed and analyzed using Stata 17 (StataCorp, 2021).

## RESULTS

### Sample Characteristics

This section describes the characteristics of the sample with non-missing demographic information (N=18,327) based on the 2013-2017 SOMI dataset. About 80% of the sample is between the ages of 18-34 which is considered a healthy age range in perinatal epidemiology (Cnattingius et al., 1992; Fraser et al., 1995; Jacobsson et al., 2004). Nineteen percent of the sample is aged 34 and older, considered a geriatric pregnancy. Just over 1% were under the age of 18. Most of the sample (84.38%) was born in the United States and 83.24% categorize themselves as only Black. The sample is highly educated with 62.7% having more than a high school diploma. Over 50% of the sample was receiving government assistance at the time of delivery in the form of Supplemental Nutrition Program for Women, Infants, and Children (WIC). Less than 10% of the sample smoked tobacco at any point during their pregnancy. About 35% of the sample has less than adequate prenatal care, intermediate (23%) inadequate (12%). Only 1.2% of the sample had some form of housing insecurity on their hospital record. Table 1 shows the distribution of birthing parents by preterm birth. Notably, there is a statistically significant difference in birthplace, education, WIC participation, prenatal care, and housing insecurity between the sample and individuals who delivered preterm. It is important to note that for housing insecurity, the observed values of preterm birth are *lower* than the expected values.

<b>Table 1.</b> Distribution of maternal characteristics among Black birthing parents by preterm birth, San Francisco Bay Area, SOMI, 2013-2017, N=18,327					
Characteristic	All live births		Preterm birth		$\chi^2$ (p)
	n	%	n	%	
<b>Age</b>					
<18	241	1.30	23	1.45	19.67 ( $< 0.001$ )
18-34	14,610	79.11	1184	74.79	
>34	3,618	19.59	376	23.75	
<b>Birthplace</b>					
USA	15,584	84.38	1408	88.95	27.38 ( $< 0.001$ )
Outside USA	2,885	15.62	175	11.05	
<b>Insurance payor</b>					
private	13,155	48.36	1044	45.0	20.78 (0.002)
Public	13,564	49.86	1219	52.55	
None/self pay	375	1.37	48	2.07	
other	110	0.4	179	7.72	
<b>Education</b>					
Less than HS	1,764	9.55	180	11.37	6.75 (0.034)
HS or equivalent	5,125	27.75	436	27.54	
Greater than HS	11,580	62.70	967	61.09	
<b>WIC Participation</b>					
Yes	9,807	53.10	790	49.91	7.09 (0.008)
No	8,662	46.90	793	50.09	
<b>Smoking</b>					
Yes	1,568	8.49	222	14.02	68.25 ( $<0.001$ )
No	16,901	91.51	1361	85.98	
<b>Adequacy of prenatal care</b>					
Adequate Plus	3,658	19.81	703	44.41	721.91 ( $<0.001$ )
Adequate	18,304	44.96	565	35.69	
Intermediate	4,208	22.78	132	8.34	
Inadequate	2,299	12.45	183	11.56	
<b>Housing insecurity</b>					
Yes	220	1.20	46	2.93	43.2749 ( $<0.001$ )
No	18,101	98.80	1,524	97.07	

## Univariate Analysis

This section describes the distribution of the outcome and exposure variables. Table 2 describes the distribution of the outcome, preterm birth. In total, 1,583 (8.6%) of the births in the sample were preterm. Most of these (83.8%) were moderately preterm or between 32-37 weeks'



gestation. About 10% were very preterm or 28-32 weeks' gestation and 6.3% were extremely preterm or less than 28 weeks' gestation. Weeks' gestation ranged from 21-43 weeks among the sample with an average of 38.7 and standard deviation of 2.07.

<b>Table 2.</b> Distribution of preterm birth among Black women in the San Francisco Bay Area, SOMI, 2013-2017, N=18,327			
	N / mean	% / SD	range
Preterm Delivery (binary)	1,583	8.57%	
Preterm Delivery Type (categorical)			
Extremely (less than 28 weeks)	99	6.25%	
Very (28 to 32 weeks)	157	9.92%	
Moderate (32 to 37 weeks)	1327	83.83%	
Weeks' Gestation (continuous)	38.7	2.07	21-43 weeks

Table 3 presents the distribution of the exposure variable, Neighborhood Displacement Typology. Three quarters of the sample (76.4%, N=13,894) lived in low-income census tracts. Among these, about 37% live in census tracts at risk of displacement. Another 34.5% live in low-income tracts that are not (yet) losing low-income housing. Still another 20.2% live in tracts undergoing displacement. Among low-income tracts, those undergoing advanced gentrification had the fewest residents at 8.5%. The fewest number of birthing parents live in MHI census tracts undergoing advanced exclusion. Fewer Black birthing people resided in moderate/high income tracts. Among this group, the bulk (64.3%) lived in tract not yet undergoing exclusion. This amounted to about 15% of the total sample. The remaining neighborhood categories, at risk of exclusion and undergoing exclusion had the fewest residents, 4.5% and 3.6% of the total sample, respectively.

<b>Table 3.</b> Distribution of Neighborhood Displacement Typology measure among Black women in the San Francisco Bay Area, SOMI, 2013-2017, N=18,327						
Neighborhood Income Categorization	N	%	Neighborhood Displacement Type	N	% within category	% total
Low-income tracts	13,894	76.36	Not losing low-income housing	4796	34.52	26.17
			At risk of displacement	5099	36.70	27.82
			Undergoing displacement	2819	20.29	15.93
			Advanced gentrification	1180	8.49	6.44
Moderate/high-income tracts	4433	23.64	Not losing low-income housing	2848	64.25	15.54
			At risk of exclusion	829	18.70	4.52
			Undergoing exclusion	656	14.80	3.58

### Bivariate Analysis

Table 4 displays the number of live births and preterm births in each type of neighborhood between the years 2013-2017. These bivariate results assess whether preterm birth crudely varies by gentrification stage. The  $\chi^2$  for low-income census tracts was 4.435  $p=0.218$ . The  $\chi^2$  for moderate to high income census tracts was 2.2622  $p=0.520$ . This indicates that there is not a statistically significant difference in preterm birth among the different gentrification stages in the general sample.

<b>Table 4.</b> Risk per 100 live births of preterm birth (< 37 weeks' gestation) by Neighborhood Displacement Typology, San Francisco Bay Area, SOMI, 2013-2017, N=18,327				
Neighborhood Displacement Type		Live Births	Preterm Birth	
			Cases	Cases per 100 live births
Low-income tracts	Not losing low-income housing	4796	391	8.15
	At risk of displacement	5099	464	9.10
	Undergoing displacement	2819	261	9.26
	Advanced gentrification	1180	91	7.71
Moderate-high income tracts	Not losing low-income housing	2848	247	8.67
	At risk of exclusion	829	61	6.84
	Undergoing exclusion	656	54	8.23

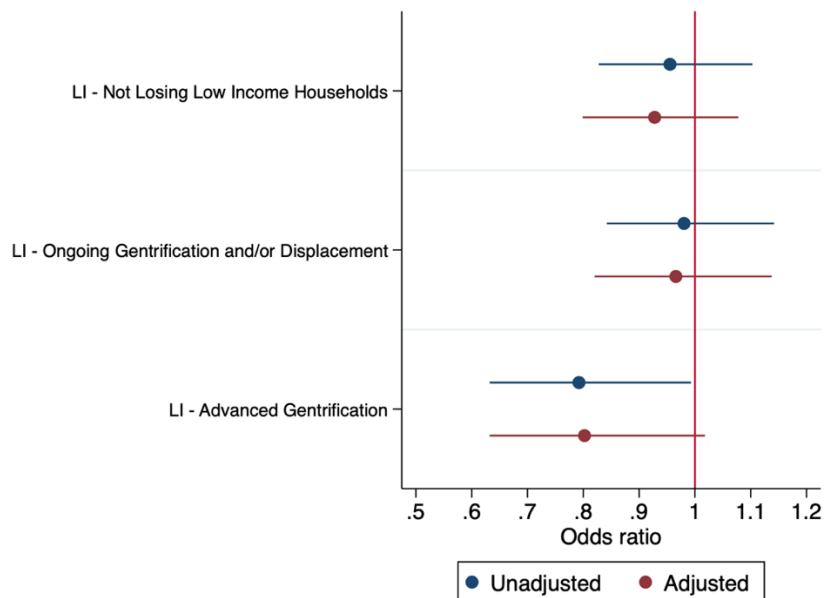
$\chi^2$  (p) low-income census tracts = 4.4358 (0.218)  
 $\chi^2$  (p) moderate to high income census tracts = 2.2622 (0.520)

## Multivariate Analysis

Figure 2 displays the unadjusted and adjusted odds ratios of preterm birth. In the unadjusted multilevel logistic regression analyses, individuals living in low-income neighborhoods undergoing advanced gentrification had *lower* odds of preterm birth than those living in neighborhoods at risk of gentrification (OR= 0.789, 95% CI: 0.623,1.000). After adjusting for maternal characteristics, the confidence interval marginally includes one indicating that this association was no longer statistically significant. However, the point estimate remained relatively stable (OR= 0.818, 95% CI: 0.642,1.042). The data do not support the hypothesis that advanced gentrification was associated with higher odds of preterm birth. Instead, these results suggest the opposite: residence in neighborhoods undergoing advanced gentrification (relative to those at risk for gentrification) is associated with lower odds of preterm birth.

**Figure 2.**

Unadjusted and adjusted odds ratios of preterm birth as a function of Neighborhood Displacement Typology, low-income tracts, SOMI, 2013-2017, N=13,994



*Note.* Reference neighborhood is low-income (LI) at risk of gentrification. Adjusted model controls for, age, birthplace, education, WIC, insurance type, smoking, and per capital county health expenditures

Table 5 displays the unadjusted and adjusted odds ratios for neighborhood displacement typology in low-income (LI) tracts. Regarding the covariates, in the adjusted model, private insurance, smoking, nativity, WIC participation, age, and per capita county health expenditures had statistically significant associations with preterm birth. Individuals with private insurance had 22% lower odds of PTB than those with public or no insurance (OR= 0.789, 95% CI: 0.660,0.942). Individuals older than 34 had odds of PTB 49% higher than birthing people younger than 34 (OR= 1.488, 95% CI: 1.280,1.729). Odds of PTB were 82% higher for individuals who smoked tobacco during pregnancy compared to nonsmokers (OR= 1.823, 95% CI: 1.533,2.168). Individuals born in the U.S. had odds of PTB 84% higher than those born outside of the US (OR= 1.844, 95% CI: 1.489,2.283). Odds of PTB were 22% lower for those participating in WIC (OR=0.782, 95% CI: 0.681,0.897). Finally, for every \$100 increase in per capita county health expenditures, odds of PTB decreased by 8% (OR=0.916, 95% CI: 0.861,0.974).

<b>Table 5.</b> Odds of preterm birth as a function of Neighborhood Displacement Typology and covariates, low-income tracts, SOMI 2013-2017, N=13,994		
	(1) Unadjusted OR [95% CI]	(2) Adjusted OR [95% CI]
Not Losing Low Income Households	0.960 [0.827,1.114]	0.942 [0.809,1.097]
At Risk of Gentrification	(ref)	(ref)
Ongoing Gentrification	0.960 [0.818,1.128]	0.972 [0.822,1.148]
Advanced Gentrification	0.789* [0.623,1.000]	0.818 [0.642,1.042]
College Edu		0.870* [0.764,0.991]
Private Insurance		0.789** [0.660,0.942]
Any smoking during pregnancy		1.823*** [1.533,2.168]
USA born		1.844*** [1.489,2.283]
sex		0.988 [0.877,1.113]
Age - older than 34		1.488*** [1.280,1.729]
WIC participation		0.782*** [0.681,0.897]
Year Categories - UDP methodology		0.986 [0.863,1.127]
Per Capita County Health Expenditures (Hundreds)		0.916** [0.861,0.974]
Observations	13994	13994
AIC	8167.4	8047.8
BIC	8205.2	8153.5

ll	-4078.7	-4009.9
chi2	3.853	142.9
<i>Note.</i> Exponentiated coefficients; 95% confidence intervals in brackets * $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$ Adjusted model controls for all variables in the table.		

### Mediation Analysis

Table 6 displays the mediation analyses which used a counterfactual approach to estimate the indirect and direct effects of neighborhood typology on preterm birth through both adequacy of prenatal care and housing insecurity. This association is not mediated by housing insecurity. The mediation analysis demonstrated that housing insecurity slightly suppress the relationship between gentrification stage and preterm birth among Black birthing people. The odds ratio for the direct effect of advanced gentrification on preterm birth is slightly lower than the total effect (OR=0.807 vs 0.798,  $p < 0.10$ ).

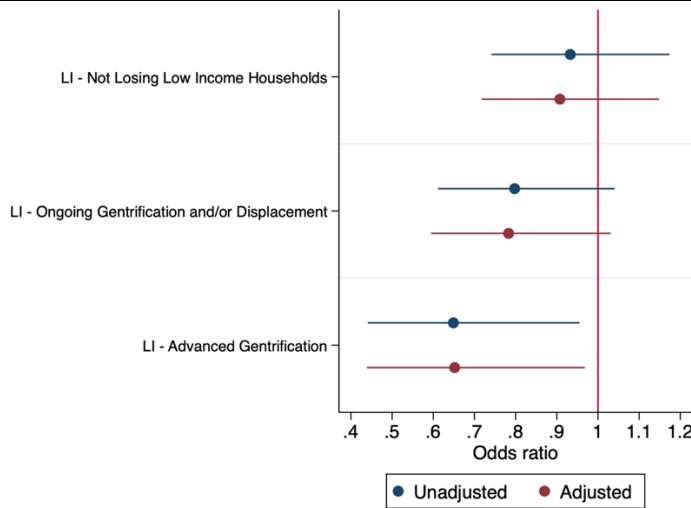
<b>Table 6.</b> Decomposition of the effect of advanced gentrification on the odds of preterm birth, Low-Income Tracts, SOMI 2013-2017, N=13,994			
	OR	SE	P
Advanced gentrification			
Total	0.807	(0.099)	0.080
Indirect (via housing insecurity)	1.011	(0.006)	0.065
Direct	0.798	(0.097)	0.064
% Mediated by housing insecurity	5.5%	(1.859)	0.976
<i>Note.</i> odds ratios with standard errors in parentheses. Based on Table 5.5, model 2. Comparison group = individuals residing in low-income census tracts at risk of gentrification. Decomposition model controls for age, birthplace, education, WIC, insurance type, smoking, and per capital county health expenditures			

### Sensitivity Analysis

Two procedures were used check the robustness of the logistic regression analyses. First, to address the concern that there may be selection bias if individuals have more than one birth in the dataset, I ran the analysis on nulliparous sample. These are individuals with no previous births. Figure 3 displays the unadjusted and adjusted odds ratios for the nulliparous sample (n=5,766). The findings are consistent with the main analysis. Compared to individuals

in neighborhoods at risk of gentrification, those in neighborhoods undergoing advanced gentrification had lower odds of preterm birth (OR= 0.652, 95% CI: 0.439, 0.968). In this model, the confidence interval did not include one.

**Figure 3.** Sensitivity analysis, unadjusted and adjusted odds ratios of preterm birth as a function of Neighborhood Displacement Typology, nulliparous sample, N=5,766

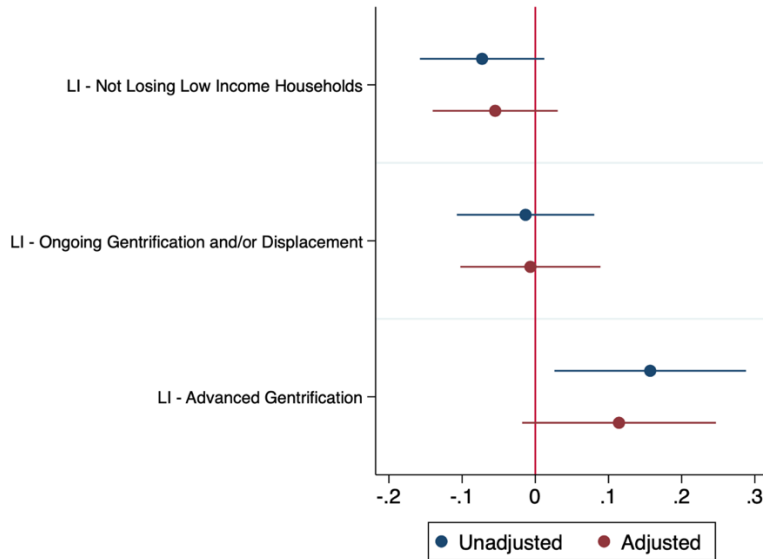


*Note.* Reference neighborhood is low-income tract (LI) at risk of gentrification  
Adjusted model controls for, age, birthplace, education, WIC, insurance type, smoking, and per capital county health expenditures

To address the concern that logistic regression may overestimate the effect size, I reran the analysis using a continuous outcome: weeks' gestation. Figure 4. displays the unadjusted and adjusted coefficients. Residence in neighborhoods undergoing advanced gentrification is associated with slightly longer gestation. After controlling for individual characteristics, the confidence interval included 1 indicating the association was no longer statistically significant. However, the results are in the direction consistent with the main analysis.

**Figure 4.**

Sensitivity analysis, unadjusted and adjusted coefficient of weeks' gestation as a function of Neighborhood Displacement Typology, N= 13,994



*Note.* Reference neighborhood is low-income tract (LI) at risk of gentrification  
Adjusted model controls for, age, birthplace, education, WIC, insurance type, smoking, and per capital county health expenditures

## DISCUSSION

*Gentrification is “protective” of preterm birth.* Results suggest that, overall, gentrification stage is not associated with preterm birth among Black women. The relationship becomes clearer when analyzing the low-income and high-income neighborhood separately. Compared to low-income tracts at risk of gentrification, residence in tracts undergoing advanced gentrification was associated with lower odds of preterm birth. This finding diverges from the only other published study on gentrification and preterm birth (Huynh & Maroko, 2014b). The divergence may be explained by the measure used to classify gentrifying neighborhoods. While the Huynh and Maroko study compared neighborhoods “eligible” for gentrification to those undergoing gentrification, the present study compared those at risk with those undergoing advanced stages.

This finding is consistent with other studies on neighborhood exclusion and pregnancy outcomes. For example, Mendez (2014) found that residence in census tracts with high rates of mortgage discrimination against Black people was “protective” of preterm birth. As in this study,

this protective effect may be a reflection that those who have the resources to live in exclusive neighborhoods, may already be at lower risk of preterm birth and may benefit from the resources available in those neighborhoods.

In this sense, one explanation for the seeming protective effect of advanced gentrification is neighborhood selection. This explanation takes the results at face value that individuals residing in a neighborhood with advanced gentrification do have lower odds of preterm birth. However, it is not the neighborhood, per se, that is protective. Rather, it may be that individuals with the financial ability to move into gentrified neighborhoods are already at lower risk of preterm birth than those who cannot afford to live in such neighborhoods. As a cross-sectional study, selection into neighborhoods cannot be ruled out. There is limited research on Black residential mobility into previously gentrified neighborhoods. Research on Black women and residential mobility suggest that downward mobility is more common among Black women than other groups (Gailey et al., 2021; Sharkey, 2012). This multidisciplinary body of work also suggests that when Black women move into neighborhoods undergoing gentrification, it is at the *early* stages of the process (Moore, 2009). These neighborhoods are more likely to be working class urban neighborhoods. These studies do not specifically examine health prior to or after moving.

The protective effect of gentrification in this study may also be partially explained by the rent gap theory. The rent gap theory developed by Neil Smith (1987). It proposes that neighborhoods begin to undergo gentrification when there is the greatest gap between actual land value and the potential land value. At this point, landlords, developers, and other parties interested in maximizing profits begin to aggressively displace residents via evictions and other forms of violence. Slater describes the actions used to clear out properties and land in neighborhoods at early stages of gentrification:

The [emptied properties] referred to above do not simply “appear” as part of some naturally occurring neighbourhood obsolescence and “decay”—they are *actively produced* by clearing out existing residents via all manner of tactics and legal



instruments, such as landlord harassment, massive rent increases, redlining, arson, the withdrawal of public services, and eminent domain (or “compulsory purchase orders” in the UK). Closing the rent gap requires, crucially, separating people currently obtaining use values from the present land use providing those use values—in order to capitalise the land to the perceived “highest and best” use. The rent gap thus highlights specific social (class) interests, where the quest for profit takes precedence over the quest for shelter (Slater, 2017, pp. 119–120).

These violent removals at earlier stages may help explain the lower odds of preterm birth in neighborhoods with advanced gentrification. There is growing evidence that the act of separating people from shelter is related to preterm birth. The research on evictions and foreclosures at the individual level suggests that being forcefully removed from one home while pregnant can increase the likelihood of preterm birth. Eviction at any point in the life course is a stressful experience (Hoke & Boen, 2021). The stress may be exacerbated during pregnancy. A study conducted in Georgia, found that eviction during the second or third trimester was associated with reduced birth weight and gestational age (Himmelstein & Desmond, 2021). Additionally, the threat of homelessness may impact a pregnant person’s health even without the formal process of eviction (Leifheit et al., 2020). Matthew Desmond’s research on eviction demonstrates that not all removals are formal evictions. Landlords engage in a myriad of tactics ranging from threats, increasing rent, neglecting repair to forcefully remove residents.

Even when individuals are not experiencing evictions or the threat of eviction, there may be spillover effects of neighborhood-level evictions on preterm birth outcomes (Sealy-Jefferson et al., 2021). The rent gap theory suggests that evictions may be more prevalent in neighborhoods at risk of gentrification compared to those with advanced gentrification. If this is case, the protective effect seen in neighborhoods with advanced gentrification may be a function of the displacement-related violence in at-risk neighborhoods.

*Housing insecurity slightly suppresses the relationship between advanced gentrification and preterm birth.* Given the unanticipated protective effect of gentrification stage, the suppression (rather than mediation) effect of housing insecurity was expected. The indirect and direct effects were in opposite directions causing a suppression of the odds ratio in the

regression model. This relationship makes conceptual sense. Holding housing insecurity constant, the protective effect is slightly stronger. Still, the suppression effect is almost negligible, explaining only 5.5% of the total effect. One explanation for this small effect size might be how housing insecurity is measured. The variable was derived from medical records and this the data used to may not be valid. It is unlikely that Black women experiencing housing insecurity will report it in a medical setting due to the punitive nature of child protective services (Fong, 2019).

## Limitations

These finding should be interpreted in light of several limitations.

*Causal inference.* For the cross-sectional analysis in Aim 1, findings should be interpreted as associational, not causal. The strength of the associations found in the study are weak-to modest. Additionally, temporality is difficult to establish because both the exposure and outcome were measured at the same time. A dose-response relationship was also difficult to establish because it is not possible to determine how long women have been living in their neighborhoods. It may be that women who are long term residents have different outcomes than those who are newcomers. Neighborhood tenure is also complicated by homeownership, which is unmeasured in this study. It is not possible to determine who in the sample owns vs. rents their home. Even though homeownership is not as beneficial to Black families as it is to white families, it likely changes the relationship between gentrification and health for Black women.

*Census tracts as neighborhood proxies.* Neighborhoods are dynamic spatial entities. A common challenge in neighborhood-based research is the use of administrative boundaries as proxies. These operationalizations can be described as atheoretical and apolitical (Riley, 2018; Schafran, 2018). In this study, it is unclear if census tracts are meaningful boundaries in terms of measuring gentrification. There may also be concern that census tracts (vs. block groups or

another scale) was inappropriate. Despite these limitations, using the census tract in this study was advantageous because of the Neighborhood Displacement Typology measure. The Urban Displacement Project conducted qualitative case studies in 9 Bay Area communities to assess the extent to which the measure was consistent with “on the ground” interpretations of gentrification. In addition, other studies comparing health outcomes in census tract boundaries and “natural neighborhoods” (Ross et al., 2004) and spatial density measures (Kramer et al., 2010b) found similar results.

*Selection bias.* The administrative dataset used for the empirical analyses in Aims 1 and 2 include most births in the region which minimized sampling bias as the population allowed for adequate statistical power. However, due to the deterministic (birth record to hospital discharge data) linkage strategy, there is a possibility of missed matches. This could have biased the results if, for example, a particular hospital was more likely to have errors in their reporting.

## Strengths

Despite these limitations, the study has several strengths.

*Plausibility.* The finding that advanced gentrification is associated with lower odds of preterm birth was not in the expected direction but it is plausible. This finding is consistent with other research on neighborhoods and maternal health. Gentrification is a neighborhood process that can be viewed in two (non-mutually exclusive) ways: as neighborhood exclusion and as neighborhood upgrading. Both are usually happening at the same time. Other measures of neighborhood exclusion (e.g., mortgage discrimination) is associated with a protective effect of preterm birth for Black women (Mendez et al., 2014). Additionally, poor neighborhoods with more health resources are also protective of adverse pregnancy outcomes (Headen et al., 2019).

*Robust measure of gentrification.* The Urban Displacement Project measure of gentrification captures gentrified, gentrifying, and non-gentrifying neighborhoods. In a comparison of measures Mujahid and colleagues found that the UDP measure was able to identify gentrified tracts that were missed with other measures (Mujahid et al., 2019). The results demonstrate that there are differences in preterm birth in particular neighborhood typologies that may be overlooked when just examining gentrification as a binary variable. This may help explain why the findings from this study differ from the only other published study on gentrification and preterm birth (Huynh & Maroko, 2014b). The qualitative differences (i.e., what is happening in the neighborhoods) should be further explored to better understand how health and illness is produced across space.

*Testing pathways linking gentrification and preterm birth.* This study is the first, to my knowledge, to test pathways linking gentrification to preterm birth. I tested two potential mediators as indicators financial strain: housing insecurity and adequacy of prenatal care. Gentrification is defined, in part, by increasing housing costs and could influence women's experience of housing insecurity which, in turn, could increase risk for preterm birth. I also hypothesized that the financial strain of living in a gentrifying neighborhood might reduce women's access to and utilization of prenatal care. Neither variable mediated the relationship between advanced gentrification and preterm birth. However, holding housing insecurity constant, strengthened the association slightly. Future research should explore other factors that may explain this relationship.

#### Implications for future research

*Testing the rent gap theory.* The finding that residence in neighborhoods with advanced gentrification is associated with lower odds of preterm birth suggests that future research should empirically test the rent gap theory and health outcomes. There is a small but growing body of literature that examines evictions and health. These studies tend to use data from the

EvictionLab which compiles formal evictions and eviction filings down to the Census block group. The EvictionLab data is then linked to survey or administrative data to examine potential associations with health outcomes. Work exploring the health implications of other forms of dispossession may be an important area. Scholars could examine how the production and exploitation of rent gaps by landlords, developers, and police are related to health outcomes and health-related resources. This would place dispossession in the larger context of housing commodification.

#### Implications for policy

The findings of this study suggest that decision-makers should prioritize anti-displacement policies. If neighborhoods at early stages of gentrification are hardest hit by displacement tactics, these policies would protect the most vulnerable residents including Black mothers. If health-promoting resources are concentrated in exclusive neighborhoods such as those undergoing advanced gentrification, anti-displacement policies would give residents more options to remain in or move into such neighborhoods. Several tenant organizations in the San Francisco Bay Area have targeted rent control, just cause eviction as key policies to foster neighborhood inclusion. Universal basic income is not a housing-specific policy, but it is one that can foster neighborhood inclusion by increasing the disposable income of Black birthing people. One such policy is being piloted in San Francisco. Delivering Birth Justice provide Black and Pacific Islander birthing people with a no-strings attached \$1000 per month to improve birth outcomes. Evaluation is underway but many of the recipients use the funds for housing costs (Z. Malawa, personal communication, November 10, 2021).

#### CONCLUSION

Living in a neighborhood undergoing advanced gentrification is associated with lower, not higher, odds of preterm birth among Black people living in the San Francisco Bay Area. This

finding should not be used as an endorsement of gentrification to improve health. Instead, it should be seen in light of other studies of neighborhood exclusion and health. To improve preterm birth among Black women and birthing people, jurisdictions and regions should prioritize policies that ensure that individual can stay in neighborhoods that are becoming more expensive and exclusive. These might include rent control, just cause eviction, and universal basic income.

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