Neighborhood Racial/Ethnic Composition Trajectories and Black-White Differences in Preterm Birth among Women in Texas

Yeonwoo Kim • Shetal Vohra-Gupta •
Claire E. Margerison • Catherine Cubbin

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Abstract The black-white disparity in preterm birth has been well documented in the USA. The racial/ethnic composition of a neighborhood, as a marker of segregation, has been considered as an underlying cause of the racial difference in preterm birth. However, past literature using cross-sectional measures of neighborhood racial/ethnic composition has shown mixed results. Neighborhoods with static racial/ethnic compositions over time may have different social, political, economic, and service environments compared to neighborhoods undergoing changing racial/ethnic compositions, which

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Y. Kim
School of Kinesiology, University of Michigan, Ann Arbor, MI, USA

Y. Kim
Institute for Social Research, University of Michigan, Ann Arbor, MI, USA

S. Vohra-Gupta • C. Cubbin
Steve Hicks School of Social Work, The University of Texas at Austin, Austin, TX, USA

C. E. Margerison
Department of Epidemiology and Biostatistics, Michigan State University, East Lansing, MI, USA

C. Cubbin (✉)
Population Research Center, The University of Texas at Austin, Austin, TX, USA
e-mail: ccubbin@austin.utexas.edu

may affect maternal health. We extend the past work by examining the contribution of neighborhood racial/ethnic composition trajectories over 20 years to the black-white difference in preterm birth. We used natality files ($N = 477,652$) from birth certificates for all live singleton births to non-Hispanic black and non-Hispanic white women in Texas from 2009 to 2011 linked to the Neighborhood Change Database. We measured neighborhood racial/ethnic trajectories over 20 years. Hierarchical generalized linear models examined relationships between neighborhood racial/ethnic trajectories and preterm birth, overall and by mother's race. Findings showed that overall, living in neighborhoods with a steady high proportion non-Hispanic black was associated with higher odds of preterm birth, compared with neighborhoods with a steady low proportion non-Hispanic black. Furthermore, while black women's odds of preterm birth was relatively unaffected by neighborhood proportions of the Latinx or non-Hispanic white population, white women had the highest odds of preterm birth in neighborhoods characterized by a steady high proportion Latinx or a steady low proportion non-Hispanic white. Black-white differences were the highest in neighborhoods characterized by a steady high proportion white. Findings suggest that white women are most protected from preterm birth when living in neighborhoods with a steady high concentration of whites or in neighborhoods with a steady low concentration of Latinxs, whereas black women experience high rates of preterm birth regardless of proportion white or Latinx.

Keywords Neighborhood racial/ethnic compositions · Neighborhood trajectories · Preterm birth · Racial disparity

Introduction

Preterm birth is the leading cause of neonatal and infant mortality [1, 2]. Preterm babies are at increased risk for adverse health outcomes, neurodevelopmental problems, and disability [3, 4]. The black-white difference in preterm birth has been documented in the USA for decades [5, 6]. For 2016, non-Hispanic black women were 50% more likely to deliver preterm compared to non-Hispanic white women (13.8% vs. 9.0%) [5]. Researchers have investigated underlying reasons for the black-white difference in adverse birth outcomes; yet, the difference has remained unexplained after adjustment for individual-level factors in most population-based studies [7–10].

Following an earlier focus on individual-level factors of racial difference in preterm birth, research has turned to neighborhood factors to potentially explain the difference. Researchers have posited the racial/ethnic composition of a neighborhood as a significant underlying cause of the racial difference in preterm birth [11–13]. For a variety of reasons stemming from institutional and interpersonal racism—including socioeconomic inequality, racial prejudice, and housing market discrimination—neighborhood racial/ethnic composition is highly variable [14, 15]. Non-Hispanic blacks tend to reside in neighborhoods with a high proportion of racial/ethnic minorities (hereafter, referred to as “predominantly non-white neighborhoods”) rather than neighborhoods with a high proportion of non-Hispanic whites (hereafter, referred to as “predominantly white neighborhoods”) [15]. Predominantly non-white neighborhoods on average have limited social, economic, educational, and healthcare opportunities and are considered as less safe and less comfortable [16–19]. A review study [14] by Williams and Collins found that the physical separation of racial groups is likely to adversely affect the practice of a broad range of health behaviors and access to high-quality medical care, which disproportionately impact poor health for blacks. Given that preterm birth is associated with neighborhood deprivation and maternal stress [20–26], it has been hypothesized that living in predominantly non-white neighborhoods prior to or during pregnancy

increases risk of preterm birth (hereafter, neighborhood deprivation hypothesis).

The overall picture of associations between neighborhood racial/ethnic composition and preterm birth becomes more complicated when considering women’s race/ethnicity. According to the ethnic density hypothesis, the health of ethnic minorities is improved when living in neighborhoods with a higher concentration of one’s own racial/ethnic group. One’s own racial/ethnic group in the residential neighborhood provides opportunities for social interaction, access to culturally accessible resources, and material, logistic, and social support that promote individual health [27–29]. In addition, living in predominantly non-white neighborhoods may place minority residents at lower risk of racial discrimination and exclusion [30]. For example, some studies [31, 32] showed that living in neighborhoods with a higher proportion of black people was associated with a lower level of discrimination among black women compared to living in neighborhoods with a low proportion of black people. In summary, the ethnic density hypothesis posits that higher social capital, social support, shared culture, culturally accessible resources, and less racial discrimination that minority residents may have in neighborhoods with many people who “look like them” may override social and material deprivation that also often occurs in predominantly non-white neighborhoods [33].

The ethnic density effect was first investigated as a correlate of mental health outcomes. In a classic study [34], an inverse association between living in one’s own ethnic neighborhood and rates of psychiatric hospital admission was found for blacks and whites. Recently, literature has shown a significant association between one’s own racial/ethnic composition in the neighborhood and better physical health outcomes, albeit with associations differing by age and race/ethnicity [33, 35–37]. Literature examining the association between the proportion of one’s own racial/ethnic group in the neighborhood and risk of preterm birth, however, shows mixed findings—a positive [38, 39], inverse [33, 40, 41], or insignificant association [33, 42] overall or within a subgroup. Also, because most of the studies focused only on a non-white sample, their analysis did not inform whether neighborhood racial/ethnic composition contributes to the black-white difference in preterm birth [33, 38, 39, 43]. There are a few birth outcome studies examining interactions between neighborhood racial/ethnic composition and women’s race, but using birth

records from 1990 to 2003 and finding inconsistent results [11, 41, 44, 45].

Neighborhoods are not static but dynamic entities that evolve through time due to changes in immigrant settlement patterns and mobility in general [40, 46, 47]. In particular, the Latinx population has increased rapidly during recent decades, and Texas is one of the three states where more than half of the US Latinx population resides [48, 49]. The proportion of African Americans has decreased in Texas over 60 years [50]. Theoretically, historically and predominantly non-white neighborhoods may have health-compromising environments—such as less investment in a broad range of services and medical care, safety concerns, lack of social support, advertisement for unhealthy foods and substances—than neighborhoods that currently, but not historically, have high proportion of racial/ethnic minorities, as a result of limited economic, social, and political power. Neighborhoods undergoing changing racial/ethnic compositions may also face benefits (e.g., social integration, diversity) and stressors (e.g., racial income inequality, unstable social change) [51–55], compared to neighborhoods with static racial/ethnic compositions over time. Using Texas census tract-level data from 1990 to 2010, our study, currently under review, found that neighborhoods varied considerably on neighborhood economic status according to neighborhood racial/ethnic trajectories [56]. For example, neighborhoods with changing (either increasing or decreasing) proportion of whites over 20 years were more likely to have high-poverty trajectories than neighborhoods with a consistently high proportion of whites during the same period [56]. Thus, consideration of neighborhood racial/ethnic trajectories may reflect economic, social, and environmental changes caused by the historical patterns of migration and mobility in Texas, compared to using a single point-in-time measure of neighborhood racial/ethnic composition.

Furthermore, living in neighborhoods with a high proportion of Latinx people (hereafter, referred to as “predominantly Latinx neighborhoods”) may contribute to reducing the risk of black mothers’ preterm birth and ultimately the black-white difference. This is because predominantly Latinx neighborhoods as the largest racial/ethnic minority group in Texas could provide black women higher levels of social capital and minority-focused resources and less racial discrimination compared to predominantly white neighborhoods [11].

This study examined whether neighborhood racial/ethnic trajectories over 20 years explain black and white mothers’ preterm birth and the black-white difference in effect estimates of preterm birth because none has examined neighborhood racial/ethnic trajectories associated with preterm birth and its black-white differences. The following hypotheses guided the study: (1) living in historically Latinx or non-Hispanic black neighborhoods will serve a protective role against preterm birth for black, but not white, women; (2) living in historically non-Hispanic white neighborhoods will serve a protective role for white, but not black, women; and (3) living in historically Latinx or non-Hispanic black neighborhoods will reduce the black-white difference in effect estimates of preterm birth compared to the difference in historically non-Hispanic white neighborhoods.

Methods

Data

Individual-level data were obtained from Texas natality files for all live, singleton births in Texas from 2009 to 2011. Census tracts were used as approximations of neighborhoods, consistent with past studies [26, 57]. Neighborhood data for the years 1990 through 2010 came from the Neighborhood Change Database (NCDB), the gold standard in examining census tract-level data over time. We did not use 1970–1980 decennial censuses because 1250 out of 5265 census tracts had records missing neighborhood racial/ethnic composition in either 1970 or 1980 (i.e., rural areas that had not yet been assigned tract geocodes). Neighborhood data were linked to natality files on the basis of tract geocodes derived from women’s residential address on birth certificates.

Our analytic sample included all singleton births to non-Hispanic black and non-Hispanic white women during the 3-year period ($N = 513,148$; black = 127,763; white = 385,385). We excluded records missing length of gestation or birth weight ($n = 9756$), those with gestational age < 22 or > 44 weeks ($n = 4337$), and those with biologically implausible birthweight-gestation combinations ($n = 2275$) based on Alexander et al. guideline [58]. We also excluded records missing 2010 geocodes ($n = 21,536$), those missing neighborhood racial/ethnic compositions from 1990 through

2010 ($n = 1472$), those not falling into any of neighborhood racial/ethnic trajectories ($n = 1946$), and those missing maternal age, nativity, parity, or education ($n = 393$). The final sample is 471,433 births (92% of the total).

Individual Measures

Our dependent variable is preterm birth. We categorized births as preterm (< 37 weeks completed gestation) or term (≥ 37 weeks completed gestation [reference]) based on the birth certificate estimate of gestational age. Individual-level covariates are mother's age at delivery (12–19 years of age; 20–34 years of age [reference]; 35 or above), mother's race (non-Hispanic black; non-Hispanic white), mother's parity (first child [reference]; second-fourth child; fifth child or more), mother's marital status (married [reference]; not married), mother's education level (less than high school; high school/GED; some college; college graduate or more [reference]), father's education level (less than high school; high school/GED; some college; college graduate or more [reference]; missing), and mother's prenatal care experience (first trimester care [reference]; no first trimester care). Young and older women may have higher risks of preterm birth than women of 20–34 years of age possibly due to social disadvantage, biological immaturity, and unhealthy behaviors for young women [59] and preexisting chronic diseases, medical problems, and infertility for older women [60, 61]. Multiparas had greater perinatal risks than primiparas [61] especially among older women [62]. Black women and low socioeconomic status (SES) women may have higher risks of preterm birth than white or high SES women because of psychosocial stress [63–66] operating through system function/susceptibility to infection and health behaviors [67, 68]. Unmarried women may experience stress from relationship instability, lack of psychosocial support, and socioeconomic disadvantage, which possibly leads to adverse birth outcomes, compared to married women [69]. Appropriate timing of prenatal care during pregnancy is important to prevent preterm birth by providing services to manage preterm labor and improving health behaviors and knowledge about early warning signs of pregnancy complications [70, 71].

Neighborhood Measures

Neighborhood racial/ethnic trajectories are the main exposure variables. We used census tract-level trajectories of the Latinx population, non-Hispanic black population, and non-Hispanic white population between 1990 and 2010.

We first created three cross-sectional measures of neighborhood-level proportions of the Latinx, non-Hispanic black, and non-Hispanic white populations based on the distribution of the 1990, 2000, and 2010 data (tertiles). Next, using the three cross-sectional measures for each time period and population, we categorized neighborhoods into five trajectories defined a priori [26]: (1) steady low trajectory, (2) steady moderate trajectory, (3) steady high trajectory, (4) increasing trajectory, and (5) decreasing trajectory. First, many neighborhoods would have a steady proportion of each population over time (i.e., steady low, steady moderate, or steady high). Census tracts in a steady low trajectory experienced either or a combination of low and moderate with no discernible pattern during all time periods. Census tracts in a steady moderate category had a moderate proportion of specified race/ethnicity at all three time periods. And, census tracts in a steady high category experienced either high or a combination of high and moderate with no discernible pattern during all time periods. Second, some neighborhoods would experience either an increase or decrease in the population of a particular racial/ethnic group over the three decades (i.e., increasing or decreasing). Census tracts in an increasing trajectory had low or moderate population in 1990 and became and remained moderate or high after 1990. Census tracts in a decreasing trajectory experienced high or moderate population in 1990 and became and remained moderate or low after 1990.

Neighborhood-level covariates are neighborhood poverty and population density (as a proxy of urbanization [72]). Advantaged neighborhoods and urban neighborhoods tend to have greater political power to build health-promoting environments (e.g., easy access to high-quality education, employment, information, and resources) [73–75], which are plausibly related to pre-pregnancy health and adverse birth outcomes [26, 76]. A cross-sectional measure of neighborhood poverty was created based on the 2006–2010 American Community Survey. We classified census tracts with less than 5% poverty as low poverty (reference group), those with 5% to 20% poverty as moderate poverty, and those with

more than 20% poverty as high poverty. The cutoff was based on the US Census definition of poverty areas. Neighborhood-level population density was calculated as people in a census tract per square mile by using the 2010 Census data.

Statistical Analysis

We first examined the prevalence of preterm birth overall and by sample characteristics. We then estimated hierarchical generalized linear models (HGLM) to examine the associations between neighborhood racial/ethnic trajectories and preterm birth (1) without adjustment for covariates and (2) with adjustment for all individual- and neighborhood-level covariates. To determine whether a black-white difference in odds ratio of preterm birth is explained by neighborhood racial/ethnic trajectories, we compared odds ratios of preterm birth associated with maternal race in the model that included all the individual-level variables and excluded neighborhood racial/ethnic variables (i.e., covariate model) to those in the models that included neighborhood racial/ethnic trajectories. If the odds ratios decreased from the individual-level model to the neighborhood-level models, it would indicate that neighborhood racial/ethnic trajectories partly explain the black-white difference in odds ratio of preterm birth.

Finally, we tested for cross-level interactions between race and neighborhood racial/ethnic trajectories. Where interaction terms had a statistically significant at $\alpha < 0.10$, we stratified the sample by women's race and conducted HGML to examine racial differences in associations between neighborhood racial/ethnic trajectories and preterm birth. In addition, we stratified the sample by each of these neighborhood racial/ethnic trajectories variables and conducted HGML to estimate the odds ratio for preterm birth among black versus white women (1) without adjustment for covariates and (2) with adjustment for all individual- and neighborhood-level covariates. We reported the interpretation of adjusted p values based on a Bonferroni adjustment as additional information because multiple null hypothesis significance test is vulnerable to type 1 error. The adjusted p values (i.e., 0.0167) were made by dividing the conventional alpha by 3.

We conducted multilevel modeling because births were nested within neighborhoods. On average, there were 93 births per census tract, and 1793 out of 5099 census tracts had 100 or more births. In addition, while

the intra-class correlation coefficient was only 2.4%, findings of unconditional model showed significant residual variance between neighborhoods ($\tau_{00} = 0.08^{***}$). Thus, the decision to use multilevel modeling was appropriate. We developed our final model by subsequently testing random intercept models with individual- and neighborhood-level correlates, random coefficient models assessing whether the slopes for women's race had a significant variance component, and cross-level interaction models for women's race and neighborhood racial/ethnic trajectories. Final models were decided with consideration of model fits, significance of slope, and model parsimony. We used SAS software version 9.4 for all analyses.

Results

Description of Sample

Table 1 presents the characteristics of non-Hispanic black and white mothers with singleton births in Texas from 2009 to 2011 ($N = 471,433$). The majority of mothers were 20 to 34 years old, three quarters were non-Hispanic white, more than 40% were primiparous, and more than 60% were married. Over one-third of births were to mothers without first trimester prenatal care, and about 30% of births were to mothers with a college degree. About a third of births were to mothers living in neighborhoods with a steady low proportion of the Latinx population, or neighborhoods with a steady high proportion of the non-Hispanic black or non-Hispanic white population. Nearly a quarter of births were to mothers living in high poverty neighborhoods.

About one in ten mothers delivered a preterm birth. The prevalence of preterm birth was higher among teens, older mothers, non-Hispanic black mothers, those delivering their 5th child or more, unmarried mothers, mothers without first trimester care, or births to low-educated mothers and fathers. The prevalence was also high for mothers living in neighborhoods with a steady high proportion of the Latinx or non-Hispanic black population, neighborhoods with a steady low proportion of the non-Hispanic white population, and high-poverty neighborhoods. The black-white difference in odds ratio of preterm birth was substantial (1.62 times higher among black mothers), and especially notable among older women, women in neighborhoods with steady low Latinx population, or women in neighborhoods with

Table 1 Descriptive statistics of individual-level characteristics, natality files from Texas, Texas, USA, 2009–2011, $N = 471,433$

Characteristics	Number	Percent	Preterm birth (%)			
			Total sample	Mother's race		
				Non-Hispanic Black	Non-Hispanic White	Ratio (Black/White)
Total sample	471,433	100.0	10.4	14.6	9.0	1.62
Mother's age						
12–19 years of age	45,197	9.6	12.7	15.5	10.8	1.44
20–34 years of age	367,344	77.9	9.9	14.1	8.6	1.64
35 or above	58,892	12.5	11.7	17.5	10.3	1.70
Mother's race						
Black, non-Hispanic	118,818	25.2	14.6	-	-	
White, non-Hispanic	352,615	74.8	9.0	-	-	
Parity						
First child	205,264	43.5	10.1	14.0	8.9	1.57
Second-fourth child	260,356	55.2	10.5	14.9	9.0	1.66
Fifth child or more	5813	1.2	16.2	20.0	13.3	1.50
Mother's marital status						
Married	295,493	62.7	9.0	13.3	8.3	1.60
Not married	175,940	37.3	12.8	15.3	10.7	1.43
Mother's prenatal care experience						
First trimester care	301,024	63.9	10.0	14.7	8.9	1.65
No first trimester care	170,409	36.2	11.0	14.5	9.2	1.58
Mother's education level						
Less than high school	53,736	11.4	14.4	17.1	12.6	1.36
High school/GED	113,282	24.0	11.8	15.1	10.1	1.50
Some college	154,541	32.8	10.5	14.2	9.2	1.54
College graduate or more	149,874	31.8	7.9	11.9	7.3	1.63
Father's education level						
Less than high school	34,947	7.4	12.5	15.5	11.2	1.38
High school/GED	106,988	22.7	11.2	14.6	10.0	1.46
Some college	126,422	26.8	9.8	13.3	8.9	1.49
College graduate or more	131,190	27.8	7.5	11.3	7.1	1.59
Missing	71,886	15.3	14.5	16.5	12.2	1.35
Neighborhood population density (2010)						
Low density	157,135	33.3	10.1	14.8	9.4	1.57
Moderate density	157,063	33.3	10.3	14.7	8.7	1.69
High density	157,235	33.4	10.8	14.5	8.8	1.65
Neighborhood poverty (2006–2010)						
Low poverty	99,184	21.0	8.5	12.4	8.0	1.55
Moderate poverty	257,708	54.7	10.1	14.2	9.1	1.56
High poverty	114,541	24.3	12.7	15.5	10.2	1.52
Neighborhood Latinx trajectories						
Steady low	150,711	32.0	9.6	14.7	8.5	1.73
Steady moderate	129,483	27.5	10.6	14.4	9.1	1.58

Table 1 (continued)

Characteristics	Number	Percent	Preterm birth (%)			
			Total sample	Mother's race		
				Non-Hispanic Black	Non-Hispanic White	Ratio (Black/White)
Steady high	51,796	11.0	12.2	15.9	10.6	1.50
Increasing	75,818	16.1	11.2	14.4	9.2	1.57
Decreasing	63,625	13.5	9.5	14.1	8.6	1.64
Neighborhood non-Hispanic black trajectories						
Steady low	75,303	16.0	9.0	13.6	8.9	1.53
Steady moderate	98,630	20.9	9.3	13.7	8.8	1.56
Steady high	144,489	30.7	12.8	15.1	9.8	1.54
Increasing	99,939	21.2	9.4	13.1	8.5	1.54
Decreasing	53,072	11.3	9.9	14.5	9.3	1.56
Neighborhood non-Hispanic white trajectories						
Steady low	70,958	15.1	14.1	15.7	11.1	1.41
Steady moderate	110,083	23.4	10.5	14.4	9.4	1.53
Steady high	150,269	31.9	8.7	13.7	8.4	1.63
Increasing	60,002	12.7	10.1	15.1	9.0	1.68
Decreasing	80,121	17.0	10.4	13.1	8.9	1.47

increasing whites. The difference also increased with increasing education of mothers or fathers.

Associations between Neighborhood Racial/Ethnic Trajectories and Preterm Birth

Between-neighborhood variance in preterm birth decreased from 0.08 to 0.02 after taking into account individual characteristics, population density, and poverty concentration (Table 2). In unadjusted models, living in neighborhoods characterized by steady moderate or high proportion of the Latinx population or increasing Latinx population (compared to a steady low proportion of Latinxs) was associated with increased odds of preterm birth (odds ratio [OR] = 1.13, 1.32, 1.21, respectively). Living in neighborhoods with a steady moderate or high proportion of the Latinx population or decreasing Latinx population (compared to a steady low proportion) remained associated with increased odds of preterm birth (OR = 1.03, 1.14, 1.04, respectively) after adjustment of individual-level sociodemographic characteristics, population density, and neighborhood poverty (see the neighborhood Latinx trajectories model in Table 2).

Living in neighborhoods with a steady high proportion of the non-Hispanic black population or decreasing non-Hispanic black population (compared to a steady low proportion) was associated with increased odds of preterm birth in unadjusted models (OR = 1.47 and 1.11, respectively). After adjustment for individual and neighborhood characteristics, living in neighborhoods with a steady high proportion of the non-Hispanic black population remained associated with a 5% increase in the odds of preterm birth (see the neighborhood black trajectories model in Table 2).

All categories of the neighborhood non-Hispanic white trajectories (compared to a steady high proportion) were significantly associated with preterm birth in unadjusted models (ORs = 1.18–1.71). After adjusting for covariates, all categories of the neighborhood non-Hispanic white trajectories (compared to a steady high proportion) were still significantly associated with the odds of preterm birth (ORs = 1.06–1.18) (see the neighborhood white trajectories model in Table 2). The odds of preterm birth associated with being a non-Hispanic black woman (vs. non-Hispanic white) were robust to including racial ethnic trajectories (adjusted ORs = 1.49, 1.46, and 1.45,

Table 2 Associations between neighborhood racial/ethnic trajectories and preterm birth, natality files from Texas, Texas, USA, 2009–2011, $N = 471,433$

Characteristics	Unadjusted models			Covariate model			Neighborhood Black trajectories model			Neighborhood Latinx trajectories model			Neighborhood White trajectories model		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Fixed effects															
Mother's age															
12–19 years of age	1.25	1.21	–1.29	0.96	0.93	–1.00	0.97	0.93	–1.009	0.97	0.93	–1.00	0.97	0.93	–1.00
20–34 years of age	1.00			1.00			1.00			1.00			1.00		
35 or above	1.27	1.24	–1.31	1.41	1.37	–1.45	1.41	1.37	–1.45	1.41	1.37	–1.45	1.41	1.37	–1.45
Mother's race															
Black, non-Hispanic	1.70	1.66	–1.73	1.48	1.45	–1.52	1.46	1.43	–1.50	1.49	1.45	–1.52	1.45	1.41	–1.49
White, non-Hispanic	1.00			1.00			1.00			1.00			1.00		
Parity															
First child	1.00			1.00			1.00			1.00			1.00		
Second-fourth child	1.04	1.02	–1.06	1.01	0.99	–1.04	1.01	0.99	–1.04	1.01	0.99	–1.04	1.01	0.99	–1.04
Fifth child or more	1.64	1.53	–1.76	1.29	1.20	–1.39	1.29	1.20	–1.39	1.29	1.20	–1.39	1.29	1.19	–1.38
Mother's marital status															
Married	1.00			1.00			1.00			1.00			1.00		
Not married	1.41	1.38	–1.44	1.05	1.02	–1.08	1.05	1.02	–1.08	1.05	1.02	–1.08	1.05	1.02	–1.08
Mother's prenatal care experience															
First trimester care	1.00			1.00			1.00			1.00			1.00		
No first trimester care	1.06	1.04	–1.08	0.91	0.89	–0.93	0.91	0.89	–0.93	0.91	0.89	–0.93	0.91	0.89	–0.93
Mother's education level															
Less than high school	1.87	1.81	–1.94	1.44	1.38	–1.50	1.44	1.38	–1.50	1.44	1.38	–1.50	1.44	1.38	–1.50
High school/GED	1.51	1.47	–1.55	1.21	1.17	–1.26	1.21	1.17	–1.26	1.21	1.17	–1.26	1.21	1.17	–1.26
Some college	1.34	1.31	–1.38	1.15	1.12	–1.18	1.15	1.11	–1.18	1.15	1.11	–1.18	1.15	1.12	–1.18
College graduate or more	1.00			1.00			1.00			1.00			1.00		
Father's education level															
Less than high school	1.70	1.63	–1.76	1.33	1.27	–1.39	1.33	1.27	–1.39	1.33	1.27	–1.39	1.33	1.27	–1.39
High school/GED	1.52	1.47	–1.56	1.28	1.23	–1.33	1.28	1.23	–1.33	1.28	1.23	–1.33	1.28	1.23	–1.33
Some college	1.32	1.28	–1.36	1.19	1.16	–1.23	1.19	1.16	–1.23	1.19	1.15	–1.23	1.19	1.15	–1.23
College graduate or more	1.00			1.00			1.00			1.00			1.00		
Missing	1.99	1.93	–2.06	1.48	1.42	–1.54	1.48	1.42	–1.54	1.48	1.42	–1.54	1.47	1.41	–1.54
Population density (logged)	1.02	1.01	–1.02	0.99	0.99	–1.00	0.99	0.99	–1.00	0.99	0.98	–1.00	0.99	0.98	–0.99
Neighborhood poverty (2006–2010)															
Low poverty	1.00			1.00			1.00			1.00			1.00		
Moderate poverty	1.23	1.19	–1.27	1.07	1.03	–1.10	1.06	1.03	–1.09	1.05	1.02	–1.09	1.04	1.00	–1.07
High poverty	1.59	1.53	–1.65	1.13	1.09	–1.17	1.11	1.07	–1.16	1.09	1.05	–1.14	1.05	1.01	–1.09
Neighborhood Latinx trajectories															
Steady low	1.00									1.00					
Steady moderate	1.13	1.09	–1.17							1.03	1.00	–1.07			
Steady high	1.32	1.26	–1.37							1.14	1.09	–1.18			
Increasing	1.21	1.16	–1.26							1.02	0.98	–1.06			
Decreasing	0.99	0.95	–1.04							1.04	1.00	–1.08			

Table 2 (continued)

Characteristics	Unadjusted models		Covariate model		Neighborhood Black trajectories model		Neighborhood Latinx trajectories model		Neighborhood White trajectories model	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Neighborhood non-Hispanic black trajectories										
Steady low	1.00				1.00					
Steady moderate	1.03	0.99 –1.08			1.01	0.97 –1.05				
Steady high	1.47	1.41 –1.52			1.05	1.01 –1.09				
Increasing	1.04	1.00 –1.08			1.00	0.96 –1.04				
Decreasing	1.11	1.06 –1.16			1.03	0.99 –1.07				
Neighborhood non-Hispanic white trajectories										
Steady low	1.71	1.65 –1.77							1.18	1.13 –1.23
Steady moderate	1.23	1.19 –1.27							1.11	1.08 –1.15
Steady high	1.00								1.00	
Increase	1.18	1.13 –1.22							1.08	1.04 –1.12
Decrease	1.22	1.18 –1.27							1.06	1.02 –1.10
<i>Random effects</i>										
Level-2 intercept			0.03***		0.03***		0.02***		0.03***	
<i>Model fit</i>										
– 2LL	-		309,323		309,314		309,276		309,251	
AIC	-		309,361		309,360		309,322		309,297	
BIC	-		309,485		309,511		309,473		309,447	

OR odds ratio, CI confidence interval

* $p < .05$, ** $p < .01$, *** $p < .001$

respectively). However, in general, model fit was better with inclusion of the racial ethnic trajectories measures in the models. Using the adjusted p values based on a Bonferroni adjustment, living in neighborhoods with a steady high proportion of the Latinx population and all categories of the neighborhood non-Hispanic white (compared to a steady high proportion) were significantly associated with preterm birth.

Cross-level Interaction of Women's Race with Neighborhood Racial/Ethnic Trajectories in Preterm Birth

Cross-level interactions between women's race and neighborhood Latinx or non-Hispanic white trajectories were significantly associated with the odds of preterm birth (see Supplemental Table 1). Regarding the cross-level interaction between women's race and neighborhood Latinx trajectories, being black (vs. being white) in neighborhoods characterized by a

steady moderate or high proportion of the Latinx population, or an increasing Latinx population was not as risky for preterm birth (OR = 0.93, 0.88, 0.92, respectively) compared with neighborhoods characterized by a steady low Latinx population. On the other hand, regarding the cross-level interaction between women's race and neighborhood non-Hispanic white trajectories, there were significant interactions between race and non-Hispanic white trajectories and Latinx trajectories at alpha 0.05. There was no significant interaction between race and neighborhood non-Hispanic black trajectories (results not shown).

To illustrate further the significant cross-level interactions between race and the trajectories, we performed stratified models by women's race. Table 3 presents the logistic regression results estimating odds ratio of preterm birth associated with neighborhood Latinx trajectories and neighborhood white trajectories by women's race. In general, for black mothers, neighborhood context in the form of

racial/ethnic trajectories did not matter for the odds of preterm birth. White mothers, however, had the highest odds in neighborhoods characterized by a steady high Latinx population or a steady low population of whites. In other words, white women seem to benefit but from being racially segregated. When based on the adjusted p values, living in a steady moderate or high proportion of the Latinx population and all categories of the neighborhood non-Hispanic white remained associated with preterm birth among non-Hispanic white women.

Table 4 displays the logistic regression results estimating odds ratio of preterm birth associated with women's race within each subgroup of neighborhood racial/ethnic trajectories. The adjusted black-white odds of preterm birth were lowest among mothers in neighborhoods with a steady high trajectory of the Latinx population ($OR = 1.39$) compared with other Latinx trajectories ($ORs: 1.47\text{--}1.58$). Notably, the CIs between steady high and steady low did not overlap. In contrast, the adjusted black-white odds of preterm birth were highest among mothers in neighborhoods with a steady high ($OR = 1.59$) or increasing ($OR = 1.55$) trajectory of the non-Hispanic white

population compared with other non-Hispanic white trajectories ($ORs: 1.34\text{--}1.49$), with mostly non-overlapping CIs. When using the adjusted p values, same results were found.

Discussion

The present study examined the contribution of neighborhood racial/ethnic compositions over time to the black-white difference in effect estimates of preterm birth. A few studies have examined the black-white difference in preterm birth using cross-sectional measures of neighborhood racial/ethnic compositions, with inconsistent results [11, 41, 44, 45]. This study extends past work by examining trajectories of neighborhood racial/ethnic composition over 20 years and interactions between women's race and neighborhood racial/ethnic trajectories. Our findings highlight that neighborhood racial/ethnic trajectories were associated with risk of preterm birth, but with different directions of association by mother's race.

Prior literature has hypothesized that predominantly non-white neighborhoods tend to have limited levels of accessibility to healthcare services, lack educational and employment opportunities, and be considered as less safe and less comfortable [16–19], which are associated with greater risk of preterm birth among both non-Hispanic black and white women [20, 25, 26]. In contrast, according to the ethnic density hypothesis, minorities have better health status in neighborhoods with a higher proportion of one's own racial/ethnic group. This is plausibly because minorities may experience less racial discrimination and have more opportunities for social interaction, culturally appropriate health care services, and material, logistic, and social support in such neighborhoods [27–32]. Our findings support both hypotheses. Living in neighborhoods with a steady high proportion of non-Hispanic blacks (compared to long-term low blacks) was associated with greater odds of preterm birth overall. Living in neighborhoods with a steady low, moderate, increasing, or decreasing proportion of non-Hispanic whites (compared to a steady high proportion of whites) was associated with higher odds of preterm birth among white women. These findings corroborate the neighborhood deprivation hypothesis.

We also found partial support for the ethnic density hypothesis. Living in predominantly Latinx neighborhoods was associated with greater risk of preterm birth for white, but not black,

Table 3 Odds ratios for preterm birth associated with neighborhood racial/ethnic trajectories by women's race, natality files from Texas, Texas, USA, 2009–2011, $N = 471,433$

Variables included in the model predicting preterm birth	Non-Hispanic Black women ^a OR (95% CI)	Non-Hispanic White women ^a OR (95% CI)
Neighborhood Latinx trajectories		
Steady low	1.00	1.00
Steady moderate	0.98 (0.93–1.03)	1.06 (1.02–1.09)
Steady high	1.04 (0.98–1.11)	1.18 (1.12–1.23)
Increase	0.96 (0.91–1.02)	1.05 (1.00–1.09)
Decrease	1.01 (0.94–1.08)	1.06 (1.01–1.10)
Neighborhood non-Hispanic white trajectories		
Steady low	1.07 (0.99–1.15)	1.24 (1.18–1.31)
Steady moderate	1.02 (0.95–1.10)	1.12 (1.08–1.16)
Steady high	1.00	1.00
Increase	1.05 (0.96–1.14)	1.07 (1.03–1.12)
Decrease	0.94 (0.87–1.02)	1.08 (1.04–1.13)

^a Mother's age, parity, marital status, prenatal care experience, and education level, father's education level, population density, and neighborhood poverty (2006–2010) were adjusted in addition to neighborhood Latinx or non-Hispanic white trajectories

OR odds ratio, CI confidence interval

Table 4 Odds ratios for preterm birth for non-Hispanic black relative to white women delivering in Texas, Natality files from Texas, Texas, USA, 2009–2011, $N = 471,433$

Variables included in the model predicting preterm birth	Unadjusted models OR (95% CI)	Adjusted models ^a OR (95% CI)
Neighborhood Latinx trajectories		
Steady low	1.80 (1.73–1.88)	1.58 (1.50–1.66)
Steady moderate	1.66 (1.60–1.73)	1.47 (1.41–1.54)
Steady high	1.56 (1.48–1.66)	1.39 (1.30–1.47)
Increase	1.63 (1.56–1.72)	1.47 (1.39–1.55)
Decrease	1.69 (1.58–1.82)	1.52 (1.41–1.63)
Neighborhood non-Hispanic white trajectories		
Steady low	1.48 (1.41–1.56)	1.34 (1.27–1.41)
Steady moderate	1.64 (1.56–1.71)	1.49 (1.42–1.56)
Steady high	1.73 (1.62–1.84)	1.59 (1.49–1.70)
Increase	1.76 (1.65–1.88)	1.55 (1.44–1.66)
Decrease	1.53 (1.45–1.60)	1.38 (1.31–1.45)

^aMother's age, parity, marital status, prenatal care experience, and education level, father's education level, population density, and neighborhood poverty (2006–2010) were adjusted in addition to neighborhood Latinx or non-Hispanic white trajectories

OR odds ratio, CI confidence interval

women. The findings could be interpreted as indicating that social and material deprivation in predominantly Latinx neighborhoods might be offset by a higher level of social support, minority-focused services, and less discrimination for non-Hispanic black women as a racial minority group [16–19].

Our results also showed that living in predominantly white neighborhoods is not protective against adverse birth outcomes among black women and that the black-white difference in odds ratio of preterm birth was elevated in predominantly white neighborhoods. This is possibly due to the mediating role of racism-related stress, social isolation, and low accessibility to culturally sensitive resources which minorities often experience [27–29]. For example, compared to blacks in predominantly non-white neighborhoods, black women in predominantly white neighborhoods may be exposed to stressful race-related experiences and have to overcome racial barriers to being involved in the community and accessing resources [30–32]. Future research should examine such mechanisms using measures of exposure to neighborhood-level racial discrimination in daily life, interactions with neighbors, social cohesion, safety, and accessible resources prior to or during pregnancy. Testing these potential mediators of objectively measured (e.g., number of healthcare facilities, crime rates)

and perceived potential mediators (e.g., perceived neighborhood safety, perceived quality of care) in such associations could explain the complexity of the black-white difference in preterm birth associated with neighborhood racial/ethnic compositions.

Predominantly non-white neighborhoods are generally considered economically and socially disadvantaged neighborhoods [16–19]. Often policies (local, state, and national) perpetuate systemic gaps between non-Hispanic white residents and residents of color leading to increased health disparities, mainly in non-Hispanic black women. Racially inclusive policy and strategies can improve the health of mothers and prevent preterm birth among black women in predominantly non-white neighborhoods by focusing on limited opportunities for adequate and affordable housing, access to healthcare, high-quality minority-focused resources, sustainable income, and quality education, all key determinants of health [77, 78]. Key strategies for Texas and its municipalities could include [79–82] (1) supporting access to health care through supporting extending Medicaid coverage one year postpartum; (2) funding community health care workers in partnership with local health clinics and hospitals; (3) increasing access and funding for more postpartum depression screenings and mental health treatment; (4) utilizing community organizations and churches and other

cultural institutions to engage community voice when local governments and neighborhood associations are considering policy changes to secure parental leave and affordable and accessible child care; and (5) providing implicit bias training for realtors, housing agents, healthcare staff and workers, teachers and education administrators, and city council members. These policies and key strategies work to increase protective factors for black women in both steady high non-Hispanic black and steady high non-Hispanic white neighborhoods, to improve the health of black mothers.

We note several limitations to the present study. We were limited in our ability to examine the ethnic density hypothesis for black women as the black population in Texas is relatively small and not as highly concentrated compared with the non-Hispanic white and Latinx population (e.g., nearly 2/3 of all neighborhoods had 10% or fewer black residents). Birth certificate data do not include information for potentially important information such as the length of time a mother lived in a neighborhood, household income, health insurance status, and residential mobility. In particular, given that 17% of all females moved in the past year in Texas according to the 2010 ACS, future longitudinal research needs to account for the length of time a woman lives in her neighborhood and racial/ethnic compositions of her previous neighborhood if she recently moved. In addition, we chose to focus on neighborhood racial/ethnic compositions, but other important neighborhood characteristics—such as racial segregation and crime—and neighborhood socioeconomic trajectories should be considered in future research. Furthermore, our sample was limited to non-Hispanic black and white women, as approved by two IRBs. We have plans for future research to include births to Latinx women and to examine those births by nativity. Finally, causal inferences cannot be made with cross-sectional data. Further research replicating our study with longitudinal data and consideration of residential mobility is warranted to clarify the effect of neighborhood racial/ethnic trajectories on preterm birth.

Despite these limitations, this study has several strengths. First, this study included all singleton births to non-Hispanic black and white women in Texas from 2009 to 2011. We measured neighborhood racial/ethnic trajectories that has not been investigated in past work examining associations between neighborhood racial/ethnic compositions and adverse birth outcomes. Our work also adds to a body of literature demonstrating that

living in a steady high concentration of whites protects white, but not black, women and that living in a steady low concentration of Latinxs protects white, but not black, women. Given evidence that the black-white difference in preterm birth varies by neighborhood racial/ethnic trajectories, researchers and policymakers should identify mechanisms through which white women benefit from living in white neighborhoods and the reason what works for white women does not work for black woman.

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Compliance with ethical standards

Conflict of Interest The authors declare that they have no conflicts of interest.

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