SSM - Population Health 19 (2022) 101176

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Racial, ethnic and nativity inequalities in gestational diabetes mellitus: The role of racial discrimination

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ARTICLE INFO

Keywords:
Racial/ethnic/nativity inequities
Gestational diabetes
Racial discrimination

ABSTRACT

Introduction: Racial/ethnic minority and foreign-born women in the United States are at high risk of experiencing racial discrimination, which is associated with adverse health outcomes. Although racial discrimination is associated with metabolic disturbances such as insulin resistance and type 2 diabetes, more studies should examine its effect on gestational diabetes mellitus (GDM), which is highest among racial/ethnic minority and foreign-born women.

Methods: We used New York City Pregnancy Risk and Assessment Monitoring System survey data (2012–2014) linked with birth certificate items (N = 4084) in bivariate and multivariate analyses to examine racial/ethnic/nativity differences in racial discrimination, and to test if racial discrimination explains racial/ethnic/nativity inequalities in GDM.

Results: The 12-month prevalence of racial discrimination (9.5%) varied across race/ethnicity and nativity status, with Black, Hispanic and foreign-born women having the highest prevalence. Interaction effects indicate that US-born Black and Hispanic women are at increased risk of racial discrimination compared to their foreign-born counterparts. Women with GDM had statistically higher prevalence of racial discrimination (14%) compared with women without GDM (9%). Racial discrimination was associated with a 57% increased unadjusted risk of GDM (RR = 1.57, 95% CI [1.19, 2.06]) that decreased to 24% after adjusting for all covariates (RR = 1.24, 95% CI [0.87, 1.78]).

Discussion: The high proportion of racial/ethnic minority and foreign-born women experiencing racial discrimination, and its potential impact on GDM, underscores the importance of culturally informed screening and intervention approaches by trained professionals.

1. Introduction

Gestational diabetes mellitus (GDM), defined as glucose intolerance with onset during pregnancy (American Diabetes Association [AmericanDiabetes Association, 2020), is associated with numerous pregnancy and birth complications, including macrosomia, shoulder dystocia, preeclampsia, and cesarean section (Plows et al., 2018). GDM is also linked to an increased incidence of post-partum type 2 diabetes, which varies across racial/ethnic groups (Wang et al., 2012). Although the overall prevalence of GDM in the United States (US) is currently 10% (AmericanDiabetes Association, 2020), it has increased in the past decade in the US, particularly among non-White women (Zhou et al., 2018). Prevalence of GDM is highest among Asian American/Pacific Islander (Asian/PI) (16%), Hispanic (12%) and Black (11%) women, and lowest among White (7%) women (DeSisto et al., 2014). Additionally, foreign-born women have almost twice the risk of GDM, compared to US-born women across all racial/ethnic groups (Kim et al., 2013).

In addition to higher prevalence of GDM among racial/ethnic minority and foreign-born women, there are also racial/ethnic and nativity differences in adverse birth outcomes associated with GDM. A study by Nguyen et al. (2012) found that Black women with GDM were almost twice as likely to develop preeclampsia or have a preterm birth and fetal anomalies compared to their White counterparts. GDM is also associated with an increased risk of developing type 2 diabetes, especially among Black women (Wang et al., 2012). While approximately 50% of GDM cases are attributed to overweight and obesity (DeSisto, 2014), this estimate also varies by race/ethnicity and nativity status (Kim et al., 2013), and does not account for additional factors contributing to GDM

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https://doi.org/10.1016/j.ssmph.2022.101176
Received 27 January 2022; Received in revised form 13 July 2022; Accepted 17 July 2022
Available online 21 July 2022

that require examination.

1.1. Psychosocial stress and health inequalities

Psychosocial stress is associated with racial/ethnic (Sternthal et al., 2011) and nativity inequalities in health (Williams & Sternthal, 2010). Pregnant women and pregnant racial/ethnic minority women in particular experience high psychosocial stress (Robinson et al., 2016). Assessment of psychosocial stress is complex, with measurement including specific stressful events or perceptions of stress (Nast et al., 2013). Studies have found associations between GDM and both perceived psychosocial stress and stressful life events (Hosler et al., 2011; Mishra et al., 2020; Silviera et al., 2014). Given that stress is common during pregnancy, especially among racial/ethnic minorities, and is associated with adverse reproductive outcomes, including GDM, it is important to identify stressors that pose the greatest health risks to pregnant women and their infants.

Racism is a stressor that affects health due to the cumulative effects of discriminatory experiences throughout the life course, at multiple levels, and is associated with adverse reproductive outcomes such as pre-term birth and low-birth weight (Sonderlund et al., 2021). Racism refers to prejudiced positions and practices at multiple levels, that perpetuate oppression and inequality by restricting opportunities for non-White groups to the advantage of White groups (Braveman et al., 2022). While the terms racism and discrimination are often used interchangeably (Giscombe & Lobel, 2005), we use 'racial discrimination' except when keeping consistent with terms used by authors in other studies.

1.2. Pathophysiology of stress

Psychosocial stress results in a predictable pattern of physiologic and neuroendocrine disturbance that is associated with insulin resistance, metabolic syndrome, and type-2 diabetes. Although allostasis is the protective cardiovascular, metabolic and immune system maintenance of homeostasis in response to stressors, prolonged activation and continued impact of the physiologic stress response, known as allostatic load, causes "wear and tear" on allostatic systems. Over time, this wear and tear from stress adversely affects health (McEwen, 1998, p. 171). While the pathophysiology of type 2 diabetes is independently predicted by obesity, insulin resistance, and other glycemic factors (Norberg et al., 2007), hypothalamic-pituitary-adrenal (HPA) arousal is a proposed neuroendocrine mechanism between stress and insulin resistance and the development of type 2 diabetes (Abraham et al., 2007). For example, stress increases cortisol and catecholamine secretion, which can activate harmful pathophysiology including insulin resistance (Innes et al., 2007), a risk factor for GDM (Barbour et al., 2007).

Research has shown an independent dose-response association between stress and risk of abnormal glucose metabolism in women (Williams et al., 2013). While type-2 diabetes is associated with stress, particularly among lower socio-economic status (SES) groups (Abraham et al., 2007), stress has only recently been examined for its association with GDM (Hosler et al., 2011; Mishra et al., 2020; Silviera et al., 2014). Racial discrimination is an important source of stress for racial/ethnic minority and foreign-born groups and may impact risk of GDM. One of the ways racism is thought to impact health is via pathophysiological mechanisms, as demonstrated by a study that found a positive association between racism and cortisol dysregulation (Tull et al., 2005).

1.3. Discrimination and metabolic risk

Racial discrimination has been linked to metabolic disturbances (e.g. glucose intolerance, insulin resistance, type 2 diabetes). Beatty Moody et al. (2018) found that discrimination was associated with 33% increased incidence of metabolic syndrome, and this association was particularly marked among Black and Hispanic women. A study by Butler et al. (2002) documented independent associations after controlling for BMI and other covariates between racism and impaired glucose tolerance. Although this association became non-significant once waist circumference was added to the model, a subsequent study showed independent relationships between racism and abnormal fasting glucose among Black women (Tull et al., 2007). Studies have also found associations between racial discrimination and insulin resistance (Chambers et al., 2004; Wagner et al., 2013), and Tull and Chambers (2001) found a relationship between racial discrimination and type 2 diabetes. Wagner et al. (2015) reported that lifetime racial discrimination experienced by Black and White women with diabetes in the US adversely affected glucose control.

To our knowledge, only one study has examined the association between discrimination and GDM. MacGregor et al. (2020) found that discrimination was associated with a 2-fold increased adjusted odds of GDM that was only partially mediated (23%) by obesity. Given that racial discrimination is a stressor that may increase risk of GDM, our study examined whether exposure to racial discrimination helps explain differences in GDM across race/ethnicity and nativity status. The aims of the study were to investigate the association of race/ethnicity and nativity status with racial discrimination, to understand the relationship between discrimination and GDM, and to test the degree to which the associations between race/ethnicity and nativity status and GDM were explained by discrimination.

2. Methods

We analyzed data from the 2012–2014 New York City (NYC) Pregnancy Risk Assessment Monitoring System (PRAMS), a population-based questionnaire regarding maternal experiences and behaviors before, during and just after live birth pregnancies (Centers for Disease Control and Prevention [CDC], 2017). This surveillance system is directed by the CDC and administered by the NYC Department of Health and Mental Hygiene. Each month in NYC, approximately 180 women are selected by stratified random sample without replacement, drawn from a frame of eligible birth certificates of live birth infants delivered in the previous 2–4 months. Data from PRAMS survey were linked to selected maternal and infant birth certificate items for a final dataset with a weighted response rate of >65% (https://www1.nyc.gov/assets/doh/downloads/pdf/ms/PRAMSintro.pdf).

2.1. Measurement

Outcome variable: GDM modeled as a dichotomous (yes/no) variable was deemed present if reported on either the PRAMS survey or birth certificate. Based on research demonstrating that accurate identification of GDM can be ascertained from self-report on PRAMS, and that the preferred method to determine GDM is to combine PRAMS and birth certificate reports (Hosler et al., 2009), we measure GDM based on report from PRAMS *or* from the birth certificate. Agreement between these sources was 0.91 with a prevalence and bias-adjusted kappa of .82, which is considered strong agreement.

***Predictor variable*:** For the purpose of brevity, we use the term racial discrimination to refer to the variable that was measured dichotomously with the PRAMS question: "During *the* 12 months *before* your new baby was born, did you feel emotionally upset (for example, angry, sad, or frustrated) as a result of how you were treated *based on your race*?"

***Race, Ethnicity and Nativity*:** Maternal race, ethnicity and nativity were determined from the infant birth certificate and categorized as US and foreign-born non-Hispanic White, non-Hispanic Black, Hispanic/Latina and Asian/PI/Other (Almeida et al., 2013). Due to low numbers, Asian/PI and Other racial/ethnic groups were combined.

***Covariates*:** Maternal sociodemographic, medical and behavioral covariates came from the birth certificate and PRAMS survey with selection based on documented associations with discrimination and GDM (Hosler et al., 2011; Silviera et al., 2014; Wagner et al., 2013; Wilson

et al., 2015). Covariates from the birth certificate included education (<high school; high school/GED; some college+), marital status (married/partner; other), employment (yes/no), health insurance (Medicaid; self/private pay; no insurance), prenatal care beginning in first trimester (Y/N), previous preterm birth (Y/N). Variables grouped according to known thresholds for GDM included age (<25; 25–34; 35+ years) and pre-pregnancy BMI (underweight <18.5kg/m^2, normal weight 18.5–24.9 kg/m^2, overweight 25.0–29.9 kg/m^2, and obese ≥30.0 kg/m^2). Covariates from PRAMS included dichotomous (Y/N) measures of pregnancy intention, previous live birth, hypertension in pregnancy, participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), exposure to alcohol and tobacco in

Table 1
Descriptive statistics of sample by race/ethnicity and nativity status, (n = 4084) New York City PRAMS 2012–2014.

Total		US-Born n = 1943 (47.6%)				*P* value*	Foreign-Born n = 2141 (52.4%)				*P* value*	P value*
	N = 325,542	White	Black	Hispanic	Asian/PI/ Other		White	Black	Hispanic	Asian/PI/ Other		
	n = 4084	n = 846	n = 481	n = 510	n = 106		n = 345	n = 380	n = 819	n = 597		(US vs. FB)
	100%	20.7%	11.8%	12.5%	2.6%		8.5%	9.3%	20.1%	14.2%		
Sociodemographic Characteristics												
Maternal age (years)												<0.001
<25	22.3	16.3	38.7	43.2	20.7	<0.001	8.7	15.5	24.1	13.9	<0.001	
25-34	54.1	53.4	48.3	42.6	51.8		61.1	54.9)	54.4)	63.9		
35+	23.5	30.4	13.0	14.3	27.5		30.2	29.6	21.5	22.2		
Education												<0.001
<High school	18.8	6.2	22.0	21.2	5.8	<0.001	6.1	11.2	37.0	24.2	<0.001	
Completed high school or GED	22.1	20.9	25.6	22.4	6.6		11.7	34.2	25.6	19.0		
4-year degree or more	59.1	72.9	52.4	56.4	87.6		82.2	54.6	37.5	56.7		
Percent Federal Poverty Level												<0.001
<100%	56.3	27.1	69.8	66.9	18.1	<0.001	36.6	80.7	78.4	63.6	<0.001	
101%–200%	11.6	8.6	14.8	10.8	11.7		14.5	11.1	10.5	14.2		
>201%	32.1	64.3	15.4	22.3	70.3		48.8	8.2	11.2	22.2		
Marital status												NS
Married	59.2	90.2	24.5	28.2	76.7	<0.001	83.5	45.5	36.6	81.4	<0.001	
Other	40.8	9.8	75.5	71.8	23.3		16.5	54.5	63.5	18.6		
Health insurance coverage												<0.001
Medicaid	57.6	29.9	65.5	67.0	21.5	<0.001	40.1	70.5	82.1	63.6	<0.001	
Private insurance/self-pay	40.9	69.0	32.3	31.2	77.4		58.4	28.4	16.4	34.5		
No insurance	1.6	1.1	2.3	1.9	1.1		1.5	1.2	1.5	1.9		
Participation in WIC												<0.001
Yes	51.5	25.4	64.0	58.9	23.8	<0.001	25.4	70.7	74.3	56.8	<0.001	
Pregnancy intention												NS
Yes	57.2	75.6	28.1	44.4	65.4	<0.001	73.6	45.2	51.6	62.1	<0.001	
Medical risk factors												
Gestational Diabetes (GDM)												<0.001
Yes	12.3	5.7	8.7	13.0	7.5	<0.001	6.1	15.4	13.4	26	<0.001	
Previous live birth												<0.001
Yes	53.4	55.2	46.8	48.2	29.3	<0.001	58.4	62.7	62.6	43.2	<0.001	
Prenatal care initiation												NS
Yes	84.5	88.1	80.2	84.6	91.8	<0.01	91.3	77.2	84.1	80.1	<0.001	
Previous preterm birth												NS
Yes	2.5	3.1	3.3	1.8	1.4	NS	3.0	2.1	2.7	1.4	NS	
Hypertension during pregnancy												<0.05
Yes	3.7	3.7	7.1	4.2	2.9	NS	1.4	7.0	3.3	1.2	<0.001	
Maternal BMI												<0.05
Underweight (<18.5 kg/m2)	6.0	4.7	5.9	2.6	10.8	<0.001	10.6	3.1	2.1	14.2	<0.001	
Normal (18.5–24.9 kg/m2)	55.1	71.2	35.0	42.6	61.5		67.9	37.0	46.2	68		
Overweight (25.0–29.9 kg/m2)	23.4	17.0	27.7	32.4	22.1		14.9	31.8	31.4	13.3		
Obese (≥30.0 kg/m2)	15.5	7.1	31.5	22.5	5.6		6.7	28.2	20.4	4.5		
Behavioral risk factors												
Alcohol use last 3 mos *pregnancy*												<0.001
Yes	10.3	19.6	5.7	6.0	20.9	<0.001	15.7	5.7	8.1	3.1	<0.001	
Tobacco use last 3 mos *pregnancy*												<0.05
Yes	1.9	1.4	5.0	2.8	1.3	<0.01	2.7	0.6	1.1	1.0	NS	
Discrimination												<0.001
Yes	9.5	1.8	19.3	10.4	5.7	<0.001	6.6	14.5	11.7	10.3	p < 0.05	

*p-value results for Chi-Square test of independence.

the last 3 months of pregnancy. Percent of federal poverty level was based on guidelines from US Census data (<100%, 101–200%, and >201%).

2.2. Data analysis

We used StataCorp (2017) to perform all analyses on PRAMS data linked with certain birth certificate variables for an original sample size of 4256 women. Analyses included cases with no missing values and excluded women with a pre-pregnancy diagnosis of diabetes (n = 118), pre-pregnancy height/weight on PRAMS or birth certificate (n = 59) and race/ethnicity or nativity (n = 8) for a final sample of N = 4084. To account for the complex survey design, we used survey (svy) commands to adjust for weighted stratified sampling, non-coverage and nonresponse components (https://www.cdc.gov/prams/methodology.htm). We used the χ^2 test of independence to examine whether covariates (Table 1), and discrimination (Table 2), differed across racial/ethnic and nativity groups. In Table 3, relative risk ratios (RR) and their 95% confidence intervals were used to estimate the risk of experiencing discrimination across race/ethnicity and nativity and all covariates. We also modeled race/ethnicity separately from nativity, as well as their interaction. In Table 4, we fit logistic regression models to estimate RR and their 95% confidence intervals for racial/ethnic and nativity differences in GDM, and the contribution of discrimination to these differences. Model 1 estimated the age adjusted risk ratios and their 95% confidence intervals of GDM across race/ethnicity and nativity. Model 2 estimated the age adjusted RR of GDM associated with discrimination. Model 3 added race/ethnicity and nativity to Model 2, which allowed for an examination of the impact of discrimination on RR of GDM associated with race/ethnicity and nativity. Model 4 added pre-pregnancy BMI to the previous model to examine how discrimination is affected by BMI adjustment. Model 5 includes all covariates for a fully adjusted estimate of the risk of GDM. Additionally, we examined race/ethnicity, nativity, and their interaction separately to determine how discrimination affected risk of GDM by race/ethnicity and by nativity, and whether racial/ethnic inequalities in GDM and discrimination differed by nativity.

3. Results

Table 1 shows significant differences in maternal covariates across race/ethnicity and nativity. Rates of missingness varied from 18% (income) to 0%. The weighted sample had an overall GDM prevalence of 12.3% (95% CI [11.1, 13.5]) with variation across race/ethnicity and nativity. GDM was highest among foreign-born Asian/PI/Other (26.0%, 95% CI [22.1, 30.4]), foreign-born Black (15.4%, 95% CI [11.4, 20.5]), and foreign-born Hispanic women (13.4%, 95% CI [10.9, 16.4]) as well as US-born Hispanic women (13.0%, 95% CI [9.8, 17.0), and lowest among US (5.7%, 95% CI [4.1, 7.8]) and foreign-born (6.1%, 95% CI [3.9, 9.4]) White women. Examining nativity separately from race/ethnicity suggests that the overall prevalence of GDM was significantly higher for foreign-born (15.9%, 95% CI [14.1, 17.8]) compared to US-born women (8.3%, 95% CI [6.9, 9.8]). US and foreign-born White women were more socioeconomically advantaged and had the lowest rates of overweight/obesity.

Table 1 shows that the prevalence of racial discrimination was higher for US-born (19.3%, 95% CI [15.0, 24.4]) and foreign-born Black women (14.5%, 95% CI [10.6, 19.5]), US-born (10.4%, 95% CI [7.7, 14.0]) and foreign-born Hispanic women (11.7%, 95% CI [9.3, 14.6]) and foreign-born Asian/PI/Other women (10.3%, 95% CI [7.7, 13.6]), compared to US-born (1.8%, 95% CI [1.1, 3.1]) and foreign-born White women (6.6%, 95% CI [4.2, 10.3]).

Table 2 shows a statistically significant difference in GDM associated with discrimination, as 13.7% (95% CI [10.5, 17.6]) of women with GDM reported racial discrimination, compared with 8.9% (95% CI [7.9, 10.1]) of women without GDM. Younger, less educated, unmarried,

Table 2
Maternal sociodemographic, medical and behavioral characteristics by discrimination category.

Characteristic	Total	Discrimination		p-value
	N (%)	Yes	No	
	n = 4004 (100%)	415 (9.5%)	3589 (90.5%)	
Race/Ethnicity and Nativity				
US-born women	**n = 1904 (47.2%)**			<0.001
Non-Hispanic White (US-born)	830 (22.4%)	18(1.8%)	812 (98.2%)	
Non-Hispanic Black (US-born)	466 (10.2%)	86 (19.3%)	380 (80.8%)	
Hispanic/Latina (US-born))	504 (12.0%)	58 (10.4%)	446 (89.6%)	
Asian/PI/Other (US-born)	104 (1.6%)	7(5.7%)	97(94.3%)	
Foreign-born women	**n = 2100 (52.8%)**			NS
Non-Hispanic White (foreign-born)	336 (9.7%)	22(6.6%)	314 (93.4%)	
Non-Hispanic Black (foreign-born)	372 (8.4%)	59 (14.5%)	313 (85.5%)	
Hispanic/Latina (foreign-born)	808 (20.2%)	106 (11.7%)	702 (88.3%)	
Asian/PI/Other (foreign-born)	584 (14.0%)	59 (10.3%)	525 (89.7%)	
Nativity Status				<0.01
US-born women		169 (8.0%)	1735 (92%)	
Foreign-born women		246 (10.8%)	1854 (89.2%)	
Sociodemographic characteristics				
Maternal Age (years)				<0.001
<25	873 (22.3%)	124 (14.2%)	749 (85.8%)	
25–34	2123 (54.2%)	208 (8.7%)	1915 (91.4%)	
35+	1008 (23.6%)	83 (6.9%)	925 (93.1%)	
Education				<0.001
<High School	773 (18.6%)	116 (13.4%)	657 (86.6%)	
Completed HS/GED	874 (22.3%)	106 (11.0%)	768 (89.0%)	
College or more	2353 (59.1%)	192 (7.6%)	2161 (92.4%)	
Marital Status				<0.001
Married/Partner	2332 (59.7%)	161 (6.4%)	2171 (93.6%)	
Other	1672 (40.3%)	254 (13.9%)	1418 (86.1%)	
Maternal Employment				<0.001
Employed	2123(53.4%)	158 (6.6%)	1965 (93.4%)	
Not employed	1876 (46.6%)	256 (12.7%)	1620 (87.3%)	
Percent Federal Poverty Level				<0.001
<100%	1848 (56.4%)	253 (12.3%)	1595 (87.7%)	
101%–200%	389 (11.6%)	39 (11.7%)	350 (88.3%)	
>201%	1050 (32.0%)	44 (3.4%)	1006 (96.6%)	
Health Insurance coverage				<0.001
Medicaid	2274 (57.5%)	301 (12.1%)	1973 (87.9%)	
Private insurance/self-pay	1650 (41.0%)	102 (5.6%)	1548 (94.4%)	
No insurance	73 (1.6%)	11 (14.1%)	62 (85.9%)	
Participation in WIC				<0.001
Yes	2025(51.4%)			

(continued on next page)

Table 2 (*continued*)

Characteristic	Total	Discrimination		p-value
	N (%)	Yes	No	
	n = 4004 (100%)	415 (9.5%)	3589 (90.5%)	
		276 (12.6%)	1749 (87.4%)	
No	1934 (48.6%)	135 (6.3%)	1799 (93.7%)	
Medical Risk Factors				
Pregnancy Intended				<0.001
Yes	2189 (57.3%)	170 (7.6%)	2019 (92.4%)	
No	1670 (42.7%)	222 (11.5%)	1448 (88.6%)	
Prenatal Care first trimester				NS
Yes	3262 (84.6%)	310 (8.8%)	2952 (91.2%)	
No	574 (15.4%)	79 (11.6%)	495 (88.4%)	
Previous Live Birth				NS
Yes	2009 (53.6%)	203 (8.4%)	1806 (91.6%)	
No	1890 (46.4%)	196 (10.4%)	1694 (89.6%)	
Previous Preterm Birth				NS
Yes	158 (2.5%)	19 (10.2%)	139 (89.8%)	
No	3478 (97.5%)	353 (9.5%)	3125 (90.5%)	
Hypertension				NS
Yes	236 (3.7%)	22 (5.4%)	214 (94.6%)	
No	3759 (96.3%)	390 (9.6%)	3369 (90.4%)	
Maternal BMI				<0.01
Underweight (<18.5 kg/m^2)	266 (6.1%)	24 (9.0%)	242 (91.0%)	
Normal weight (18.5–24.9 kg/m^2)	2169 (55.2%)	195 (8.2%)	1974 (91.8%)	
Overweight (25.0–29.9 kg/m^2)	912 (23.4%)	98 (9.6%)	814 (90.5%)	
Obese (>30.0 kg/m^2)	657 (15.3%)	98 (14.4%)	559 (85.6%)	
Gestational Diabetes				<0.01
Yes	523 (12.3%)	78 (13.7%)	445 (86.3%)	
No	3481 (87.7%)	337 (8.9%)	3144 (91.1%)	
Behavioral Risk Factors				
Tobacco Use				NS
Yes	87 (1.8%)	16 (13.6%)	71 (86.4%)	
No	3893 (98.2%)	396 (9.4%)	3497 (90.6%)	
Alcohol Use				NS
Yes	381 (10.3%)	29 (6.9%)	352 (93.1%)	
No	3584 (89.7%)	377 (9.6%)	3207 (90.4%)	

unemployed, low income, and uninsured women, or those using Medicaid reported more discrimination.

After adjusting for maternal covariates in Table 3, US-born Black women had 5 times the risk (RR = 5.01, 95% CI [2.37, 10.61]) and US-born Hispanic women had 3-times the risk (RR = 3.07, 95% CI [1.47, 6.45]) of discrimination relative to US-born White women. The risk of discrimination for US-born Asian/PI/Other women was not significantly higher than US-born White women. Foreign-born White (RR = 2.85, 95% CI [1.29, 6.34]) Black (RR = 3.31, 95% CI [1.49, 7.37]), Hispanic (RR = 3.34, 95% CI [1.63, 6.84]) and Asian/PI/Other (RR = 3.44, 95% CI [1.66, 7.16]) women all had a significantly higher risk of reporting discrimination compared to US-born White women.

Table 3
Relative risk of discrimination by maternal sociodemographic characteristics.

	Discrimination	
	Unadjusted RR (95% CI)	Adjusted RR (95% CI)[a]
	N = 4004	N = 2698
Race/Ethnicity/Nativity		
Non-Hispanic White (US-born)	1.00	1.00
Non-Hispanic White (foreign-born)	3.66 (1.81, 7.40)***	2.85 (1.29, 6.34)*
Non-Hispanic Black (US-born)	10.61 (5.85, 19.23) ***	5.01 (2.37, 10.61) ***
Non-Hispanic Black (foreign-born)	7.99 (4.29, 14.90)***	3.31 (1.49, 7.37)**
Hispanic/Latina (US-born)	5.75 (3.09, 10.70)***	3.07 (1.47, 6.45)**
Hispanic/Latina (foreign-born)	6.45 (3.59, 11.59)***	3.34 (1.63, 6.84)**
Asian/PI/Other (US-born)	3.15 (1.16, 8.60)*	0.90 (0.14, 5.65)
Asian/PI/Other (foreign-born)	5.68 (3.08, 10.47)***	3.44 (1.66, 7.16)**
Maternal Age (years)		
18-24 (ref.)		1.00
25–34		0.86 (0.60, 1.24)
35+		0.96 (0.61, 1.54)
Education		
<High School		0.86 (0.55, 1.33)
Completed HS/GED (ref.)		1.00
College or more		1.01 (0.69, 1.46)
Percent Federal Poverty Level		
<100%		1.43 (0.79, 2.57)
101%–200%		1.92 (1.12, 3.30)*
>201% (ref.)		1.00
Health Insurance coverage		
Medicaid		1.13 (0.73, 1.76)
Private insurance/self-pay (ref.)		1.00
No insurance		1.50 (0.52, 4.29)
Married/Partner (ref.)		0.83 (0.59, 1.16)
Employed (ref.)		0.68 (0.50, 0.91)*
Participation in WIC (ref.)		1.21 (0.82, 1.78)
Medical Risk Factors		
Intended pregnancy (ref.)		1.05 (0.78, 1.41)
PNC first trimester (ref.)		0.96 (0.65, 1.41)
Previous live birth (ref.)		0.84 (0.61, 1.16)
Previous preterm birth (ref.)		0.52 (0.19, 1.43)
Hypertension (ref.)		0.46 (0.19, 1.07)
Maternal BMI		
Underweight (<18.5 kg/m^2)		1.07 (0.58, 1.97)
Normal weight (18.5–24.9 kg/m^2) (ref.)		1.00
Overweight (25.0–29.9 kg/m^2)		0.94 (0.65, 1.38)
Obese (>30.0 kg/m^2)		1.46 (1.01, 2.13)*
Behavioral Risk Factors		
Tobacco Use (ref.)		0.93 (0.37, 2.33)
Alcohol Use (ref.)		0.81 (0.43, 1.52)
Main Effects[b]		
Race-Ethnicity		
White (ref.)		1.00
Non-Hispanic Black		5.01 (2.37, 10.61) ***
Hispanic/Latina		3.07 (1.47, 6.45)**
Asian/PI/Other Race/ethnicity		0.90 (0.14, 5.65)
Nativity		
US-born (ref.)		1.00
Foreign-born		2.85 (1.29, 6.34)**
Interaction Effects[b]		
Foreign-born x Non-Hispanic Black		0.23 (0.08, 0.64)**
Foreign-born x Hispanic Latina		0.38 (0.15, 0.97)*
Foreign-born x Asian/PI/Other		1.34 (0.19, 9.54)

*p < 0.05, **p < 0.01, ***p < 0.001.

[a] adjusted for race/ethnicity/nativity and maternal sociodemographic, medical and behavioral covariates.

[b] adjusted for maternal sociodemographic, medical and behavioral covariates.

Black women had a 5-fold (RR = 5.01, 95% CI [2.37, 10.61]) and Hispanic women had a 3-fold (RR = 3.07, 95% CI [1.47, 6.45]) risk of racial discrimination compared to White women. Foreign-born women had almost a 3-fold (RR = 2.85, 95% CI [1.29, 6.34]) risk of discrimination compared to US-born women. While Black and Hispanic women

Table 4
Relative risk of GDM among mothers in NYC pregnancy risk assessment monitoring system, 2012–2014

	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e,f]
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
	n = 4084	n = 4004	n = 4004	n = 4004	n = 2698
	N = 325,542	N = 319,384	N = 319,384	N = 319,384	N = 212,530
Race/ethnicity/nativity status					
Non-Hispanic White (US-born)	1.00		1.00	1.00	1.00
Non-Hispanic White (foreign-born)	1.06 (0.62, 1.81)		1.03 (0.59, 1.78)	1.04 (0.60, 1.79)	1.20 (0.63, 2.29)
Non-Hispanic Black (US-born)	1.67 (1.04, 2.69)*		1.58 (0.97, 2.60)	1.20 (0.73, 2.00)	1.29 (0.67, 2.50)
Non-Hispanic Black (foreign-born)	2.71 (1.76, 4.15)***		2.69 (1.74, 4.15)***	2.12 (1.36, 3.29)***	1.71 (0.95, 3.08)
Hispanic/Latina (US-born)	2.50 (1.64, 3.82)***		2.45 (1.59, 3.77)***	1.99 (1.98, 3.08)**	1.93 (1.09, 3.40)*
Hispanic/Latina (foreign-born)	2.44 (1.68, 3.55)***		2.37 (1.62, 3.47)***	1.98 (1.35, 2.93)***	1.62 (0.95, 2.77)
Asian/PI/Other (US-born)	1.32 (0.61, 2.87)		1.36 (0.62, 2.95)	1.34 (0.62, 2.91)	1.61 (0.66, 3.93)
Asian/PI/Other (foreign-born)	4.61 (3.25, 6.55)***		4.56 (3.19, 6.52)***	4.65 (3.26, 6.64)***	3.31 (2.05, 5.37)***
Maternal Age (years)					
18-24 (ref.)	1.00	1.00	1.00	1.00	1.00
25–34	1.28 (0.96, 1.69)	1.34 (1.02, 1.77)*	1.29 (0.97, 1.71)	1.25 (0.95, 1.64)	1.49 (1.01, 2.19)*
35+	1.56 (1.14, 2.11)**	1.51 (1.12, 2.04)**	1.55 (1.14, 2.11)**	1.47 (1.08, 1.99)*	2.10 (1.35, 3.26)***
Racial/Ethnic Discrimination					
Experienced Racial/Ethnic Discrimination		1.57 (1.19, 2.06)***	1.35 (1.03, 1.77)*	1.30 (1.00, 1.70)*	1.24 (0.87, 1.78)
Maternal BMI					
Underweight (<18.5 kg/m^2)				1.12 (0.75, 1.69)	1.13 (0.69, 1.84)
Normal weight (18.5–24.9 kg/m^2) (ref.)				1.00	1.00
Overweight (25.0–29.9 kg/m^2)				1.53 (1.20, 1.94)***	1.35 (0.98, 1.87)
Obese (>30.0 kg/m^2)				2.14 (1.68, 2.74)***	1.85 (1.33, 2.58)***
Main Effects					
Race-Ethnicity					
White (ref.)	1.00		1.00	1.00	1.00
Non-Hispanic Black	1.67 (1.04, 2.69)*		1.58 (0.97, 2.60)	1.20 (0.73, 2.00)	1.29 (0.67, 2.50)
Hispanic/Latina	2.50 (1.64, 3.82)***		2.45 (1.59, 3.77)***	1.99 (1.29, 3.08)**	1.93 (1.09, 3.40)*
Asian/PI/Other Race/ethnicity	1.32 (0.61, 2.87)		1.36 (0.62, 2.95)	1.34 (0.62, 2.91)	1.61 (0.66, 3.93)
Nativity					
US-born (ref.)	1.00		1.00	1.00	1.00
Foreign-born	1.06 (0.62, 1.81)		1.03 (0.59, 1.78)	1.04 (0.60, 1.80)	1.20 (0.63, 2.29)
Interaction Effects					
Foreign-born x Non-Hispanic White	1.00		1.00	1.00	1.00
Foreign-born x Non-Hispanic Black	1.53 (0.75, 3.11)		1.65 (0.80, 3.40)	1.69 (0.82, 3.48)	1.11 (0.46, 2.65)
Foreign-born x Hispanic Latina	0.92 (0.49, 1.75)		0.94 (0.49, 1.81)	0.96 (0.50, 1.84)	0.70 (0.32, 1.53)
Foreign-born x Asian/PI/Other	3.29 (1.33, 8.13)*		3.27 (1.31, 8.14)*	3.34 (1.35, 8.31)**	1.72 (0.60, 4.91)

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001.
[a] Adjusted for age and race/ethnicity/nativity.
[b] Adjusted for age and discrimination.
[c] Adjusted for age, discrimination and race/ethnicity/nativity.
[d] Adjusted for age, discrimination, race/ethnicity/nativity and BMI.
[e] Adjusted for age, discrimination, race/ethnicity/nativity, BMI and maternal sociodemographic, medical and behavioral covariates.
[f] Goodness of fit: pseudo-R2 (based on a logistic regression without survey weights) = .074.

are at increased risk of discrimination compared to White women, and foreign-born women are at increased risk of discrimination compared to US-born women, foreign-born Black (RR = 0.23, 95% CI [0.08, 0.64]) and Hispanic women (RR = 0.38, 95% CI [0.15, 0.97]) had a lower risk of discrimination compared to their US-born counterparts.

3.1. Multivariable analyses: GDM and racial discrimination

Discrimination was associated with a 57% increased risk of GDM in the crude model (RR = 1.57, 95% CI [1.19, 2.06]). Adjusting for pre-pregnancy BMI, age and race/ethnicity and nativity (Model 4) attenuated the association to a 30% increased risk (RR = 1.30, 95% CI [1.00, 1.70]). Once all covariates were added to Model 5, discrimination was associated with a 24% increased risk of GDM (RR = 1.24, 95% CI [0.87, 1.78]), but was no longer statistically significant. Adding income in the final model resulted in a reduction in the number of observations, so we ran a sensitivity analysis without income in the fully adjusted model, and found that discrimination was associated with a 36% increased risk of GDM (RR = 1.36, 95% CI [1.00, 1.83]). We also tested whether the findings would be robust if alternative missing data strategies were employed (i.e. listwise deletion and dummy variable coding for missing income data) (Cohen & Cohen, 1985), and found that in fact the findings remained intact.

Model 1 of Table 4 shows the unadjusted association between race/ethnicity and nativity and risk of GDM. US-born Black (RR = 1.67, 95% CI [1.04, 2.69]) and US-born Hispanic (RR = 2.50, 95% CI [1.64, 3.82]) women had a higher risk of GDM compared to US-born White women. Foreign-born Black (RR = 2.71, 95% CI [1.76, 4.15]), Hispanic (RR = 2.44, 95% CI [1.68, 3.55]), and Asian/PI/Other (RR = 4.61, 95% CI [3.25, 6.55]) women also had significantly higher risk of GDM relative to US-born White women. When discrimination was added in Model 3, the risk of GDM for US-born Black women was no longer significantly higher than US-born White women. Adding discrimination did not result in a significant change in GDM for any other racial/ethnic or nativity

group relative to the referent group.

After adjusting for pre-pregnancy BMI in Model 4, risk of GDM was attenuated but remained double for foreign-born Black (RR = 2.12, 95% CI [1.36, 3.29]), and US (RR = 1.99, 95% CI [1.98, 3.08]) and foreign-born (RR = 1.98, 95% CI [1.35, 2.93]) Hispanic women compared to US-born White women. Foreign-born Asian/PI/Other women had over 4.5-times the risk of GDM (RR = 4.65, 95% CI [3.26, 6.64]) compared to US-born White women. After adjusting for all covariates in Model 5, risk of GDM remained almost twice as high among US-born Hispanic women (RR = 1.93, 95%CI [1.09, 3.40]), while foreign-born Asian/PI/Other women had over 3-times the risk (RR = 3.31, 95% CI [2.05, 5.37]) compared to US-born White women.

Main effect estimates of GDM by race/ethnicity indicate that Black (RR = 1.67, 95% CI [1.04, 2.69]) and Hispanic (RR = 2.50, 95% CI [1.64, 3.82]) women had increased risk of GDM compared to White women. Once we controlled for discrimination, the risk of GDM for Black women was no longer significantly higher compared to White women, but did not change for Hispanic women. After fully adjusting for covariates, risk of GDM remained almost double for Hispanic women (RR = 1.93, 95% CI [1.09, 3.40]) compared to White women. Main effect results for nativity indicate that foreign-born women did not have a significantly increased risk of GDM compared to US-born women. However, there was a significant interaction between race and nativity for foreign-born Asian/PI/Other women who had over 3-times the risk of GDM (RR = 3.29, 95% CI [1.33, 8.13]) compared to US-born Asian/PI women. Once all covariates were included, this interaction disappeared.

4. Discussion

This study found significant differences in experiences of racial discrimination across race/ethnicity and nativity status among pregnant women; racial/ethnic minorities and foreign-born women reported more discrimination, and racial/ethnic differences in discrimination were modified by nativity. We also found a positive association between racial discrimination and GDM; a finding that adds to a growing body of literature on the noxious impact of racial discrimination on reproductive health (Alhusen et al., 2016).

The first aim of our study was to examine the distribution of racial discrimination experiences 12 months before giving birth across race/ethnicity and nativity. We found that 9.5% of the overall sample reported discrimination, with wide variation across race/ethnicity and nativity. Our finding that 17% of Black women reported discrimination is similar to results from Bower et al. (2018) who used 2004–2012 PRAMS data, and reported that 14% of Black women felt upset by experiences of racial discrimination. These findings should be regarded with caution to avoid minimizing the prevalence of racial discrimination, as studies have found between 44% (Lee et al., 2019) and 78% (Ertel et al., 2012) of participants reporting lifetime experiences (compared to 12-month prevalence) of discrimination. Conclusions drawn from our results should reflect an understanding of differences in measurement such as timing, frequency, and experiences vs. perceptions of discrimination, as well as feelings due to experiences of discrimination. This highlights the scrutiny required when making comparisons across studies with different measurements of discrimination, and the need for more research examining the best ways to measure this complex construct.

Our finding that racial/ethnic minority and foreign-born women report more discrimination compared to US-born White women is consistent with other studies (Almeida et al., 2016; Perry et al., 2013). While we documented that Black and Hispanic women have a 5- and 3-fold risk of discrimination, respectively, compared to White women, and that foreign-born women had almost a 3-fold risk compared to US-born women, these were qualified by statistical interactions suggesting that being foreign-born may be protective for Black and Hispanic women relative to their US-born counterparts. Our results, which move beyond Black-White comparisons, are consistent with Krieger et al.'s (2011) findings that US-born Black participants reported higher rates of discrimination compared to their foreign-born counterparts. Additionally, other research has found that US-born Hispanics report more discrimination than their foreign-born counterparts, possibly due to better English proficiency and greater exposure to discrimination in residential and occupational settings (Almeida et al., 2016; Perez et al., 2008). Taken together, our findings add to research indicating that racial discrimination is higher among racial/ethnic minority and foreign-born women compared to US-born White women, but highlights the importance of examining how differences in discrimination are modified by nativity, as some aspect of being foreign-born may be protective of discrimination for certain foreign-born groups.

We also found that racial discrimination was associated with a higher risk of GDM relative to women who did not report discrimination, which is consistent with many studies that have found relationships between discrimination and adverse pregnancy outcomes (Alhusen et al., 2016), including GDM (MacGregor et al., 2020). After controlling for all covariates, the association between discrimination and GDM lost statistical significance. Including income in the final model did not substantively change the effect size but resulted in many observations being lost. Conducting a sensitivity analysis omitting income indicated a statistically significant increased risk of GDM. Although the cross-sectional nature of the data make it difficult to distinguish temporal ordering, the effect of income on the association between discrimination and GDM points to the need for an intersectional lens, in which discrimination is considered in the context of poverty. Perry et al. (2013) found significant associations of racial and gender discrimination with increased financial and employment problems among African American women. Limited socioeconomic attainment is a proposed pathway by which racism affects health, as racial/ethnic minorities face barriers due to discrimination that shape inequalities in SES, which in turn create conditions that harm health due to decreased access to employment, education and health care (Williams et al., 2019). Thus, it is important to examine the unique effect of SES on the associations between racial discrimination and health, such as that found in our sensitivity analysis demonstrating that income was found to be associated with the relationship between discrimination and GDM. While this association became statistically insignificant once we accounted for income, the finding that effect size and direction remain the same, coupled with the collinearity between discrimination and income (Williams et al., 2019), provides evidence in support of our hypothesis that discrimination is associated with a higher risk of GDM, and is an important contribution to the discrimination-health literature. Future research should examine how discrimination acts on GDM via SES and other pathways, which would allow for a more nuanced understanding of the mechanisms that contribute to inequalities in GDM.

Stress is another proposed pathway to adverse health. Sternthal et al. (2011) found associations between stressors and poor health, particularly among US-born Black and Hispanic participants, even after controlling for SES. Stress is thought to mediate the association between discrimination and health (Cuevas et al., 2013) as experiences of discrimination are emotionally distressing and can trigger the stress response, and cause wear and tear on bodily systems (Williams & Mohammed, 2009). The stress biology pathway is one of the most recognized mechanisms between racial discrimination and adverse birth outcomes (Alhusen et al., 2016).

Our final objective was to test the degree to which the association of race/ethnicity and nativity with GDM is explained by discrimination. Although we found that racial/ethnic minority and foreign-born women have significantly higher risk of GDM compared to US-born White women, which is consistent with other studies (DeSisto et al., 2014), adding discrimination to the model did not change risk for most racial/ethnic and nativity groups. This suggests that racial/ethnic and nativity inequalities in GDM are likely explained by variables other than discrimination in the 12 months before delivery. However, adding discrimination to the prior age, race/ethnicity and nativity adjusted

model slightly attenuated risk of GDM for US-born Black women compared to US-born White women. Studies have found associations between discrimination and glucose intolerance, insulin resistance and type 2 diabetes (Chambers et al., 2004) among Black women (Wagner et al., 2013). There were no significant interactions between nativity and racial group, suggesting that nativity differences in GDM are not modified by race.

Pregnancy is a sensitive time in the life course when women deserve adequate social and emotional resources. However, our study suggests that many pregnant women experience racial discrimination, which can harm their reproductive health outcomes (Paradies et al., 2015), including metabolic risk factors (Beatty Moody et al., 2018). Our study extends prior research by demonstrating that racial discrimination is prevalent among a population-based, heterogeneous sample of pregnant women in NYC, and supports the notion that discrimination may in part explain the elevated risk of GDM among US-born Black women compared to US-born White women. Racial discrimination structures opportunities and access based on race/ethnicity/nativity at multiple levels, which adversely affects health due to barriers in employment, education and healthcare (Williams & Mohammed, 2009). While we need to further understand the magnitude of impact that discrimination has on GDM in order to best allocate resources, this research provides additional evidence of the urgency to combat the racialized social structures that adversely impact reproductive health (Williams et al., 2019).

Our findings should be considered in light of certain limitations. First, the question about discrimination asks about experiences in the 12 months before giving birth, which may pertain to experiences after GDM diagnosis. In addition, the recall of discrimination is subject to perception bias, which reflects how motivated and willing participants are to talk about their experiences, and may have depressed the actual rate of discrimination. For example, minimization bias is one aspect of perception bias where participants may not be willing to report discrimination due to denial of the experience having occurred, the psychological costs of reporting the experience and ambiguity of discriminatory experiences (Lewis et al., 2015).

Another limitation is that racial discrimination on PRAMS is measured with a single question about racial discrimination rather than nuanced questions about the situations in which the discrimination occurred such as school, work, or community (Krieger, 1999). Although the PRAMS question about discrimination experiences specifies a time-period of 12-months before birth, it is not possible to disentangle health effects in relation to this temporal measure of exposure from cumulative effects of exposure across a lifetime. According to a review of self-reported racism and health, studies with time-frame exposures that are unspecified or a year or less have significantly higher health outcomes compared to lifetime and 1 to 5-year time-frame exposures, possibly because they are the same exposures and/or because it reduces recall bias (Paradies, 2006). An important focus for future research on the etiology of GDM is to improve the measure of discrimination in a way that captures the various types, as well as when and in what context it occurs (Almeida et al., 2022).

5. Conclusions

The current study extends research on discrimination and health inequalities by demonstrating that racial discrimination is common among pregnant racial/ethnic minority and foreign-born women in NYC, and highlights the importance of examining the interaction between race/ethnicity and nativity. Our study also demonstrates that racial discrimination is associated with GDM, and may be contribute to racial/ethnic and nativity inequalities in GDM. Policies and practices should address the racial/ethnic and nativity inequities in exposure to discrimination, and SES inequalities that contribute to the development of disease. All women deserve pregnancies that are free from discrimination to optimize reproductive health outcomes.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. We acknowledge and appreciate the PRAMS Working Group and the Centers for Disease Control and Prevention.

Availability of data

N/A.

Software application

StataCorp, 2017

Ethics approval

Simmons University IRB determined the study qualified for exemption.

Consent to participate

N/A.

Consent for publication

New York City Department of Health and Mental Hygiene who provided the data has consented to submitting this manuscript for publication.

Author's statement

Kristin Erbetta: Conceptualization, Methodology, Formal Analysis, Data Curation, Writing-Original Draft Preparation, Visualization.

Joanna Almeida: Conceptualization, Methodology, Writing-Review and Editing, Visualization.

Marcus Waldman: Methodology, Formal Analysis, Writing-Review and Editing.

Ethical statement

1) This material is the authors' own original work, which has not been previously published elsewhere.

2) The paper is not currently being considered for publication elsewhere.

3) The paper reflects the authors' own research and analysis in a truthful and complete manner.

4) The paper properly credits the meaningful contributions of co-authors and co-researchers.

5) The results are appropriately placed in the context of prior and existing research.

6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.

7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Data availability

The data that has been used is confidential.

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