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Does Racial Segregation Aggravate or Alleviate the Association between Race/Ethnicity and Maternal Smoking during Pregnancy: A Multilevel Analysis

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Introduction

Maternal smoking during pregnancy has significant implications for both the mother and her child.^{1,2} In addition to the countless negative consequences associated with smoking at anytime, smoking during pregnancy puts women at an increased risk for deep vein thrombosis, stroke, pulmonary embolus, myocardial infarction, influenza, pneumonia, bronchitis, asthma, gastrointestinal ulcers, ectopic pregnancy,³ and breast cancer.⁴ When women smoke during their pregnancy, they also put their infant at a greater risk for low birth weight,⁵⁻¹¹ placental abruption,^{8,12} birth defects,¹³⁻¹⁵ preterm delivery,^{16,17} and fetal and infant mortality.^{16,18} Smoking during pregnancy has also been found to impose *lasting* negative effects on children's learning and memory,¹⁹ language development,²⁰ and cognitive scores,²¹ as well as adverse behavioral outcomes for children, including cognitive and attention deficits, conduct disorder, and substance use.²²⁻²⁴

Previous research has identified characteristics of mothers that are associated with an increased likelihood of smoking during pregnancy. These maternal characteristics include being from a non-Hispanic white racial background,^{25,26} not being married,²⁷⁻³¹ receiving late prenatal care,^{29,32} gaining more than the recommended amount of weight during pregnancy,³¹ and being pregnant with a second or higher order birth.^{31,33,34} In addition, women from a low socioeconomic status, such as having a low household income,^{29,31,35} fewer years of education,^{29-31,34} or of poverty status³⁶ are more likely to smoke during pregnancy.²⁷ On the other hand, women who are from a non-Hispanic black,³⁰ Asian, or Hispanic racial/ethnic background are significantly less likely to smoke while they are pregnant compared to non-Hispanic white women.³¹ In addition, women who are working,³² hold a bachelor degree or higher,^{32,37} or whose pregnancies were planned³⁷⁻³⁹ are significantly less likely to smoke in contrast to their counterparts. Rates of maternal smoking during pregnancy are also lower among teenage women.^{30,37} However, it should be noted that even though teenagers are more likely to quit smoking during their pregnancy compared to older women, they are significantly more likely to resume smoking after giving birth.³⁷

Previous research on maternal smoking during pregnancy has recommended that factors beyond the individual woman should be considered;^{40,41} however, studies that have actually considered contextual-level influences on individual maternal smoking during pregnancy behavior have been limited.⁴² To the best of our knowledge, there have been two American studies that have explicitly considered how characteristics of the place a woman lives influence the likelihood of smoking while she was pregnant. Pickett and her colleagues found that living in a predominantly working-class area significantly increases the risk that a woman will smoke during her pregnancy.⁴⁰ However, this study was restricted to white women living in California. Bell et al. showed that both low and high residential segregation are associated with a higher odds of smoking during pregnancy compared to moderate residential segregation.⁴³ It should be noted that this study was limited to African American women who lived in a metropolitan statistical area with a population of at least 100,000 residents and at least 5,000 of the residents were African Americans.

While maternal smoking during pregnancy is one of the most significant risk factors for poor pregnancy outcomes, it is also one of the most modifiable and preventable.^{16,44,45} The benefits associated with decreasing the percentage of women who smoke during their pregnancy and the societal cost associated with it have long been an important health policy concern,⁴⁶⁻⁵¹ even so much that *Healthy People, 2020* has identified reducing maternal smoking during pregnancy from 10.4% (2007) to 1.4% by 2020 as one of its objectives.⁵² Therefore, understanding *both* individual and residential context risk factors for smoking during pregnancy is essential for reaching this goal. This study will build upon previous studies of maternal smoking during pregnancy by examining how residential segregation is associated with the odds of smoking during pregnancy among white, black, Asian, and

Hispanic women in the continental United States (US). We will also consider how individual race group interacts with residential segregation to influence maternal smoking during pregnancy. Examining this interaction may be particularly useful for understanding whether residential segregation affects the odds of maternal smoking during pregnancy differently for women of different racial/ethnic backgrounds. The results of this study can be used to identify ways to reduce maternal smoking during pregnancy in the US.

Residential segregation and smoking during pregnancy

Residential segregation (hereafter, segregation), or the separation of one racial/ethnic group from another,⁵³ and its effect on health follows two distinctive theoretical foundations: (1) place stratification suggests segregation is harmful to the health of minorities and (2) ethnic enclaves are beneficial for well-being.⁵⁴ According to the place stratification perspective, discrimination of African Americans by white individuals and institutions encourages segregation.⁵⁵ In this regard, segregation has been found to be negatively associated with a number of health outcomes and health-related behaviors, and does so through a number of interconnected mechanisms.⁵⁶ Segregation leads to reduced educational and employment opportunities^{57,58} and produces negative social environments⁵⁶ such as high crime rates⁵⁹⁻⁶¹ and concentrated poverty.^{55,62} This framework appears to work for understanding how the segregation of blacks from whites impacts health and health behaviors, but is not consistent with Asian-white and Hispanic-white segregation.⁵⁴ On the other hand, as Walton explains, the reasons behind segregation among other minority groups is different from those of African Americans, because Hispanic and Asian immigrants tend to live in immigrant enclaves with the intention of easing the transition to the US and receiving social support.⁵⁴ These ethnic enclaves may provide increased social support and social engagement among family and friends, enhance integration into the community, provide more exposure to educational and occupational resources, and decrease exposure to discrimination,⁵⁴ all of which may contribute to reducing maternal smoking during pregnancy. According to these two perspectives, segregation may affect maternal smoking during pregnancy differently depending on the racial/ethnic segregation being compared.

Data and methodology

The individual-level data for this study comes from the National Center for Health Statistics 2008 non-public use detailed natality files.⁶³ This dataset is based on the total population of women who lived in the US and had a live birth during the 2008 calendar year. Smoking during pregnancy is not reported on the birth certificate in California; therefore, women who resided in California will be excluded from the analysis. Also, American Indian/Alaskan Native (AIAN) women are excluded from the analysis, because the AIAN population is too small to look at AIAN residential segregation. The tract- and county-level data come from the American Community Survey 5-year estimates.⁶⁴

In order to examine the factors associated with maternal smoking during pregnancy, a series of multilevel logistic regression will be estimated. These models will allow us to determine whether segregation has a direct effect on maternal smoking during pregnancy, while controlling for county-level socioeconomic status and the non-Hispanic white population. We will also test for cross-level interactions between individual race/ethnicity and segregation. This will help us to determine whether the effect of race on smoking during pregnancy works differently depending upon the level of segregation in the county. Massey and Denton outline the following dimensions of segregation: evenness, exposure, concentration, centralization, and clustering.⁵³ We measure segregation using the dimension of exposure using the interaction index (χP_y^*).^{53,65} This measure was selected, because it compares two subgroups to each other when calculating the segregation measure instead of considering

one group by itself. This measure was also chosen because it best reflects our theoretical conceptualization that there are potentially different mechanisms for different racial/ethnic groups; and it captures segregation of several minority groups relative to the non-Hispanic white majority. We measure each index of segregation by aggregating up from the tract-level to the county-level.

Residential exposure refers to the possibility of interaction between residents of different races within a county. Indexes of exposure measure the extent to which residents come into contact with one another simply by sharing a common residential area. The interaction index, a basic measure of residential exposure, measures the extent to which residents of different racial groups (white-black for example) are exposed to residents of the opposite race. It has been denoted as ${}_xP_y^*$ and calculated:

$${}_xP_y^* = \sum_{i=1}^n \left| \frac{x_i}{X} * \frac{y_i}{t_i} \right| \text{ where } x_i, y_i, \text{ and } t_i \text{ are the number of residents who are non-Hispanic black, the}$$

number of residents who are non-Hispanic white, and the total population of tract i within a county, respectively. X represents the total number of non-Hispanic black residents in the county. The index varies between 0 and 1 and can be interpreted as the probability that a minority group resident shares an area with a majority group (e.g., non-Hispanic black shares with non-Hispanic white).

Preliminary results

Overall, the results in Table 1 show that there is no direct effect of segregation on maternal smoking during pregnancy; however, segregation moderates the race/ethnicity-smoking during pregnancy relationship. This is the case when each of the segregation measures are tested independently (Models I-III) and simultaneously (Model IV). Specifically, as shown in Model IV (final model), non-Hispanic black women are 69 percent less likely to smoke while they are pregnant compared to non-Hispanic white women. However, non-Hispanic black women who live in a county where non-Hispanic blacks are more integrated with non-Hispanic whites are 85 percent less likely than non-Hispanic whites to smoke while they are pregnant. In other words, for non-Hispanic black women, living in a county where non-Hispanic blacks are more segregated from non-Hispanic whites increases the odds of maternal smoking during pregnancy, after controlling for the non-Hispanic white population in the county. This finding follows the place stratification argument discussed previously. Non-Hispanic Asian women are 81 percent less likely to smoke during their pregnancy compared to non-Hispanic white women. Despite this, non-Hispanic Asian women who live in a county where non-Hispanic Asian women are more integrated into the county are 26 percent less likely to smoke during their pregnancy compared to non-Hispanic white women. Therefore, for non-Hispanic Asian women, living in a county that is more segregated from the non-Hispanic white population reduces the odds of maternal smoking during pregnancy. Hispanic women are approximately 90 percent less likely to smoke while they are pregnant compared to non-Hispanic white women. However, Hispanic women who live in a county where Hispanics are more integrated with whites are 68 percent less likely to smoke while they are pregnant compared to non-Hispanic white women. Like the experience of non-Hispanic Asian women, Hispanic women who live in a county where the Hispanic population is more segregated from the white population are less likely to smoke while they are pregnant. The findings for both Asian and Hispanic women echo the ethnic enclave argument. These findings are also consistent with segmented assimilation theory in that Asians and Hispanics are following a downward assimilation trajectory by assimilating into the culture of the non-Hispanic whites⁶⁶ where smoking prevalence is the highest.²⁶

Table 1. Multilevel logistic regression models predicting the odds of maternal smoking during pregnancy. *PRELIMINARY RESULTS*

	Model I	Model II	Model III	Model IV
Individual-level measures (N=2,720,375)				
Intercept	0.014***	0.014***	0.014***	0.014***
Maternal age				
Age	1.293***	1.293***	1.293***	1.293***
Age squared	0.996***	0.996***	0.996***	0.996***
Race/Ethnicity (Non-Hispanic White=reference)				
Non-Hispanic Black	0.311***	0.306***	0.305***	0.310***
Non-Hispanic Asian	0.196***	0.190***	0.195***	0.189***
Hispanic	0.093***	0.093***	0.090***	0.090***
Marital status				
Married	0.325***	0.326***	0.326***	0.325***
Maternal education (Less than High School=reference)				
High school/GED	0.612***	0.612***	0.612***	0.612***
Some college/Associate's degree	0.331***	0.331***	0.331***	0.331***
Bachelor's degree or higher	0.060***	0.060***	0.060***	0.060***
Weight gain during pregnancy				
Weight gain	0.987***	0.987***	0.987***	0.987***
Weight gain squared	1.000***	1.000***	1.000***	1.000***
Prenatal Care Utilization (Inadequate care=reference)				
Intermediate care	0.782***	0.782***	0.782***	0.782***
Adequate care	0.682***	0.682***	0.682***	0.682***
Adequate plus care	0.731***	0.731***	0.731***	0.731***
Parity				
First birth	0.714***	0.714***	0.714***	0.714***
County-level measures (N=2,444)				
Direct Associations				
Residential segregation				
NHB:NHW interaction index	0.998			1.221
NHA:NHW interaction index		0.966		1.032
H:NHW interaction index			0.895	0.726
Controls				
Proportion Non-Hispanic white	5.392***	5.494***	5.651***	5.550***
SES	0.808***	0.809***	0.808***	0.806***
Moderating Associations				
Non-Hispanic Black*NHB:NHW interaction index	0.437***			0.479***
Non-Hispanic Asian*NHA:NHW interaction index		3.797**		3.931**
Hispanic*H:NHW interaction index			3.712***	3.592***
Variance Components				
Intercept	0.141***	0.141***	0.140***	0.140***

Note: Results are reported in odds ratios; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

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