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Sai Ramya Maddali Date

The Impact of Economic Segregation on Very Preterm Birth across MSAs in the United States: 2010-2011

By

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Master of Public Health

Epidemiology

_____

Michael Kramer, PhD

Committee Chair

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BS
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2013

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An abstract of
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Abstract

The Impact of Economic Segregation on Very Preterm Birth across MSAs in the United States: 2010-2011

By Sai Ramya Maddali

Background: Being born very preterm (VPT) can negatively impact infant health in many ways, including hearing impairment, developmental delay, and cerebral palsy. Higher risk of VPT has been associated with racial segregation and income inequality, therefore there is some evidence that living in a metropolitan statistical area (MSA) with high economic segregation may contribute to an increased probability of VPT.

Methods: This study used Generalized Estimating Equations to assess the association between the level of economic segregation within an MSA that a mother lives and the probability of her giving birth VPT, controlling for individual risk factors and county level covariates. The study uses live births to mothers over 18 years old in 2010 and 2011 and spans 184 MSAs across the US. The level of economic segregation in an MSA was based on income data from the 2012 national census.

Results: This study suggests that there is an association between economic segregation and the probability of VPT and that the association varies by maternal race/ethnicity, maternal age, and proportion of the non-Hispanic black population in an MSA. Non-Hispanic black women experience nearly a two-fold increase in the probability of VPT when living in an MSA with high economic segregation compared to living in an MSA with low/no economic segregation (Figure 1). However, the level of economic segregation has a minor impact on non-Hispanic white women's probability of VPT (Figure 1). High versus low economic segregation appears to have a stronger relative association with the probability of VPT for mothers in the mid-reproductive age (28 years old) compared to younger (18 years old) and older (35 years old) ages. The association between economic segregation on VPT also appears to increase as the proportion of the MSA that is non-Hispanic black increases, suggesting a relationship between economic segregation and racial segregation.

Discussion: There is evidence that living in a MSA that is economically segregated impacts a mother's probability of giving birth very preterm, particularly for non-Hispanic black mothers. However, this association could potentially be mediated by or entirely due to the correlation between racial segregation and economic segregation.

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Introduction

Very Preterm Birth

Perinatal outcomes have a profound impact on lifelong health. Infants born prior to term (37 weeks gestational age) are referred to as preterm, or very preterm (VPT; prior to 32 weeks gestational age) [6]. In 2013 alone, 11.4% of infants born in the United States were born preterm[55]. Of those born preterm, 16% were born very preterm[54]. Overall approximately 2% of all live-births in the United States are VPT. Infants who are born VPT have higher rates of infant mortality compared to infants born late preterm (34-36 weeks' gestational age), preterm, and full term; in fact the chance of survival for neonates increases each additional gestational week [26, 42]. In 2013 alone infant mortality rates for very preterm births was 163.71 per 1,000 live births compared to infant mortality rates for all preterm births, 34.76 per 1,000 live births, and full term, 2.19 per 1,000 live births[54,55]. Though the majority of infants born prior to full term are born late preterm, the highest burden of infant mortality rests with infants who are born very preterm or extremely preterm[56]. Further complications of preterm birth have also been reported by the Centers for Disease Control and Prevention (CDC); breathing difficulties, vision problems, feeding issues, cerebral palsy, developmental delay, and hearing impairment to name a few[9]. Aarnoudse-Moens et al in their 2011 study found that children born VPT perform worse in mathematics (arithmetic) and numerical reasoning skills than children born at or after 37 weeks.

The magnitude of this burden draws the audience to a simple question, what causes very preterm birth? Preterm birth, VPT birth, and extremely preterm birth have

been associated with a myriad of risk factors: maternal age, maternal race/ethnicity, maternal education, gestational age at which prenatal care was initiated, smoking and drug use during pregnancy, levels of maternal stress, live-birth order (parity), mother's marital status, nativity, and various psychosocial factors[11, 28, 39, 46, 54]. Some of these factors have been further explored individually.

Race/Ethnicity

Racial and ethnic disparities in rates of preterm birth have been well described. Non-Hispanic black women have the highest rates of VPT birth compared to any other racial/ethnic category, nearly 2.5 times greater than non-Hispanic white women[56]. This disparity continues to exist after adjusting for other risk factors of VPT such as highest educational level achieved, maternal age, and parity (the number of times a woman has been pregnant and has carried the pregnancy to greater than 20 weeks) [56]. MacDorman et al. explored the relationship between race/ethnicity and preterm birth through a study of trends in preterm-related mortality by race/ethnicity in the United States from 1999-2004[56]. They found that in 2004 the preterm-related infant mortality rates were over 3 times higher for non-Hispanic black women than for non-Hispanic white women. They also found the total infant mortality across non-Hispanic white, Mexican, and Asian mothers was less than just the preterm-related mortality for non-Hispanic black mothers[56]. Other research has shown evidence of similar racial and ethnic disparities in occurrence of preterm and very preterm birth rates in non-Hispanic black women compared to non-Hispanic white women[20,21]. Racial disparities in the probability of very preterm birth have been hypothesized to be related to racial segregation, stress related to

interpersonal and systemic racism, potential biological and genetic factors, and exposure to individual risk factors across different racial groups among other factors[20]. However, no one pathway fully explains the disparities that exist.

Smoking

Tobacco consumption in the form of cigarette smoking is also a risk factor for preterm and very preterm birth. In fact, smoking has been implicated as a risk factor for nearly 60 years (starting in 1957)[14,16]. The ban of smoking in communities such as Pueblo, Colorado has shown marked improvement in neonatal preterm birth (23% decrease in the odds of preterm birth)[35]. Smoking is not only deleterious to preterm birth but also contributes to other poor maternal health outcomes such as miscarriage, fetal growth restriction, and ectopic pregnancies to name a few [14, 16, 35,36].

Maternal Age

The association between maternal age and preterm and VPT birth has also been explored. There exists an upward parabolic relationship, in which very young mothers (adolescents and teenagers) and older mothers have the highest risk for preterm and VPT birth[43]. This association could be due to accumulation of chronic stressors across their life course or even partially influenced by level of education attained or parity[43]. Branum et al. in a study of the influence of maternal age on very preterm birth of twins found that the impact of maternal age on preterm birth is affected by level of maternal education and parity, women who are older but more educated have a reduced risk of very preterm birth compared to women who are older but less educated[43].

Prior Preterm Birth

One of the strongest risk factors for very preterm birth is history or occurrence of prior preterm birth. Mazaki-Tovi et al. in their study of recurrent preterm birth found that women who had previously given birth preterm had 2.5 times the risk of a subsequent preterm birth than women who did not have a history of preterm birth[27]. Furthermore, the authors found that the earlier the initial preterm birth occurred, the higher the risk was for a subsequent preterm birth event. Meaning that women who have given birth extremely preterm or very preterm are at a higher risk for another preterm birth event than women who have never given birth preterm[27].

Maternal Education

Maternal education level is an important risk factor of very preterm birth to explore as well. Generally, the established trend is that women with higher education have a reduced risk of very preterm birth[3]. This is undoubtedly associated with higher individual income, greater access to care, and other health outcomes associated with higher SES. Lower rates of obesity and smoking during pregnancy are generally found in groups who are higher SES as well[3]. Maternal education in conjunction with other risk factors (specifically maternal age and parity) can be stronger indications of risk for very preterm birth. An older woman (40 + years) with low education who is giving birth to her 4th child is at high risk for preterm birth and at a higher risk for VPT or XPT[3].

Neighborhood Factors

Studies have also suggested an association between area level socioeconomic inequalities (i.e. high levels of neighborhood poverty, low socioeconomic status, etc.) and high rates of preterm and VPT birth[20,33,44]. These neighborhood level factors impact the individual's exposure to stress, crime, and pollution as well as access to good quality schools, parks, and nutritious food [5,19]. As these factors in turn impact important risk factors for preterm birth such as level of stress during pregnancy, exposure to smoking, and level of maternal education, they impact rates of preterm and very preterm birth. Other social factors also implicated are: level of racial segregation and income inequality[20,21,22]. This paper seeks to add to the literature about the impact of neighborhood composition and macrosocial factors by exploring the impact of economic segregation on very preterm birth rates.

Economic Segregation

Concentrations of wealth and poverty within cities is not an uncommon sight, particularly because of the growing income gap in the U.S. The geographic distribution of income can be related to differences in the allocation of health resources, such as access to healthy food and higher quality of care and also to increased social instability (shown through crime and violence rates). Though related, income inequality and economic segregation are different measures of social inequality. Income inequality is the uneven distribution of income in a population; in other words, income inequality refers to the individual income gap between the affluent and the poor or middle-class in the United States. Higher levels of income inequality are also associated with higher mortality rates

across cities in the US [33, 45, 46]. For the last three decades, income inequality has been steadily rising in the United States and has been accompanied by an increase in the spatial concentration of poverty and wealth [18, 50]. Economic segregation has been increasing in U.S. Metropolitan Statistical Areas (MSAs) for the past few decades, even within racial/ethnic groups[18]. The rich are living among the rich and the poor are living among the poor. This segregation of the population based on income is referred to as economic segregation. To explain further, there can be high income inequality in an area that is not economically segregated; in which people of different economic classes living among each other in closer geographic region. Dr. Ichirio Kawachi of Harvard University argues that not only are income inequality and economic segregation related, their relationship is causal[19]. He argues that as income inequality increases, the affluent in a neighborhood move to other neighborhoods where there are other people of affluence. The process by which an individual selects their residence depends on a few different factors, primarily the job/labor market and the housing market. The spatial distance which an individual is willing to travel from work to home is included in how an MSA/CBSA (Core-Based Statistical Area) is determined.

Measurement

Though there are several methods to measure economic segregation, this paper will focus on the H index or the Rank-Order Information Index and its variants[5,37,38]. The Rank-Order Information Index measures economic segregation by comparing the variation of family income in an MSA to variance of the family income in the census tract; essentially it measures spatial homogeneity of the rich and the poor in a given area

[5,37,38.] The H-Index is bound by the values 0 (in which the MSA has no economic segregation) and 1 (in which the MSA is entirely segregated by income). [5,37,38] It can capture the total economic segregation in a population, or can focus on one end of the income distribution or another. For instance, the segregation of the those in poverty (the bottom 10% of families) and those in affluence (the top 10% of families) can be measured by variants of H: H10 and H90 respectively[5,37,38]. H10 and H90 are similarly bounded by 0 and 1, as their values approach 1 those in poverty and affluence (respectively) live in homogenous clusters, separate from those of other income quantiles. Vice versa as H10 and H90 approach 0, those in poverty and affluence (respectively) live in economically diverse areas and the economic classes are more spatially integrated[5,37,38]. Another measurement of economic segregation that was considered was the dissimilarity index (DX), which is often used in racial segregation literature[37]. The DX measures the spatial evenness or unevenness (e.g. heterogeneity) of specific groups of interest; non-Hispanic Blacks and non-Hispanic Whites or (for the purpose of this study) those in poverty vs those in affluence[31]. One limitation of this measure is that the DX uses income as a categorical variable which results in the loss of data whereas the H (Rank Order) Index, H 10, and H 90 all use income as a continuous variable[37]. The measurement of economic segregation differs from income inequality, which is often measured by the widely accepted Gini Coefficient [33]. The Gini coefficient measures the difference from the actual income distribution of an area and a hypothetical population where every family has the same income; measures of economic segregation assess how mixed families of different incomes are in a given area [33,37,38].

Economic Segregation and Health Outcomes

The level to which income groups are separated within a geographic region has important implications for the health of the communities within that region. Bischoff and Reardon explore this theory in their article, "Residential Segregation by Income 1979-2009". They state that income (economic) segregation may "accentuate the economic advantage of high-income families and exacerbate the economic disadvantage of low-income families."[5]. Bischoff and Reardon theorize that the income composition of a neighborhood impacts other neighborhood level factors such as crime rates, distribution of public resources such as parks and quality of education, and even political power[5]. These neighborhood level factors have been shown to be associated with health of the overall neighborhood; an example would be that better schools mean better physical activity programs which lead to lower rates of childhood obesity which lead to lower rates of adult obesity[5]. Olson et al. in "Impact of Income and Income Inequality on Infant Health Outcomes in the United States" found evidence of an association between preterm birth and income inequality (as measured by aforementioned Gini Coefficient)[33]. Olson et al say that, "significant proportions of the variance in PTB rates, LBW rates, VLBW rates, and IMRs could be attributed to the combined impact of income and income inequality"[33].

Very Preterm Birth and Economic Segregation

The reason for exploring the relationship between very preterm birth rates and levels of economic segregation are three-fold. First, socioeconomic inequalities have been linked with the incidence of very preterm birth [33,45]. Second, if the allocation of

public resources follows the affluent, then areas that are more divided by wealth will have issues of access to quality care and other neighborhood factors[18]. The division of resources could impact perinatal health outcomes such as very preterm birth. Finally, higher levels of economic segregation and concentrations of poverty have been found to be associated with high levels of mortality in MSAs [41,50]. Though these all suggest a potential relationship between economic segregation and perinatal outcomes (such as very preterm birth), an association has not been explored directly. The aim of this study is to investigate the association between levels of economic segregation and risk for very preterm birth (birth less than 32 weeks' gestational age) across Metropolitan Statistical Areas (MSAs) in the United States.

Methods

Data

Data for all live births from 2010 and 2011 was obtained from the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) using the National Vital Statistics System which records vital events such as marriages, deaths, births, divorces and fetal deaths for five U.S. territories, New York City, Washington DC, and the 50 states. Data was made available through the submission of a data-use request from NCHS in order to access county identifiers necessary to link births to their MSAs of residence. Data was restricted to singleton births with a birth weight greater than 500 grams and gestational age of at least 22 weeks. Additionally, mothers less than 18 years of age were excluded from the study. Only non-Hispanic white and non-Hispanic black mothers were included in the analyses. A total of 2,554,644 observations were eligible.

Variables

Outcome: Very Preterm Birth

Gestational age was estimated by mothers' self-reported last menstrual period. Though there are multiple ways to define preterm and very preterm birth, for this analysis an infant born greater than 37 weeks was considered Term, born between 32 and 37 weeks was considered Moderately Preterm, and between 22 and 32 weeks was considered Very Preterm. The outcome of very preterm birth was coded as a binary variable, an event of very preterm birth vs preterm or term birth.

Exposure: H 10, H 90, and H Segregation Indices

Level of economic segregation was determined by the use of the rank-order information theory index (also referred to as the H index) as described by Bischoff and Reardon[5]. The index uses a combination of data from the U.S. Census and the American Community Survey to develop a measure of income segregation at the metropolitan level [5]. In this analysis, the H (Rank Order) index and its variants pull from the 2012 U.S. Census data on family income distribution measures in 16 income categories. Two variants of the H index were used alongside overall H in this analysis: H 10 and H 90. All variants' values range from 0 (no spatial segregation of income) and 1 (complete spatial segregation of income). H 10 (the segregation of poverty) measures the spatial distribution of the families at the lowest 10% of the income range across an MSA[5]. H 90 (the segregation of affluence) measure the spatial separation of families at the highest 10% of the income range. As H 90 approaches 1, families in the highest 10^{th} percentile are more highly clustered together; similarly, with H 10 families in the lowest 10^{th} percentile[5]. H 10, H 90, and H indices were categorized into quintiles based on the distribution of the 184 MSAs included in the dataset, the first being the least economically segregated and the fifth being the most economically segregated. Mother's residential county was collected from birth certificate data and matched with MSA codes which in turn were matched with MSA codes with values for H 10, H 90, and H segregation indices. No missing values of the segregation indices were included in the analyses.

Covariates

Other variables considered to be potential confounders and effect modifiers were also included in the analysis and were identified through literature review. The following individual covariates were determined from birth certificates: maternal history of preterm birth, maternal race/ethnicity, parity, maternal age, maternal age squared, smoking status during pregnancy, level of maternal education, and proportion of non-Hispanic blacks in an MSA. History of preterm birth was measured by presence of a prior preterm birth or no prior preterm birth, 74,510 (2.9%) of women were missing from this variable. Maternal Race/Ethnicity was restricted to non-Hispanic white and non-Hispanic black mothers; 661,640 (13.09) women were missing from this variable and were excluded from the analysis. Parity was determined using information on Live Birth Order and categorized as no previous births, one or two previous births, and three or more pervious births, no observations were missing. Maternal age and maternal age squared were included as continuous variables in order to capture the quadratic relationship between age and the outcome; the variables were both complete with no missing observations. Maternal age was centered on the mean age of mothers with singleton live births, 28.33 years. Smoking status during pregnancy was categorized as one or more cigarettes during pregnancy versus no cigarettes during pregnancy, 15.03% of the population was missing information on smoking status during pregnancy. Self-reported maternal education was measured as less than high school, high school graduate, associate degree or some college, bachelor's degree, and master's, doctorate, or professional degree. 83,962 (3.3%) of women were missing from this variable. The proportion of the population of the MSA who is non-Hispanic black was included as a continuous variable, calculated dividing the

number of non-Hispanic black individuals over the total population and was a complete variable in the 184 MSAs included in the analysis.

Modeling Strategy

Three different models were fit to assess the association between very preterm birth and each of the segregation indices: H10, H90, and H. Generalized estimating equations (GEEs) were used to estimate the association between MSA level H10, H90, and H segregation indices and Very Preterm Birth, accounting for clustering of births within an MSA. Confounder associations were assessed by fitting GEE models with the exposure, a single confounder, and the outcome. If the variable altered the relationship between segregation and very preterm birth in a meaningful way, it was included in the model selection process.

Collinearity was assessed and no issues were detected among the covariates. Backwards elimination was then used to remove non-significant interaction terms at $\alpha=.05$. Two-way interactions between the segregation indices and each individual covariate (maternal history of preterm birth, maternal race/ethnicity, parity, maternal age, maternal age squared, smoking status during pregnancy, level of maternal education, and proportion of the MSA that is non-Hispanic black) were assessed and dropped if non-significant. Three-way interactions among segregation indices, maternal race/ethnicity, and maternal age/maternal age squared were also assessed at $\alpha=.05$. Model fit was assessed using QIC.

All statistical analyses were done using SAS version 9.4 (SAS Institute; Cary, NC), and GEE models were done in SAS using PROC GENMOD with a repeated statement. Figures were generated using Microsoft Excel 2010.

Results

Between 2010 and 2011, there were 7,968,325 births within the US. Of these 2,914,287 births occurred in non-metropolitan counties and were missing data on segregation indices or were unable to be matched by maternal county and state of residence and were excluded. From the 5,054,038 births with segregation indices data available, 176,988 were multiple births and 8,138 births less than 500 grams at birth and were excluded from the study. 6,169 births that occurred at less than 22 weeks' gestational age were also excluded from the study. 2,331,488 mothers were not non-Hispanic white or non-Hispanic black or were missing maternal race/ethnicity and were excluded as well as 134,387 mothers less than 18 years of age or missing maternal age. A total of 2,554,644 births that fit the eligibility criteria of the study were included in the study.

Tables 0a, 0b, and 0c show the distribution of very preterm birth risk and the individual covariates (maternal history of preterm birth, maternal race/ethnicity, parity, maternal age, maternal age squared, smoking status during pregnancy, level of maternal education, and proportion of the MSA that is non-Hispanic black) by H 10, H 90, and H quintiles. As level of segregation increases (from the first quintile to the fifth), the percentage of very preterm birth increases (1.32% in the first quintile of H 10 to 1.58% in the last quintile of H 10). Similar trends are observed in the H 90 and H segregation indices: 1.25% in the first quintile of H 90 to 1.52% in the last quintile of H 90 and from 1.29% in the first quintile of H to 1.50% in the last quintile of H. Quintiles of higher segregation tended to have higher percentages of non-Hispanic black women than quintiles of lower segregation; 30% in the last quintile of H 90 compared to 10% in the

first quintile of H 90. The mean age of mothers also increases slightly with level of segregation; 27.5 (std. dev. 5.54) years old in the first quintile of H to 28.7 (std. dev. 5.84) years old in the last quintile. The mean proportion of non-Hispanic black population in each MSA also increases with the level of economic segregation; from 9% in the first quintile of H 10 to 17% in the fifth quintile of H 10. A similar increase in the proportion of non-Hispanic black population in each MSA of in observed with increasing segregation of affluence and overall segregation.

Table 1 describes the relationship between the outcome, very preterm birth, and the individual covariates. Higher levels of Maternal Education are associated with a greater percentage of term births in MSAs; 6.93% of very preterm births are among mothers with a master's, doctorate, or professional degree compared to 12.63% of term births. Additionally, Table 1 analyses show that there is greater representation of non-Hispanic black women among women who have a very preterm birth than among women who have a term birth (44.96% compared to 21.58%). Among women who have had a very preterm birth, a higher percentage have smoked at least one cigarette during their pregnancy than among women who have had a term birth (16.69% compared to 10.46%). Similarly, the percentage of women who have had a prior preterm birth is higher among women who have had a very preterm birth than women who have had preterm birth or term birth (8.23% very preterm compared to 6.69% preterm and 2.01% term).

Tables 2a, 2b, and 2c list the odds ratios comparing the odds of VPT (< 32 weeks vs. > 32 weeks) with changes in the individual and area level predictors (segregation indices, maternal history of preterm birth, maternal race/ethnicity, parity, maternal age, maternal age squared, smoking status during pregnancy, and level of maternal education).

Controlling for maternal history of preterm birth, the odds ratio of VPT increase as the level of economic segregation increases; as the segregation of poverty increases from Q2 to Q5, the OR of VPT increases from 0.94 (95%CI 0.85, 1.05) to 1.18 (95%CI 1.08 to 1.28). Similar patterns are observed in the H 90 and overall H quintiles when controlling for history of preterm birth. The OR for VPT also increases as the level of segregation increases from Q2 to Q5 when controlling for the other individual covariates, except maternal race/ethnicity. The OR of VPT increases across H 10 quintiles but decreases across the H 90 and H overall indices when controlling for maternal race/ethnicity.

Tables 3a, 3b, and 3c display the results from the three GEE models relating the odds of VPT (< 32 weeks vs. > 32 weeks) to segregation quintiles by each segregation index. The GEE model for the H 10 segregation index controlled for all individual covariates and interaction between segregation and maternal age and segregation and maternal age squared; the interaction between segregation and maternal race/ethnicity for H 10 was not signification at a p-value of 0.2569. After controlling for all covariates and using MSAs in Q1 as the reference, living in an MSA in the 2nd and 3rd quintiles of economic segregation was generally associated with a lower odds ratio of VPT than living in an MSA in the 4th and 5th quintiles; from 0.96 (95% CI 0.91, 1.02) in Q2 to 1.00 (95% CI 0.94, 1.05) in Q5 for white women with less than high school education who did not smoke during pregnancy, have no history of preterm birth, who are giving birth to their first child, are approximately 28 years of age, and live in area with a very low proportion of non-Hispanic Black individuals (Table 3a). However, the odds ratios contained the null value of 1.00. The GEE model for H 90 controlled for all individual covariates and two-way interactions between the segregation indices and maternal

race/ethnicity, segregation indices and maternal age, and between segregation indices and maternal age squared. After controlling for all covariates and using MSAs in Q1 as the reference, living in MSAs in the 2nd and 3rd quintile in segregation of affluence was generally associated with a lower odds ratio of VPT than living in the 4th and 5th quintiles for white women with less than high school education who did not smoke during pregnancy, have no history of preterm birth, who are giving birth to their first child, are approximately 28 years of age, and live in area with a very low proportion of non-Hispanic Black individuals. The odds ratio of VPT (< 32 vs. > 32 weeks) decreases from 1.03 (95%CI 0.97, 1.10) in Q2 to 0.95 (95%CI 0.91, 0.99) in Q5. However, both odds ratios are not significant; p-value 0.5828 for Q2 and 0.2584 for Q5. The GEE model for the H (Rank Order) Index controlled for all individual covariates and two-way interactions between the segregation indices and maternal race/ethnicity, segregation indices and maternal age, between segregation indices and maternal age squared, and between segregation indices and proportion of non-Hispanic Black population in the MSA. The odds ratio of VPT (< 32 vs. > 32 weeks) increases from 0.88 (95%CI 0.82, 0.95) in Q2 to 0.94 (95%CI 0.87, 1.01) in Q5 for white women with less than high school education who did not smoke during pregnancy, have no history of preterm birth, who are giving birth to their first child, are approximately 28 years of age, and live in area with a very low proportion of non-Hispanic Black individuals. However, both odds ratios are not significant at alpha=.05; p-value 0.0958 for Q2 and 0.4117 for Q5.

Figures 1a, 1b, and 1c display the maternal age and maternal race/ethnicity stratum specific odds ratios of VPT for women in MSAs in Q5 compared to MSAs in Q1 across the segregation indices. Though the interaction between maternal race/ethnicity

and the H 10 index was not overall significant, it was included in the model to observe any heterogeneity in the odds of VPT by maternal race/ethnicity. In all indices and age groups, black women experience a higher OR of VPT in areas of high segregation compared to areas of low segregation than white women. For example, 18-year-old non-Hispanic black women in areas that are heavily segregated by affluence experience 2.01(95%CI 1.86, 2.17) times the odds of VPT than 18-year-old non-Hispanic black women in areas that have no segregation of affluence. Non-Hispanic black women who are 28 years old (the average maternal age) experienced a slightly higher OR of VPT, 2.57 (95%CI 2.45, 2.68) in areas with high segregation of affluence than areas with no segregation of affluence. Non-Hispanic white women, however, appear to sometimes experience a decrease in the OR of VPT in Q5 compared to Q1. 18-year-old non-Hispanic white women have 0.75 (95%CI 0.69, 0.81) times the odds of VPT in areas of high segregation of affluence than in areas of low segregation of affluence. Similar results are present across the H 10 and H Overall indices.

The model for the H Overall index has a significant interaction between proportion non-Hispanic black population in an MSA and the exposure. Figure 2 displays stratum specific OR of VPT for women in Q5 MSAs compared to women in Q1 MSAs by the proportion of the MSA population that is non-Hispanic black. Overall, the OR of VPT for women in Q5 compared to women in Q1 increases as the proportion of the MSA population that is non-Hispanic black increases. Women in MSAs with a low proportion (10%) of non-Hispanic blacks experience a lower OR of VPT (OR 1.00, 95%CI 0.94, 1.07) than women in MSAs with a high proportion (90%) of non-Hispanic blacks (OR 1.68, 95%CI 1.39, 1.98). There confidence intervals do not overlap, therefore the effect

of overall economic segregation appears to be significantly impacted by the proportion of the MSA that is non-Hispanic black.

To observe the association between overall economic segregation and within race economic segregation, economic segregation among non-Hispanic whites and economic segregation among non-Hispanic black was plotted against the H (Rank Order) index for 184 MSAs. A Pearson's Correlation Coefficient was calculated to observe any potential relationships. Economic segregation among non-Hispanic blacks in an MSA was only weakly correlated with overall economic segregation ($r = -0.127$); however, economic segregation among non-Hispanic whites in an MSA had a strong positive linear association with overall economic segregation in an MSA ($r = 0.898$).

Discussion

Based on this study's results, there is evidence to suggest a relationship between level of economic segregation within an MSA and the probability VPT. The impact of economic segregation on VPT appears to vary by maternal age, maternal race/ethnicity, and the proportion of non-Hispanic blacks in an MSA. The association between economic segregation and VPT may be impacted the level of racial segregation in an MSA.

Across the three indices there was a significant interaction between maternal age and economic segregation (Figure 1). The magnitude of the relative association between VPT and high versus low economic segregation appears to be stronger for women who are in mid-reproductive years (approximately 28 years old) than for women who are younger (18 years old) and older years (35 years old). This could reflect differences in baseline risk of VPT in low-segregation MSA's at those ages. The risk of VPT for maternal ages 18 and 35 is still larger than the risk of VPT for the average maternal age (28 years) in areas of low economic segregation (Q1), which was used as the referent group. Therefore, the risk of VPT from MSAs in Q1 to MSAs in Q5 may not have increased for women in the younger and older maternal ages as much for women in the mid-reproductive years.

Living in an area of high economic segregation appears to be associated with a higher probability of VPT for non-Hispanic black women than non-Hispanic white women (Figures 1a, 1b, and 1c). The stratum specific odds ratios show that across the age groups, non-Hispanic black women in high economically segregated areas experience nearly two times the odds of VPT than non-Hispanic black women in areas with low

economic segregation. This relationship is consistent across the indices of poverty, affluence, and overall economic segregation. The level of economic segregation in an MSA does not appear to as significantly impact non-Hispanic white women's odds of VPT as it does for non-Hispanic black women's odds of VPT. The results intimate that increasing levels of economic segregation may modestly reduce or not impact the risk of VPT for non-Hispanic white women. This suggests that MSA of residence is more influential for the perinatal health of non-Hispanic black women than non-Hispanic white women.

This association between maternal race/ethnicity and economic segregation could be due to the relationship between level of economic segregation and level of racial segregation, hinted at by the significant interaction between proportion of the non-Hispanic black population in the MSA and the H (Rank Order) segregation index. The proportion of the non-Hispanic black population in an MSA alone was also significant in the H 10 and H 90 models as a single covariate with no interaction. The association between economic segregation and VPT seems to get stronger as the proportion of non-Hispanic blacks in the MSA increases, suggesting that economic segregation may be serving as a proxy for racial segregation (Figure 2). Further analyses are needed to explore the association between economic segregation and racial segregation.

To explore the relationship between race and economic segregation, Pearson's Correlation Coefficient was calculated for the association between economic segregation and within-race economic segregation for non-Hispanic whites and non-Hispanic blacks separately. Though there is a weak negative linear relationship between overall economic segregation and economic segregation among non-Hispanic blacks ($r = -0.127$), there is a

strong positive linear relationship between overall economic segregation and economic segregation among non-Hispanic whites (r = 0.898) (Figure 3). This result is expected because overall economic segregation is a weighted average of the within-race measures of economic segregation and there are more non-Hispanic whites in MSAs than non-Hispanic blacks.

As in previous literature, the analyses show a relationship with the individual covariates and VPT; maternal race/ethnicity, maternal age, maternal age squared, smoking during pregnancy, a history of preterm birth, maternal education, and parity were all significant predictors of VPT. Smoking during pregnancy, history of preterm birth, lower maternal education, and higher parity all showed an increased risk of VPT (Table 1, Table 2abc, and Table 3abc) [1, 4, 6, 7, 11, 16, 20, 22, 27].

Previous literature found that the income inequality, measured by the Gini coefficient in each of the 50 states of the US, negatively impacted infant health outcomes (preterm birth, low birth weight, very low birth weight, and infant mortality rates) [33]. Although income inequality and economic segregation are different measures, a similar effect was expected. However, for this study, economic segregation indices were considered only at the MSA level. It is possible that the spatial scale by which the segregation of income impacts very preterm birth could differ from the MSA level to a smaller or larger scale. Further studies assessing the relationship between economic segregation and very preterm birth across multiple spatial levels would be beneficial in assessing which scale is appropriate to utilize.

This cross-sectional analysis also did not take into consideration the length of exposure to economic segregation; women with longer exposure to MSAs of high levels

of economic segregation may experience a different risk in VPT than women in shorter exposure times. Also, although proportion of the non-Hispanic black population of an MSA was included in the models, the analysis also did not take into consideration a potential relationship between economic segregation and racial segregation. This is particularly important to explore given the significant interaction between maternal race/ethnicity and level of economic segregation in the segregation of affluence and over all segregation. Further, because the data is limited by the birth certificates, it is possible that an unmeasured confounder impacts the association between economic segregation and very preterm birth.

The association between economic segregation in an MSA and the probability of very preterm birth for women residing in the MSA is potentially related to the association between racial segregation in an MSA and the probability of very preterm birth. This study did not assess the relationship between racial segregation and economic segregation. The differences in these associations should be teased out and differentiated further to explore the impact of economic segregation on VPT.

Future Directions

This study used Generalized Estimating Equations to include both individual and MSA level covariates in the models. Maternal residence was only considered at the time of the birth, consequently the length of exposure to various levels of economic segregation was not assessed. This is a factor for future studies to explore.

Future analyses for this study will explore a possible collinear relationship between the racial segregation and economic segregation. It is possible that racial segregation impacts very preterm birth through economic segregation; future analyses will provide a distinction between these exposures to clarify the pathways through which segregation impacts perinatal health outcomes.

Table 0a: Demographics and Risk Factors for Mothers with Live Births in MSAs across the U.S. by Segregation of Poverty (n=2,554,644 births)

	H (10th Percentile) Index*				
Covariate	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
	Mean(SD) or %				
MSA (n=184)					
Very Preterm	1.32	1.27	1.42	1.34	1.58
Preterm	7.99	7.90	8.62	8.28	8.38
Term	90.69	90.83	89.96	90.39	90.04
Maternal Education					
Less than high school	9.67	9.61	8.99	9.29	10.26
High school graduate	26.25	25.68	25.32	21.02	22.32
Associate Degree or Some College	35.99	33.60	30.51	31.55	30.20
Bachelor's Degree	20.07	21.33	23.64	25.16	22.66
Master's, Doctorate, or Professional Degree	8.02	9.78	11.54	12.99	14.55
Maternal Race/Ethnicity					
White	86.57	83.65	75.30	78.98	71.67
African American	13.43	16.35	24.70	21.02	28.33
Mother smoked during pregnancy					
Yes	13.01	8.61	11.08	10.26	11.81
Maternal age, years**	27.75 (5.60)	28.10 (5.63)	28.35 (5.80)	28.49 (5.69)	28.45 (5.80)
Maternal age squared, years**	801.96 (323.79)	821.08 (327.84)	837.12 (338.99)	843.90 (332.92)	843.17 (338.09)
Parity					
1	41.35	40.3	41.63	41.48	41.04
2 - 3 Children	48.05	47.69	47.05	47.36	47.16
4 or more	10.6	12.01	11.32	11.16	11.8
Prior Preterm Birth					
Yes	2.29	2.15	2.27	2.39	2.93
Proportion Black in MSA	0.09 (0.09)	0.10 (0.09)	0.15 (0.11)	0.13 (0.07)	0.17 (0.08)

* H Index based on the total population 2012
**Mothers less than 18 years of age were excluded from the analysis
*** Births data is from live births in 2010 and 2011

Table 0b: Demographics and Risk Factors for Mothers with Live Births in MSAs across the U.S. by Segregation of Affluence (n=2,554,644 births)

	H (90th Percentile) Index*				
	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
Covariate	Mean(SD) or %				
MSA (n=184)					
Very Preterm	1.25	1.26	1.31	1.43	1.52
Preterm	7.77	7.63	7.99	8.48	8.58
Term	90.98	91.11	90.70	90.08	89.90
Maternal Education					
Less than high school	11.19	9.87	9.85	9.27	9.36
High school graduate	27.20	23.16	24.49	24.15	22.13
Associate Degree or Some College	33.72	35.62	33.24	31.77	29.60
Bachelor's Degree	18.49	22.16	21.43	22.82	24.81
Master's, Doctorate, or Professional Degree	9.40	9.20	11.00	12.00	14.09
Maternal Race/Ethnicity					
White	89.86	87.45	82.26	79.08	69.43
African American	10.14	12.55	17.74	20.92	30.57
Mother smoked during pregnancy					
Yes	15.14	12.03	12.11	11.83	8.80
Maternal age, years**	27.80 (5.61)	27.83 (5.48)	28.26 (5.61)	28.18 (5.70)	28.65 (5.86)
Maternal age squared, years**	803.80 (324.17)	804.57 (316.76)	830.20 (327.08)	826.76 (332.05)	855.43 (343.46)
Parity					
1	40.57	38.95	41.10	41.62	41.57
2 - 3 Children	47.94	48.04	47.80	47.54	46.76
4 or more	11.49	13.01	11.11	10.84	11.66
Prior Preterm Birth					
Yes	2.75	3.12	2.93	2.41	2.19
Proportion Black in MSA	0.07 (0.05)	0.08 (0.09)	0.11 (0.09)	0.13 (0.09)	0.18 (0.09)

* H Index based on the total population 2012
**Mothers less than 18 years of age were excluded from the analysis
*** Births data is from live births in 2010 and 2011

Table 0c: Demographics and Risk Factors for Mothers with Live Births in MSAs across the U.S. by Overall Economic Segregation (n=2,554,644 births)

	H (Rank order Total) Index*				
	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
Covariate	Mean(SD) or %				
MSA (n=184)					
Very Preterm	1.29	1.27	1.35	1.44	1.50
Moderately Preterm	8.01	7.86	8.25	8.41	8.46
Term	90.69	90.87	90.39	90.15	90.04
Maternal Education					
Less than high school	11.42	9.77	9.58	9.49	9.33
High school graduate	27.12	25.48	23.94	24.17	21.75
Associate Degree or Some College	35.49	33.29	32.58	31.64	29.92
Bachelor's Degree	18.28	21.12	22.74	22.82	24.68
Master's, Doctorate, or Professional Degree	7.69	10.34	11.16	11.88	14.32
Maternal Race/Ethnicity					
White	88.56	86.60	81.83	76.26	70.69
African American	11.44	13.40	18.17	23.74	29.31
Mother smoked during pregnancy					
Yes	15.67	12.24	11.68	12.94	8.61
Maternal age, years**	27.48 (5.54)	28.12 (5.62)	28.25 (5.60)	28.18 (5.75)	28.65 (5.84)
Maternal age squared, years**	785.78 (318.80)	822.58 (326.61)	829.49 (326.22)	827.39 (334.61)	855.12 (342.21)
Parity					
1	40.88	40.55	40.76	40.40	42.05
2 - 3 Children	48.13	47.95	47.62	47.30	46.89
4 or more	10.99	11.50	11..62	12.30	11.06
Prior Preterm Birth					
Yes	2.57	2.87	2.96	2.36	2.22
Proportion Black in MSA	0.08 (0.08)	0.08 (0.06)	0.11 (0.09)	0.16 (0.10)	0.17 (0.08)

* H Index based on the total population 2012
**Mothers less than 18 years of age were excluded from the analysis
*** Births data is from live births in 2010 and 2011

Table 1: Demographics and Risk Factors for Mothers with Infants Born to Very Preterm, Preterm, and Term (n=2,554,644 births)

Covariate	Very Preterm	Moderately Preterm	Term
	Mean (SD) or %	Mean (SD) or %	Mean (SD) or %
MSA (n=184)			
H (10th Percentile) Index			
1st Quintile	7.13	7.4	7.72
2nd Quintile	13.65	14.52	15.37
3rd Quintile	21.44	22.28	21.38
4th Quintile	22.94	24.23	24.34
5th Quintile	34.84	31.56	31.19
H (90th Percentile) Index			
1st Quintile	7.18	7.65	8.23
2nd Quintile	8.10	8.39	9.22
3rd Quintile	15.48	16.15	16.87
4th Quintile	24.16	24.40	23.83
5th Quintile	45.09	43.41	41.85
H (Rank order) Index			
1st Quintile	6.35	6.73	7.00
2nd Quintile	10.94	11.56	12.30
3rd Quintile	18.30	19.06	19.20
4th Quintile	21.64	21.60	21.30
5th Quintile	42.77	41.06	40.21
Maternal Education			
Less than high school	15.68	13.47	9.15
High school graduate	30.61	27.28	23.02
Associate Degree or Some College	32.40	32.23	31.50
Bachelor's Degree	14.38	17.64	23.69
Master's, Doctorate, or Professional Degree	6.93	9.38	12.63
Maternal Race/Ethnicity			
White	55.04	67.85	78.42
African American	44.96	32.15	21.58
Mother smoked during pregnancy			
Yes	16.69	14.49	10.46
Maternal age, years**	27.81 (6.23)	28.19 (6.09)	28.35 (5.69)
Maternal age squared**	812.05 (363.54)	831.77 (357.04)	836.24 (331.98)
Parity			
1	44.16	38.7	41.38
2 - 3 Children	4.07	45.64	47.62
4 or more	15.77	15.66	11.01
Prior Preterm Birth			
Yes	8.23	6.69	2.01
Proportion Black in MSA	0.16 (0.10)	0.15 (0.10)	0.14 (0.09)

* H Index based on the total population 2012

** Births data is from live births in 2010 and 2011

Table 2a. OR of VPT by Segregation Indices Adjusting for Maternal Education, Maternal Race/Ethnicity, and Smoking during Pregnancy

	Outcome: Very Preterm Birth								
	Maternal Education[i]			**Maternal Race/Ethnicity[ii]**			**Smoking during Pregnancy[iii]**		
Exposure	OR[iv]	Lower Limit	Upper Limit	OR[iv]	Lower Limit	Upper Limit	OR[iv]	Lower Limit	Upper Limit
H 10 Index									
*1st Quintile **									
2nd Quintile	0.96	0.88	1.06	0.90	0.85	0.96	0.96	0.87	1.06
3rd Quintile	1.09	1.01	1.19	0.94	0.88	1.00	1.05	0.97	1.16
4th Quintile	1.14	1.05	1.23	0.93	0.89	0.98	1.09	1.00	1.19
5th Quintile	1.27	1.17	1.37	0.97	0.92	1.01	1.20	1.10	1.31
H 90 Index									
*1st Quintile **									
2nd Quintile	1.03	0.96	1.11	0.96	0.91	1.01	1.01	0.93	1.09
3rd Quintile	1.08	1.01	1.15	0.93	0.88	0.97	1.05	0.98	1.12
4th Quintile	1.20	1.13	1.27	0.97	0.93	1.02	1.16	1.10	1.23
5th Quintile	1.29	1.22	1.36	0.92	0.88	1.00	1.23	1.17	1.30
H Overall Index									
*1st Quintile **									
2nd Quintile	1.00	0.92	1.08	0.93	0.88	0.99	0.98	0.90	1.06
3rd Quintile	1.09	1.02	1.16	0.93	0.89	0.97	1.04	0.98	1.12
4th Quintile	1.12	1.05	1.19	0.94	0.89	0.99	1.07	1.01	1.14
5th Quintile	1.24	1.17	1.32	0.89	0.85	0.93	1.18	1.11	1.26

** referent group*

i. The referent group for maternal education is mothers with less than a high education.

ii. The referent group for maternal race/ethnicity is non-Hispanic white mothers.

iii. The referent group for smoking during pregnancy is mothers who did not smoke during pregnancy.

iv. OR of VPT is the odds of VPT (<32 weeks gestational age) compared to the odds of not VPT (>32 weeks gestational age).

Table 2b. OR of VPT by Segregation Indices Adjusting for Maternal Age, Parity, and History of Preterm Birth

	Outcome: Very Preterm Birth								
	Maternal Age[i]			Parity[ii]			History of Preterm Birth[iii]		
Exposure	OR[iv]	Lower Limit	Upper Limit	OR[iv]	Lower Limit	Upper Limit	OR[iv]	Lower Limit	Upper Limit
H 10 Index									
*1st Quintile **									
2nd Quintile	0.95	0.86	1.04	0.93	0.84	1.03	0.94	0.85	1.05
3rd Quintile	1.05	0.97	1.15	1.04	0.95	1.14	1.04	0.95	1.14
4th Quintile	1.08	1.00	1.18	1.07	0.98	1.16	1.07	0.98	1.17
5th Quintile	1.21	1.11	1.31	1.19	1.09	1.29	1.18	1.08	1.28
H 90 Index									
*1st Quintile **									
2nd Quintile	0.99	0.92	1.08	0.99	0.91	1.07	0.98	0.90	1.07
3rd Quintile	1.04	0.97	1.11	1.03	0.96	1.11	1.02	0.95	1.10
4th Quintile	1.15	1.08	1.22	1.14	1.07	1.21	1.15	1.08	1.22
5th Quintile	1.20	1.14	1.27	1.18	1.12	1.25	1.20	1.13	1.27
H Overall Index									
*1st Quintile **									
2nd Quintile	0.97	0.89	1.05	0.95	0.87	1.04	0.95	0.91	1.09
3rd Quintile	1.03	0.97	1.10	1.17	0.95	1.09	1.01	0.94	1.08
4th Quintile	1.07	1.00	1.14	1.05	0.99	1.13	1.06	0.99	1.13
5th Quintile	1.15	1.09	1.23	1.13	1.06	1.21	1.15	1.07	1.22

** referent group*

i. The referent group for maternal age is mothers who are 28.33 years old.

ii. The referent group for parity is mothers with no prior births.

iii. The referent group for history of preterm birth is mothers with no history of preterm birth.

iv. OR of VPT is the odds of VPT (<32 weeks gestational age) compared to the odds of not VPT (>32 weeks gestational age).

Table 2c. OR of VPT by Segregation Indices Adjusting for Percentage of Black Population in MSA

	Outcome: Very Preterm Birth		
	Proportion Black in MSA[i]		
Exposure	OR[ii]	Lower Limit	Upper Limit
H 10 Index			
*1st Quintile **			
2nd Quintile	0.93	0.88	1.00
3rd Quintile	1.01	0.95	1.07
4th Quintile	0.96	0.91	1.02
5th Quintile	0.98	0.93	1.04
H 90 Index			
*1st Quintile **			
2nd Quintile	0.97	0.92	1.02
3rd Quintile	0.94	0.90	0.99
4th Quintile	0.98	0.94	1.03
5th Quintile	0.97	0.93	1.01
H Overall Index			
*1st Quintile **			
2nd Quintile	0.97	0.91	1.03
3rd Quintile	0.96	0.91	1.01
4th Quintile	0.96	0.92	1.01
5th Quintile	0.95	0.90	0.99

** referent group*

i. The referent group for proportion black in MSA is 0.

ii. OR of VPT is the odds of VPT (<32 weeks gestational age) compared to the odds of not VPT (>32 weeks gestational age).

Table 3a. Model Results for Economic Segregation (H 10) and Very Preterm Birth Adjusting for all Individual Covariates and Significant Interaction Terms

Variable	OR[i]	Lower Limit	Upper Limit	P-value
H 10 Index				
*1st Quintile ** *				
2nd Quintile	0.963	0.908	1.022	0.5245
3rd Quintile	1.027	0.966	1.092	0.6614
4th Quintile	1.002	0.952	1.054	0.9758
5th Quintile	0.992	0.940	1.046	0.8775
History of Preterm Birth (Yes vs. No)	3.598	3.477	3.723	<.0001
Parity				
*1** *				
2 - 3 Children	0.642	0.631	0.654	<.0001
4 or more	0.686	0.665	0.708	<.0001
Maternal Race/Ethnicity				
*Non-Hispanic White** *				
Non-Hispanic Black	2.514	2.455	2.575	<.0001
Maternal Age* **	1.019	1.015	1.023	<.0001
Maternal Age Squared* **	1.003	1.002	1.003	<.0001
Smoking Status during Pregnancy (Yes vs. No)	1.509	1.481	1.538	<.0001
Maternal Education				
*Less than high school** *				
High school graduate	0.880	0.862	0.899	<.0001
Associate Degree or Some College	0.756	0.741	0.772	<.0001
Bachelor's Degree	0.527	0.511	0.542	<.0001
Master's, Doctorate, or Professional Degree	0.450	0.437	0.464	<.0001
H 10 Index * Maternal Age				
*1st Quintile * Maternal Age ** *				
*2nd Quintile * Maternal Age*	1.003	0.999	1.008	0.4921
*3rd Quintile * Maternal Age*	1.009	1.004	1.013	0.0485
*4th Quintile * Maternal Age*	1.002	0.998	1.007	0.6009
*5th Quintile * Maternal Age*	1.007	1.003	1.011	0.071
H 10 Index * Maternal Age Squared				
*1st Quintile * Maternal Age Squared ** *				
*2nd Quintile * Maternal Age Squared*	0.999	0.999	1.000	0.2502
*3rd Quintile * Maternal Age Squared*	0.998	0.998	0.999	0.0026
*4th Quintile * Maternal Age Squared*	0.999	0.998	0.999	0.0186
*5th Quintile * Maternal Age Squared*	0.998	0.998	0.999	0.0037
Proportion Black in MSA	2.237	1.979	2.530	<.0001

***referent group*

i. OR of VPT is the odds of VPT (<32 weeks gestational age) compared to the odds of not VPT (>32 weeks gestational age).

Table 3b. Model Results for Economic Segregation (H 90) and Very Preterm Birth Adjusting for all Individual Covariates and Significant Interaction Terms

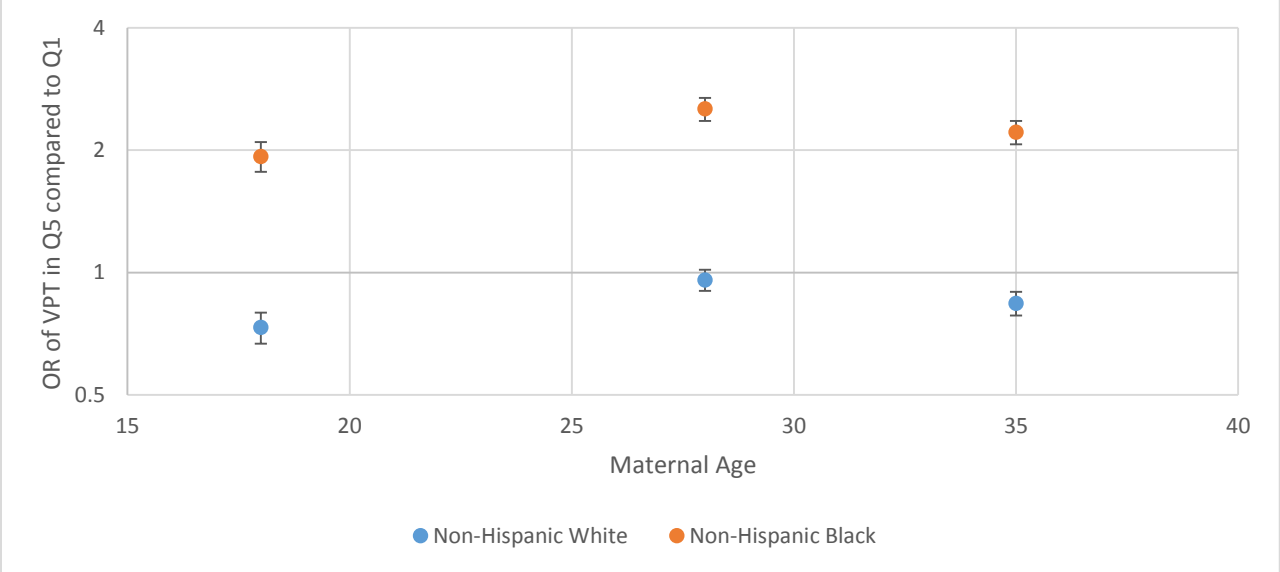
Variable	OR[i]	Lower Limit	Upper Limit	P-value
H (Rank order) Index				
*1st Quintile ** *				
2nd Quintile	1.034	0.973	1.099	0.5828
3rd Quintile	0.976	0.931	1.022	0.5982
4th Quintile	1.017	0.973	1.064	0.7008
5th Quintile	0.953	0.912	0.994	0.2584
History of Preterm Birth (Yes vs. No)	3.593	3.473	3.716	<.0001
Parity				
*1** *				
2 - 3 Children	0.642	0.631	0.654	<.0001
4 or more	0.685	0.664	0.707	<.0001
Maternal Race/Ethnicity				
*Non-Hispanic White** *				
Non-Hispanic Black	2.281	2.142	2.428	<.0001
Maternal Age* **	1.018	1.015	1.022	<.0001
Maternal Age Squared* **	1.003	1.002	1.003	<.0001
Smoking Status during Pregnancy (Yes vs. No)	1.507	1.478	1.535	<.0001
Maternal Education				
*Less than high school** *				
High school graduate	0.880	0.862	0.898	<.0001
Associate Degree or Some College	0.756	0.741	0.772	<.0001
Bachelor's Degree	0.528	0.512	0.544	<.0001
Master's, Doctorate, or Professional Degree	0.452	0.438	0.466	<.0001
H (Rank order) Index * Maternal Race/Ethnicity				
*1st Quintile * Non-Hispanic Black*				
*2nd Quintile * Non-Hispanic Black*	0.944	0.865	1.029	0.5039
*3rd Quintile * Non-Hispanic Black*	1.028	0.952	1.111	0.7161
*4th Quintile * Non-Hispanic Black*	1.077	1.004	1.155	0.2942
*5th Quintile * Non-Hispanic Black*	1.181	1.102	1.267	0.0172
H (Rank order) Index * Maternal Age				
*1st Quintile * Maternal Age*				
*2nd Quintile * Maternal Age*	1.001	0.995	1.006	0.879
*3rd Quintile * Maternal Age*	1.006	1.001	1.010	0.1958
*4th Quintile * Maternal Age*	1.008	1.004	1.012	0.0626
*5th Quintile * Maternal Age*	1.008	1.003	1.012	0.0729
H (Rank order) Index * Maternal Age Squared				
*2nd Quintile * Maternal Age Squared*	1.000	0.999	1.000	0.3894
*3rd Quintile * Maternal Age Squared*	0.999	0.998	0.999	0.0368
*4th Quintile * Maternal Age Squared*	0.999	0.999	1.000	0.0383
*5th Quintile * Maternal Age Squared*	0.999	0.998	0.999	0.0024
Proportion Black in MSA	2.283	1.979	2.632	<.0001
***reference group*				

i. OR of VPT is the odds of VPT (<32 weeks gestational age) compared to the odds of not VPT (>32 weeks gestational age).

Table 3c. Model Results for Economic Segregation (H Overall) and Very Preterm Birth Adjusting for all Individual Covariates and Significant Interaction Terms

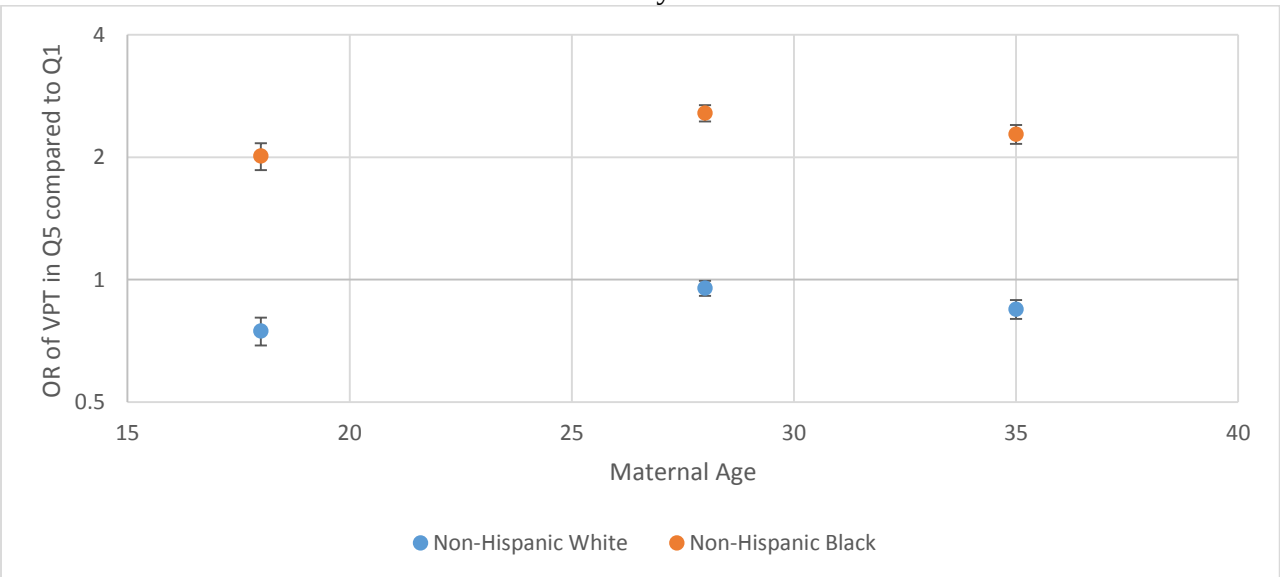
Variable	OR[i]	Lower Limit	Upper Limit	P-value
H (Rank order) Index				
*1st Quintile **				
2nd Quintile	0.882	0.818	0.951	0.0958
3rd Quintile	0.969	0.907	1.034	0.6282
4th Quintile	0.948	0.872	1.030	0.5226
5th Quintile	0.941	0.874	1.013	0.4117
History of Preterm Birth (Yes vs. No)	3.596	3.476	3.721	<.0001
Parity				
*1**				
2 - 3 Children	0.642	0.630	0.654	<.0001
4 or more	0.685	0.664	0.707	<.0001
Maternal Race/Ethnicity				
*Non-Hispanic White**				
Non-Hispanic Black	2.189	2.026	2.364	<.0001
Maternal Age* **	1.016	1.012	1.020	<.0001
Maternal Age Squared* **	1.003	1.003	1.004	<.0001
Smoking Status during Pregnancy (Yes vs. No)	1.504	1.476	1.532	<.0001
Maternal Education				
*Less than high school**				
High school graduate	0.881	0.863	0.900	<.0001
Associate Degree or Some College	0.758	0.742	0.774	<.0001
Bachelor's Degree	0.530	0.515	0.546	<.0001
Master's, Doctorate, or Professional Degree	0.454	0.440	0.469	<.0001
H (Rank order) Index * Maternal Race/Ethnicity				
*1st Quintile * Non-Hispanic Black**				
*2nd Quintile * Non-Hispanic Black*	0.986	0.896	1.085	0.8834
*3rd Quintile * Non-Hispanic Black*	1.053	0.967	1.148	0.5439
*4th Quintile * Non-Hispanic Black*	1.121	1.022	1.230	0.2178
*5th Quintile * Non-Hispanic Black*	1.245	1.146	1.352	0.0083
H (Rank order) Index * Maternal Age				
*1st Quintile * Maternal Age**				
*2nd Quintile * Maternal Age*	1.009	1.004	1.015	0.0838
*3rd Quintile * Maternal Age*	1.007	1.002	1.011	0.1474
*4th Quintile * Maternal Age*	1.008	1.003	1.013	0.1124
*5th Quintile * Maternal Age*	1.011	1.006	1.015	0.015
H (Rank order) Index * Maternal Age Squared				
*1st Quintile * Maternal Age Squared**				
*2nd Quintile * Maternal Age Squared*	0.999	0.998	0.999	0.043
*3rd Quintile * Maternal Age Squared*	0.999	0.999	1.000	0.1694
*4th Quintile * Maternal Age Squared*	0.998	0.998	0.999	0.0089
*5th Quintile * Maternal Age Squared*	0.998	0.998	0.999	0.0006
Proportion Black in MSA	2.019	1.582	2.575	0.0039
H (Rank order) Index * Proportion Black in MSA				
*1st Quintile * Proportion Black in MSA**				
*2nd Quintile * Proportion Black in MSA*	5.165	3.146	8.481	0.0009
*3rd Quintile * Proportion Black in MSA*	1.131	0.798	1.602	0.7247
*4th Quintile * Proportion Black in MSA*	1.557	1.036	2.340	0.277
*5th Quintile * Proportion Black in MSA*	0.945	0.678	1.319	0.8659

Figure 1a. OR of VPT for Women in MSAs of High Segregation of Poverty compared to Women in MSAs of Low Segregation of Poverty by Maternal Age and Maternal Race/Ethnicity



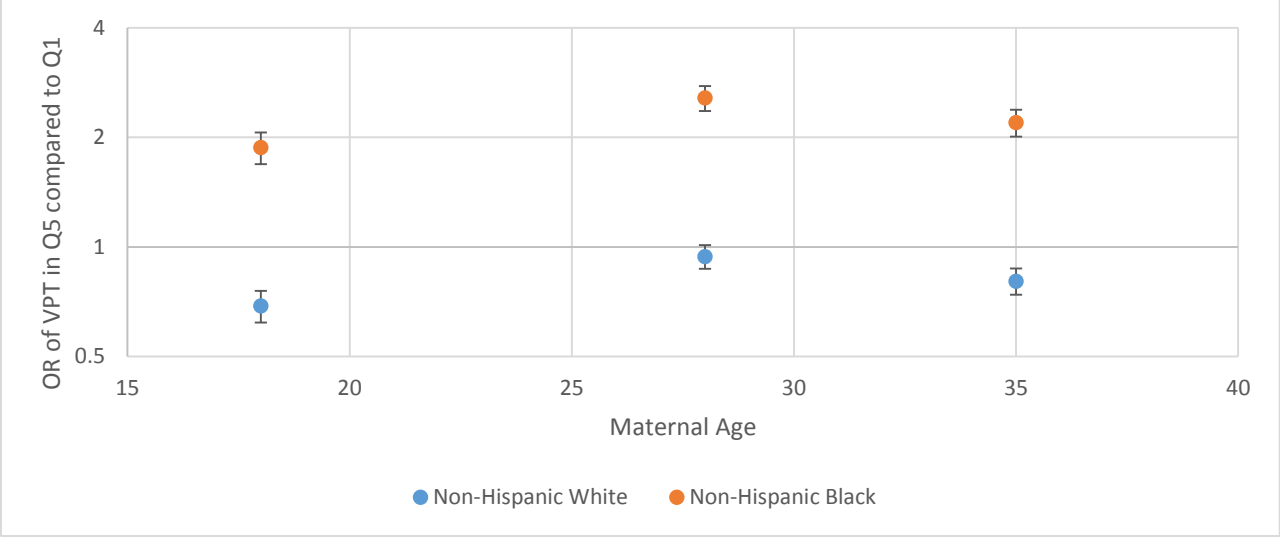
i. The model controlled for all individual covariates and included interactions between maternal race/ethincity and the segregation of poverty, maternal age and the segregation of poverty, and maternal age squared and the segregation of poverty.

Figure 1b. OR of VPT for Women in MSAs of High Segregation of Affluence compared to Women in MSAs of Low Segregation of Affluence by Maternal Age and Maternal Race/Ethnicity



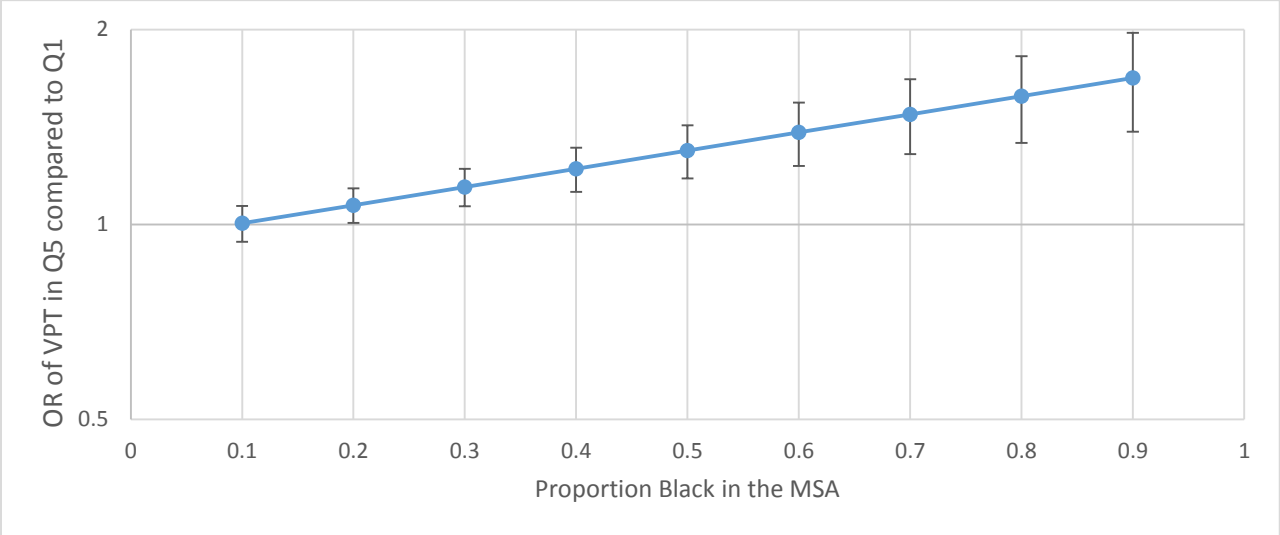
i. The model controlled for all individual covariates and included interactions between maternal race/ethincity and the segregation of affluence, maternal age and the segregation of affluence, and maternal age squared and the segregation of affluence.

Figure 1c. OR of VPT for Women in MSAs of High Overall Segregation compared to Women in MSAs of Low Overall Segregation by Maternal Age and Maternal Race/Ethnicity



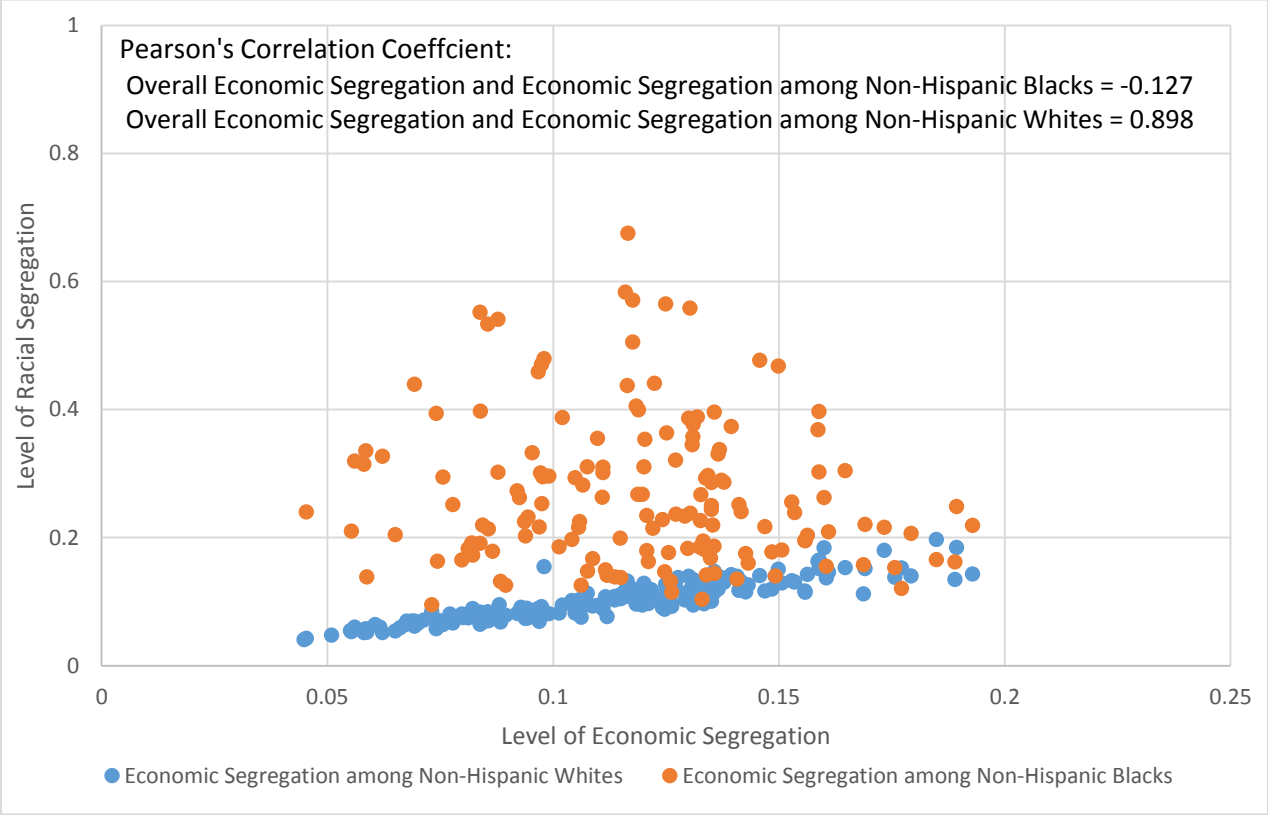
i. The model controlled for all individual covariates and included interactions between maternal race/ethincity and overall economic segregation, maternal age and overall economic segregation, maternal age squared and overall economic segregation, and proportion non-Hispanic black in the MSA. The porportion non-Hispanic black was held constant at 0.

Figure 2. OR of VPT for Women in MSAs of High Segregation Overall compared to Women in MSAs of Low Segregation Overall by Proportion of Non-Hispanic Black Population in the MSA



i. The model controlled for all individual covariates and included interactions between maternal race/ethincity and overall economic segregation, maternal age and overall economic segregation, maternal age squared and overall economic segregation, and proportion non-Hispanic black in anMSA and overall economic segregation. Maternal race/ethincity was held constant at the referent category (non-Hispanic white mothers) as was maternal age (28.33 years old).

Figure 3. Correlation between Race-Specific Economic Segregation and Overall Economic Segregation across MSAs (n=184)



i. Pearson's correlation coefficient was calculated for the association between overall economic segregation and within-race economic segregation for non-Hispanic whites and non-Hispanic blacks separately. There is a weak negative linear relationship between overall economic segregation and economic segregation among non-Hispanic blacks (r = -0.127) and a strong positive linear relationship between overall economic segregation and economic segregation among non-Hispanic whites (r = 0.898).

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