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Hailey Greenstone April 12, 2022

Beyond the Virus: How Ethnoracial Preterm Birth Disparities Interact with COVID-19 Indicators

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
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Bachelor of Arts with Honors

Sociology

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Abstract

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In the COVID-19 pandemic, healthcare has been significantly affected beyond the SARS-CoV-2 viral infection itself. Despite this, little research has been conducted around the intersection of race and COVID-19 effects on healthcare in relation to pregnancy outcomes—specifically, preterm birth. Using a quasi-experimental quantitative design to compare the years 2019 and 2020 for preterm birth risk, I examined these three questions: (1) how has the year 2020 affected county-level preterm birth risk in Georgia; (2) how have racial health disparities in preterm birth risk changed between 2019 and 2020 by county in Georgia; and (3) what is the relationship between county-level COVID-19 outcomes, race, and preterm birth risk in Georgia counties? The results showed consistently higher preterm risk for Black mothers regardless of year, COVID, or their intersection, but also showed conflicting preterm risk for Asian mothers depending on COVID-19 factors, year, and their intersection. These findings reveal the need to continue pushing for reduced pregnancy disparities for Black mothers as well as the importance of continuing to research the pandemic's effects on pregnancy outcomes in greater detail in order to uncover possible reasons for the discrepancies in preterm risk for Asian mothers found in this study.

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Acknowledgements

I would like to acknowledge the following people for their support throughout the development of my thesis:

Dr. Sewell, for inspiring and encouraging my interests in ethnoracial health disparities and supporting me throughout the past two years as a student, researcher, and as a person. Your mentorship has profoundly shaped my Emory experience and will continually make me a better person and future physician.

Dr. Idler, for your consistent investment in me as we have communicated about everything from class content to my honors thesis to my post-graduation plans.

Dr. Patel, for serving on my committee as well as for supporting me as I discovered my medical sociology research interests while I worked on COVID-19 research.

Liz Pittenger and Katalia Alexander, for giving me community as we have all tackled our respective theses; it has meant so much to me to have you both to talk to, work with, and process challenges with throughout this year.

My roommates, Abby Williams, Sabine Schroepfer, and Karida Adetoro, for providing moral support and encouraging me and reminding me to look up from STATA once in a while.

My parents and siblings, for everything.

And the entire Emory Sociology department for teaching me how to think critically and intersectionally, giving me better tools to understand the world, and helping to shape my values for the better.

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Introduction

Since the SARS-CoV-2 virus first arrived in the United States, every facet of American life has shifted dramatically. This is observed through financial and economic suffering caused by job losses and income reductions (World Health Organization 2020c), the weakening of educational infrastructure due to school closings and funding cuts (World Health Organization 2020c), and significant psychological and emotional effects of the pandemic through increased stressors and uncertainty (Best 2020). Health has been profoundly affected by the pandemic in many ways. The increased mental health crises such as substance use disorders, depression, and suicide (Pedrosa et al. 2020), the elevated rates of domestic violence (World Health Organization 2020b), and the ever-present risk of contracting the SARS-CoV-2 virus with nearly any social contact (Best 2020) have overwhelmed the healthcare industry and have left healthcare workers and public health officials scrambling to address the country's many diverse needs.

Within the healthcare system, the pandemic has wreaked havoc. Many nonemergent forms of care were put on hold to reserve resources for COVID-19 patients and minimize transmission risk in healthcare settings, which reduced preventative care, among other interventions (Alsan, Chandra, and Simon 2021). Additionally, financial challenges in the healthcare sector led many smaller practices and rural hospitals to close or increase charges (Alsan et al. 2021). The combined effects of fearing infection and the newly found financial strain induced by the pandemic caused many people to avoid healthcare settings at all costs (Alsan et al. 2021). Healthcare workers have been overworked and have experienced high rates of burnout due to increased rates of patient death, isolation from social networks due to high risk of exposure, and frustrations with much of the public's—and public policy officials'—lack of interest in protecting their communities (Saladino, Algeri, and Auriemma 2020).

Along with the many negative effects of the COVID-19 pandemic, many other significant stressors arose during 2020, including heightened social unrest around police brutality and a highly polarizing presidential election. The collective effects of these events have disproportionately harmed marginalized communities beyond previously existing inequities. The burdens on these populations are made visible by higher COVID-19 mortality rates for Black, American Indian, and Hispanic people due to many social determinants of health including widespread effects of systemic racism that puts these groups at a higher risk of poverty, uninsured status, exposure to the virus, and hospitalization (Alsan et al. 2021).

This pattern is made more prominent in the Southern United States. In general, Southern states have been significantly harmed by the pandemic. This can be seen through high unemployment rates, the wide-reaching effects of school closures (40% of U.S. children impacted were in the South) and the challenges to social norms that were brought about by introducing social distancing policies (Johnston and Chen 2020). In addition to the higher COVID-19 burden in the South, Black Americans also have a disproportionately high rate of COVID-19 mortality in these regions, while both Black Americans and Asian Americans in the South are facing significant discriminatory behaviors and violence (Johnston and Chen 2020). The harm done to racial and ethnic minorities by the virus itself is of great importance; however, the broader health implications of the pandemic are present and point to a potential for worsening health disparities on a broader scale in the South.

While it is easy to believe that much of life and normalcy stopped because of the pandemic, many regular parts of the human experience continued. Among these life events that remained was birth. In 2020, though there was a decrease in the number of births that occurred,

there were over 3.6 million babies born in the United States (Hamilton, Martin, and Osterman 2021).

One of many medically vulnerable groups observed during the pandemic has been pregnant individuals. Pregnancy is of note in the context of a viral infection for many reasons, both physiological and contextual. Physiologically, pregnancy has been shown to be associated with worse outcomes during the COVID-19 pandemic, both in terms of pregnancy complications and more severe illness (CDC 2022). Contextually, pregnant people have had to navigate a need for prenatal healthcare amidst the threat of severe COVID-19 illness. These individuals have needed to balance receiving treatment in healthcare settings, which puts individuals at a higher risk of exposure on top of financial and isolation stressors (Alsan et al. 2021). Altogether, pregnancy has been highly complicated during the COVID-19 pandemic.

Concerns about pregnancy in the pandemic are especially relevant when considering the racial pregnancy disparities in Georgia. The overall preterm birthrate in Georgia between 2017-2019 is 11.4%, with a rate of 7 per 1000 for infant mortality. Between 2017-2019, the preterm birthrate averaged to 14.5% for Black mothers, 12.1% for American Indian mothers, 10% for White mothers, 9.8% for Hispanic mothers, and 8.8% for Asian and Pacific Islander mothers (National Center for Health Statistics 2022). These disparities reveal the importance in the evaluation of potential shifts in pregnancy outcomes in GA, where there is a nearly 6% difference between Asian and Pacific islander mothers' preterm birthrate and Black mothers' preterm birthrate. Between the increased health needs in pregnancy, the presence of existing pregnancy health disparities, and the social and health challenges observed during the pandemic, it is critical to study the effects of the COVID-19 pandemic on pregnant mothers.

Literature Review

In current studies of race, pregnancy, and COVID-19, research spans everything from the direct effects of the virus on pregnant women to social factors and racial disparities. Methodologies in each study are also quite distinct, including quantitative and qualitative techniques to understand the realities of pregnancy and racial disparities during a viral pandemic. In this literature review, I analyze articles from all arenas, both social science and natural science, to better understand the complicated and nuanced nature of pregnancy outcomes during the pandemic. However, my research will be centered in sociology to address some of the current gaps in studying this intricate topic.

To conduct the literature review, I used the words pandemic, COVID-19, race, and pregnancy (as well as variations of these terms) to search recent literature through the JSTOR database. In an effort to broaden the literature review, as the research for this topic is limited due to the novelty of COVID-19, terms were searched all together as well as with omissions, and the research includes studies from across the United States and from other countries. The resulting collection of articles was then analyzed and grouped by topic. This review groups the literature as follows: literature with a focus on racial disparities, research centered on the intersection of pregnancy and viral infection, and articles studying pregnancy in the context of social structures affected by the pandemic. There will then be a discussion of gaps in current research and limitations of the studies in order to identify where my research will support and improve upon existing understandings of pandemic-related disparities in pregnancy outcomes.

In this paper, I use the term “SARS-CoV-2” exclusively to refer to the direct biological effects of the virus itself on pregnancy and/or health disparities. In contrast, “pandemic” or

"COVID-19" will refer to the sociological factors contributing to changes in pregnancy outcomes and related disparities.

Racial Disparities in the Pandemic

Racial health disparities have been studied through many lenses and topics; however, it is important to push such research forward since these inequities persist and were magnified during the pandemic, with a disproportionate burden of SARS-CoV-2 infections on racial minorities in the United States (Mackey et al. 2020; Ogedegbe et al. 2020; Raifman and Raifman 2020; Zelner et al. 2021). In the NYU Langone Health System, for example, Black and Hispanic patients were more likely than White patients to have tested positive between March 2020 and April 2020, even after adjusting for covariates such as neighborhood SES (Ogedegbe et al. 2020). The existence of these inequities is driven by variation in exposure for people of color (Zelner et al. 2021). People of color in this country have a higher risk of working in essential jobs and living in crowded conditions. Additionally, people of color are at increased risk of comorbidities associated with increased risk of SARS-CoV-2 severity, since structural oppression has led to differential likelihood of chronic illness for marginalized populations. (Raifman and Raifman 2020). During the pandemic, ethnoracial minorities have been viewed as expendable, placing them at a greater risk of harm from COVID-19. Due to their higher rates of work in frontline industries and service occupations that do not provide health coverage or sick days among marginalized populations, these communities are placed at a higher risk of contracting COVID-19 at their place of work; that is, COVID-19 exacerbated structural inequalities that worsen health for systematically marginalized populations already experiencing health disparities (Edwards 2021).

There is a clear pattern of systematically putting people of color at higher risk of exposure to the virus during the pandemic while concurrently limiting their ability to receive care. However, the obstruction to healthcare access and quality for people of color in this country has existed for centuries and can easily be observed through trends in infant and maternal mortality in the past few decades.

In most wealthy nations, rates of maternal mortality have decreased consistently over the last several decades; in the United States, maternal mortality has trended upward (Krisberg 2019). For example, between 1990 and 2017, the US maternal mortality rate has increased from 12 to 19, while in the United Kingdom, the maternal mortality rate has decreased from 10 to 7 (Douthard et al. 2021). Within the United States, maternal mortality rates are further stratified by race. As of 2019, White women had rates of maternal mortality at 17.9 deaths per 100,000 births, while Black women had rates at 44.0, a rate 2.5 time greater (Hoyert 2022). This difference, while less extreme, holds true for other women of color when compared to White women's maternal mortality patterns (Krisberg 2019). Regarding infant mortality, infant deaths per 1000 births for Black mothers are twice that of White mothers—a rate that has decreased from over 12 to approximately 11 infants per 1000 for Black mothers, while White mothers have seen a decrease from 5.5 to 5 infants per 1000 (National Center for Health Statistics 2021).

Despite these realities, few studies have called to attention the ways in which the pandemic has affected health more broadly by race outside of the SARS-CoV-2 infection. One such study examines how Black women in Philadelphia have experienced pregnancy during the COVID-19 pandemic in the context of mental health and COVID-19 anxieties (Gur et al. 2020). These data were collected from 3548 women between April 17 and May 1 of 2020. This research revealed that Black women's jobs were more likely to be negatively affected and that they were

more likely to know people who had died from COVID-19. Additionally, Black women's worries centered around finances, currently having SARS-CoV-2 infections, and dying from the disease, with the economic burden being a key factor; regarding pregnancy, they were concerned about the quality of prenatal care they would receive, having a good birthing experience, and having access to postnatal needs (Gur et al. 2020). Although contracting the disease itself is relevant to racial health disparities and pregnancy, there is room to expand upon research regarding the effects of the pandemic on racial health disparities beyond the SARS-CoV-2 infection, particularly in a quantitative methodology to support the qualitative work of researchers such as Dr. Gur.

Pregnancy and Viral Infections

Pregnancy is a complicated condition that can change the body's response to illness and injury; additionally, it is important to study since both mother and fetus (or child, post-birth) are affected by those health risks. As such, much research on pregnancy as it relates to SARS-CoV-2 viral infection has revolved around the effects of the virus on pregnancy outcomes and pregnant women's bodies.

Previous research on pandemics, such as influenza, has noted the importance of viewing pregnancy as a period of increased vulnerability. Pregnant women have unique needs and considerations that must be met if they are to be protected during a pandemic. This includes recognition of the challenges for pregnant women in nonpharmacological interventions, like social distancing, due to prenatal needs; concerns about the ways in which antiviral medications affect pregnant women's bodies and fetuses differently; and researching potential risks of newly developed vaccines to both mother and fetus during pregnancy (Rasmussen et al. 2008).

Despite the novelty of the SARS-CoV-2 virus and resulting pandemic, quite a few studies have been conducted regarding the effects of SARS-CoV-2 on birthing outcomes and pregnant women's health because of concerns around the unique effects of pregnancy on the body. According to a study in a New York City hospital between April and June 2020, there were no differences in infant outcomes by mothers' COVID-19 status (Liu et al. 2021). Using a convenience sample from the COVID-NET tracker, COVID-19 associated hospitalization rates were disproportionately higher for pregnant women compared to women who were not pregnant (Delahoy et al. 2020). Delahoy et al. hypothesized that reasons for this could vary from the possibility that pregnant women actually have more severe SARS-CoV-2 infections, to there being a lower threshold for admitting pregnant women to the hospital, including for birth itself, or that there was a higher likelihood of testing pregnant women (2020). A systematic review of clinical outcomes of pregnant women with the virus showed that there were few significant differences in both pregnancy and COVID-19 outcomes compared to the non-infected pregnant population and the infected non-pregnant population, respectively (Gao et al. 2020), which communicates that any observed differences in pregnancy outcomes during the pandemic are likely due to non-biological factors.

There has been some intersectional research on outcomes for infected pregnant women by race. A study at Brigham and Women's Hospital in Boston analyzing outcomes by race for pregnant women with positive PCR tests early in the pandemic showed that most of the pregnant women who tested positive there were women of color and that most of the pregnant women with severe COVID-19 outcomes were also women of color (Onwuzurike et al 2020). In another study in Manhattan hospitals, Emeruwa focuses on perinatal and neonatal outcomes, for which there were no differences by race for women who tested positive from mid-March to late April.

These studies demonstrate a need to understand the broader societal effects of the pandemic on pregnant women.

Pandemic-Related Changes to Social Structures and Subsequent Effects on Pregnancy

As SARS-CoV-2 spread rapidly across the world, the pandemic led to understandable organizational changes to reduce exposure risk through methods such as lockdowns and quarantines. In the United States, the pandemic response was prolonged due to a lack of both uniform response and emphasis on controlling viral spread. As a result, these public health measures and the overwhelmed medical infrastructure have led to social challenges ranging from mental health and domestic violence crises to reduced healthcare access for non-SARS-CoV-2 medical needs. There are some studies that have undertaken research around such concerns; however, there is still room to understand the extent of social suffering that has been exacerbated by the pandemic so that such problems can be reduced in the immediate future and more effectively addressed in public health crises to come.

Research comparing racial and ethnic disparities in preterm birth before and during the pandemic has shown that, at least in the context of a New York City health system early in the pandemic, there was no evidence of changes in the existing preterm birth disparities (Janevic et al. 2021). However, a systematic review on how the pandemic has affected both maternal and perinatal outcomes globally has shown evidence that there has been an increase in poor birthing outcomes for both infants and mothers, especially in low- and middle-income countries (Chmielewska et al. 2021). This review suggested that "the increased rate of adverse outcomes might be driven mainly by the inefficiency of health-care systems and their inability to cope with the pandemic" (Chmielewska et al. 2021: 769). Noting such concerns at a global scale calls attention to the effects of the pandemic on maternal mortality and poor birthing outcomes in the

United States, where for Black women in particular, the rates align with many low- and middle-income countries.

These three broad topics—racial disparities in the pandemic, pregnancy and viral infections, and pandemic-related changes to social structures and subsequent effects on pregnancy— show that while the research conducted thus far around pregnancy and race in the context of the COVID-19 pandemic is important, there is still a lot of work that needs to be done in order to fully grasp the severity of issues that have arisen alongside SARS-CoV-2 infection rates.

Limitations and Research Gaps

The literature above has provided a great framework for future research. However, there are limitations and research gaps to their studies that my study intends to address.

Most of the research discussed above has taken place in the Northeast, in places such as New York City, Boston, and parts of New Jersey. These urban northeastern locations do not provide generalizable findings to other regions of the country or to rural areas. By focusing on Georgia in my study, I hope to expand the current body of knowledge to include a Southeastern state with both metropolitan settings like Atlanta as well as a significant rural population.

Additionally, most of the quantitative analysis on COVID-19 and pregnancy looked only at the first few months of quarantine in the United States, as the northeastern cities mentioned were among those areas hit hardest early in the pandemic. This does not provide an adequate understanding of the longer-term effects of reductions to prenatal care access across the entire pregnancy experience, for example, which may cause alterations in preterm birthrates and other pregnancy outcomes that could only be observed when looking at the whole of 2020. That was

not possible for many researchers who have already published, but as I am studying this topic later, I have access to data that encompasses the entirety of 2020.

Much of the current clinical research on COVID-19 and pregnancy centers itself on the virus and its physiological effects on pregnancy. However, this focus disregards the importance of understanding the ways in which social changes and pre-existing social inequalities in the context of a pandemic can affect vulnerable and marginalized populations, including pregnant women of color. While research on the biological risks to contracting COVID-19 while pregnant are relevant, there needs to be more attention given to the broader implications of living through a pandemic that has resulted in lockdowns and further reduced healthcare access.

Lastly, most research focuses on the Black/White dichotomy in the United States, with some acknowledgement of Latinx populations. However, Asian populations also should be included in understandings of pregnancy in a pandemic. Georgia has a diverse population, with pockets of refugee communities, Asian and Pacific Islander people, and those of Hispanic origin, as well as the Black/White dichotomy, so my research hopes to effectively include a broader cross-section of the pregnant population over the course of the pandemic.

Research Questions

This study aims to uncover changes to existing preterm birthrate disparities due to the vastly different context of 2020, the first year of the pandemic, as compared to 2019 in the state of Georgia through a quasi-experimental analysis methodology.

1. How has the year of 2020, which included a pandemic, social unrest, and a polarizing presidential election, altered county-level pregnancy outcomes as measured by preterm birth rates in the state of Georgia?

2. How have racial health disparities in preterm birthrates changed between the years 2019 and 2020 at the county level in Georgia?
3. What is the relationship between COVID-19 outcomes and preterm birthrates in Georgian counties?
    a. How is this relationship impacted by factoring in racial health disparities?

Hypotheses

1. Ethnoracial differences in preterm birth will be present when holding the year constant.
2. Ethnoracial differences in preterm birth rates will increase when giving birth in 2020 as compared to 2019.
3. County-level conditions related to COVID-19 risk will be associated with preterm birth risk regardless of year, as it serves as a proxy for healthcare system failures.
4. COVID-19-related risk at the county level will be positively associated with preterm birth risk in 2020, especially for the percentages of women and pregnant individuals who are under investigation for COVID-19 infection, as those factors are likely to be tied to pre-existing structural components of the county and healthcare.
5. The pre-existing systemic factors that are revealed during the pandemic are not the same across all ethnoracial groups, which may place such groups at risk pre-pandemic.
6. COVID-19 factors will raise the risk of preterm birth for Black mothers and Latinx mothers but not for Asian mothers (all relative to White mothers) when accounting for pre-existing ethnoracial differences, pre-existing birth risks, county-level COVID-19 condition rates, and the extent to which these three relate and intersect.

Materials and Methods

This study is conducted through a quasi-experimental design. This methodology allows for comparison of preterm birth rates by county in the state of Georgia between the years 2019 and 2020. While any distinctions cannot be solely attributed to the sociological effects of the pandemic through this technique, the broad societal implications of the year 2020 are able to be compared to a year without the added pressures of a pandemic, a highly polarizing election, and increased civil unrest around police brutality and white supremacy—that year being 2019.

Data

This study utilized two sets of data to intersect the viral effects of the pandemic with the pregnancy outcomes observed in Georgia counties. The first dataset is COVID-19 data about people under investigation (PUI) for COVID-19, obtained from the Georgia Department of Public Health by Dr. Alyasah Sewell. The PUI data provides deidentified counts of COVID-19 outcomes ranging from positive testing to death, numerous potential risk factors such as comorbidities and healthcare exposures, and demographic variables such as race, ethnicity, age, and county of residence for PUIs in 2020 in Georgia. The PUI information is used to contextualize the second dataset, and as such was collapsed into county-level rates of COVID-19 outcomes and demographics.

The second dataset was also accessed through the Georgia Department of Public Health, using their Public Health Information Portal (PHIP) to request data that is not publicly accessible. This dataset provides deidentified individual-level data on pregnancy outcomes such as preterm birth and fetal deaths, pregnancy risk factors such as preeclampsia and eclampsia, and the racial and ethnic composition of pregnant people in Georgia by county during the years 2019 and 2020.

Variables

The independent variables in this study are year, mother's racial category, and mother's ethnicity. The two years included in this study were 2019 and 2020. The racial categories identified through the pregnancy dataset were White, Black/African American, Asian, Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, and Multiracial. Ethnicity was defined as Hispanic/Latinx or non-Hispanic/non-Latinx. Due to very low numbers, Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, and Multiracial race categories were omitted. For the purposes of analysis, four categories were created: White, Black, Asian, and Latinx, where Latinx includes all individuals who identified as Latinx regardless of race, and White, Black, and Asian omitted these individuals. Further cross-classification was not possible due to small cell sizes.

The dependent variable of interest is preterm birth status. Preterm birth is defined as a birth before 37 weeks of pregnancy and occurs in 1 of every 10 pregnancies on average in the United States, not accounting for racial and ethnic differences in preterm rates (CDC 2021). There are many complications in infants that can arise alongside or as a result of preterm birth, ranging from feeding challenges and underdeveloped organs to infant deaths (CDC 2021). Major risk factors for preterm birth include chronic conditions such as high blood pressure and diabetes, major life stressors, and previous premature births (Mayo Clinic 2022). It is known that Black mothers have a higher risk of preterm birth, though the causes remain unknown (Mayo Clinic 2022).

The remaining variables of interest are included to determine their effects on the preterm birth associations with race/ethnicity and year. These include county-level rates of COVID-19 positivity, hospitalization, and death, as well as the rates of people under investigation who are

female or pregnant. People under investigation for COVID-19 include all those who were known to be at risk for having contracted COVID-19, thereby getting tested for COVID-19. It is worth noting that being a person under investigation (PUI) requires some sort of contact with a healthcare system in order to be identified as at risk and to receive testing. Mediating COVID-19 variables allow for the pandemic's indirect effects on preterm birth to be assessed, as there are many events of 2020, such as heightened national awareness of police brutality and an impending election, that could potentially contribute to increased risk of preterm birth through major life stressors differentially by race/ethnicity. By focusing on the county-level COVID-19 rates, contextual factors such as high prevalence of COVID-19 infection and the health systems most immediately accessible to residents of a county are taken into consideration through the proxy of people being tested and treated for COVID-19.

For the purposes of logistic regression analysis, higher-order variables were created to determine interaction effects. Second-order interaction variables intersect mother's race and year of pregnancy, mother's race and her county's COVID-19 conditions, and year of pregnancy and mother's county's COVID-19 conditions. Third-order interaction variables combine mother's race, year of pregnancy, and COVID-19 conditions in her county.

Data Analysis

Analyses were conducted through the STATA software package. Descriptive statistics at the county-level were obtained for both pregnancy data and COVID-19 data, including means, standard deviations, and quartile information. Tabulations and correlations were run to determine which variables had a potential for significance in regression. Finally, logistic regressions, clustered by county, were run for first-order, second-order, and third-order variables to determine

the odds ratios and statistical significance of these variables on preterm birth risk. The models themselves are logistic due to the dichotomous nature of preterm birth, the dependent variable.

Results

Descriptive Statistics

As shown in Table 1, the average proportion of people under investigation (PUI) who were confirmed to have COVID-19 was 0.69, with a range from 0.26 to 0.95 by county. The PUI who were hospitalized per county averaged to a proportion of 0.12, with a smaller range (0.02-0.48). The average death rate per county was 5% of the PUI, ranging from as low as 3% to 40% of the PUI in a given county. Since the population of interest was pregnant individuals, data to consider possibility of pregnancy were included to contextualize the PUI in each county. The average proportion of PUI of women of childbearing age (ages 15 to 40 years) was 0.38. On average, 55% of the PUI across counties were female. The rate of pregnancy among PUI in a given county had a mean of 0.01 and stayed between 0 and 0.04.

Tables 2 and 3 show the average proportions of pregnancy outcomes, pregnancy complications, and racial and ethnic categories of the mother in Georgia in the years 2019 and 2020, respectively. Of the pregnancies documented in 2019, the county average for live births was 0.99 of all births, with a mean of 0.12 being preterm and a mean of 0.01 resulting in fetal death prior to birth. These numbers were identical in 2020, with only slight changes to variation and range. The average racial and ethnic composition of pregnant mothers across all counties was approximately 65% white, 31% Black, 1-2% Asian, and 2% multiracial, with NHPI and American Indian mothers comprising a very small proportion of the county on average (0%). The mean proportion of Hispanic mothers in a county was 0.09, ranging from 0 to 0.49.

Logistic Regression Analysis

Six models were run to determine the presence and extent of relationships between ethnoracial category, year of birth, county-level PUI condition rates, and preterm birth risk. The first model used only first-order ethnoracial and year variables to establish a baseline relationship between preterm birth risk and race, as well as between preterm birth risk and year. The odds of preterm birth were 52.4% higher for Black mothers compared to White mothers, 3.6% lower for Latinx mothers, and 15% lower for Asian mothers. Of these, only the odds ratios for Black mothers and Asian mothers were statistically significantly different from those for White mothers. Relative to 2019, 2020 preterm birth risk overall was shown to decrease, albeit not significantly (Table 4).

The second model incorporated the intersectional race-year variables. While decreases in preterm birth risk were seen for all race-year variables, there were no statistically significant differences in this model except for the main effect of Black mothers with an odds ratio of 1.537 when not accounting for year (Table 5). PUI conditions were then introduced into the modeling framework with the race and year first-order variables (Table 6). The trends in these odds ratios aligned with Table 4, where Black mothers had a significantly greater risk of preterm birth compared to White women by about 50%, Asian mothers had significant decreases in preterm birth risk around 15%, and there were lower but not statistically significant odds for Latinx mothers and the year 2020 across all five PUI condition regressions. Of the conditions themselves, the only one that is statistically significant in its relationship to preterm birth risk was PUI COVID-19 death. This demonstrated that in counties with higher rates of COVID-19 deaths during 2020, there was a slightly increased odds ratio for preterm birth across years and racial categories. The fourth model, seen in Table 7, built upon Table 6 by adding a PUI condition-year second-order variable to the regressions. Very similar trends were observed in

this model, both in terms of statistical significance and the magnitude of the odds ratios. The PUI condition-year interaction variable showed odds ratios approximating 1 for all PUI conditions, none of which were significant.

Table 8 tested for pre-existing factors that placed certain ethnoracial groups at higher risk for preterm birth pre-pandemic by including mother's race-PUI condition variables in the model. In this model, statistical significance was not present for any mother's race-PUI condition variables and the odds ratios themselves stayed between 0.993 and 1.182 across the different PUI conditions and mother race categories that were included. Additionally, while general patterns of higher odds ratios for Black mothers, lower odds ratios for Asian mothers, and the association between COVID-19 death rates and preterm birth risk were maintained, there was reduced statistical significance in these patterns, especially apparent in the lack of significance among Asian mothers' odds ratios across the different PUI conditions included in regression.

In Table 9, the theoretical framework that the intersection of mother's race, year, and county-level PUI conditions differentially affected odds of preterm birth risk was directly tested. Black mothers' race alone still held significance for all but the percent of PUI women per county. Latinx and Asian mothers' race had statistically significant odds ratios only for the PUI pregnant condition, such that Latinx and Asian women living in counties with higher rates of PUI who were pregnant have lower risk of preterm birth. Of the mother's race-year interaction variables, only Asian mothers showed statistical significance. In this model, the odds ratios for Asian mothers in 2020 were significantly higher in counties with a greater proportion of PUI who are pregnant or who have confirmed COVID-19 positive tests. Counties with greater proportions of PUI hospitalization and death had statistically significant odds ratios of 1.010 and 1.025, respectively, demonstrating that higher rates of hospitalization and death in a pregnant

woman's county were associated with a higher risk of her giving birth prematurely. For the race-PUI condition interaction variables, preterm birth was positively and statistically significantly associated with Latinx and Asian mother-PUI pregnant variables, such that when both variables were simultaneously accounted for, Latinx and Asian mothers had higher risks of preterm birth where more pregnant women were under investigation for COVID-19 exposure. Lastly, of the race-year-PUI interaction variables, only the Asian-2020-PUI pregnant and PUI COVID-19 confirmed variables were statistically significant. When all three were accounted for, Asian mothers' odds of preterm birth was 0.476 in counties where pregnant PUI was higher and 0.982 in counties where COVID-19 confirmed positivity was higher.

Discussion

The six models used to account for preterm birth rates in Georgia between 2019 and 2020 indicate that race continues to be strongly tied to preterm birth disparities; however, there is more nuance than race alone in explaining preterm birth risk for mothers in Georgia counties. Broadly, preterm risk was lower (though lacking statistical significance) in 2020 than in 2019 when race—and the many sociological implications associated with race—were omitted. Introducing just mother's race into the equation, without factoring in the year, reveals the expected patterns of higher preterm risk for Black mothers and lower risk for Latinx and Asian mothers. Of all the PUI conditions examined in this study, the only one to consistently hold significance on its own was COVID-19 death rates, such that in counties where death rates of people under investigation were higher, preterm risk was elevated. This is understandable, as structural factors related to healthcare systems are involved with both death rates and preterm risk, so in counties where death rates are higher, there may be worse healthcare access and quality that contribute also to

higher preterm risk both prior to and during the pandemic. In some cases, these commonly observed trends were complicated by factors such as PUI condition and year.

Hypothesis 1 was supported (Table 4), showing distinct preterm risk for Black and Asian mothers as compared to White mothers. There was no significant shift in preterm risk when the race-year interaction was included for Table 5, failing to support Hypothesis 2. The third hypothesis, which stated that county-level COVID-19 risk indicators would be associated with increased risk of preterm birth, was only seen with COVID-19 death rates, such that counties with higher rates of COVID-19 death saw more women give birth prematurely (Table 6). The fourth hypothesis expected the relationship between PUI-year variables and preterm birthrates to be positively related, but there was no significance observed for any PUI condition-year interaction term (Table 7). Hypothesis 5 tested the alternate hypothesis, which was that there were systematically disparate healthcare factors that related to both county-level COVID-19 risk and ethnoracial preterm risk. This hypothesis was unsupported, as odds ratios for all PUI-race variables were insignificant (Table 8). Finally, the sixth hypothesis—which tested the primary conceptual model of mother's race, PUI county-level rates, and year of birth as all interacting with preterm birth—was not supported. There was no statistical significance to the combined race-PUI condition-year variables with either Black or Latinx mothers. However, there were unanticipated findings that resulted from the combined race-PUI condition-year variables for Asian mothers when the models included county-level rates of either pregnancy or confirmed COVID-19 infection in PUI.

While many of the higher-level models (Tables 6-8) showed few or no significant differences, the trends observed in the last model (Table 9) were interesting in their significance or lack thereof. There was no significance for Black mothers' preterm risk when other factors

such as year, county-level PUI proportions, or both factors were included. This could mean that preterm birth risk for Black communities in Georgia is tied to pre-existing factors that were not altered by the pandemic in significant ways. Another plausible hypothesis for this lack of significance is that factors specific to the pandemic did not inform preterm risk and any possible significant shifts in 2020—rather, sociopolitical factors or essential and frontline work proportions may reveal distinctions in preterm risk not uncovered in this study.

Despite the lack of significance in Table 9 for Black mothers, there were significant alterations in preterm risk for Latinx and Asian mothers that this model demonstrated. Second-order race-PUI pregnancy variables showed increased preterm birth risk for these two traditionally lower-risk populations when ignoring year. The higher risk of preterm birth for Latinx and Asian mothers when accounting for higher proportions of PUI who were pregnant in their county of residence follows logically, as there are likely additional factors at play that put such mothers at risk outside of the pandemic. Possible factors could be related to a variety of situations, such as low socioeconomic status trends in counties where more pregnant women ended up potentially exposed to COVID-19 when the pandemic arrived. In these environments, pregnant women are probably more likely to need to continue working and less likely to have the prenatal care they need, leading to increased risk of preterm birth. Further complicating this narrative, however, is that Asian mothers showed the only odds ratios that were significant for the third-order interaction variables. Asian mothers showed a significant decrease in preterm risk during 2020 when higher rates of COVID-19 were confirmed in their county or when more people under investigation were pregnant. There are conflicting odds ratios when 2020 is incorporated into the interaction variable than when it is omitted, which could imply that in counties where more COVID-19 positive confirmed tests were found or where more PUI were

pregnant, healthcare access and quality increased to such a degree during 2020 that it counteracted any factors that were worsening preterm birth risk for Asian mothers in 2019.

Limitations and Future Directions

While this study does uniquely contribute to understandings of the relationship between county-level COVID-19 factors, year of birth, and mother's race in preterm birth risk, it is limited in its scope. There were many factors that were sociologically altered in 2020, and as such, many variables were omitted in this study. Specifically, it is challenging to measure sociopolitical stress and suffering to gauge its role in preterm disparities. Additionally, maternal mortality data would have been informative in understanding pandemic effects on pregnancy outcomes; however, these data were not available at the time of this study. Lastly, due to the nature of the limited timeframe and restricting the geographical locations to Georgia counties, there was a lack of sufficient numbers to appropriately test ethnoracial interactions in the regressions, leading to oversimplified racial and ethnic categories for these variables. Despite the limitations of this study, it does point to future research that will be important in understanding the relationship between the COVID-19 pandemic and other arenas of health disparities. One such study that could reveal shifts in pregnancy outcome disparities would be to observe COVID-19 vaccination access and vaccination rates in counties and relate it to pregnancy outcome disparities, as vaccine access and rates indicate a number of potential successes—or failings—regarding healthcare quality, access, trust, and ability to educate the populations in a county. Other studies could analyze sociopolitical factors in 2020 and determine if these other highly prevalent effects of 2020 show an association to pregnancy outcomes.

Conclusion

While these results were unexpected and did not often support my hypotheses, it is important to recognize the ways in which preterm birth has shifted, or failed to shift, in relation to the COVID-19 pandemic. While Black mothers' preterm risk was not revealed to have worsened in response to factors in the pandemic itself, their risk is still far higher than it should be at a rate of 1.5 relative to White mothers' risk. It is also critical to continue uncovering what sociological factors lower preterm risk for Asian and Latinx mothers so that preterm rates can hopefully be lowered for all mothers. Additionally, determining how Asian mothers in counties with higher rates of PUI who were pregnant or confirmed COVID-19 positive saw further decreased risk of preterm birth could suggest possible interventions to support the reduction of preterm birth disparities.

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Appendix A: Tables

Table 1: Proportions by County of COVID-19 Outcomes and Covariates in Georgia for PUI

Variables	Mean	SD	Min	25th Percentile	Median	75th Percentile	Max
COVID-19 Positive	0.69	0.14	0.26	0.60	0.72	0.79	0.95
COVID-19 Hospitalization	0.12	0.06	0.02	0.08	0.11	0.15	0.48
COVID-19 Death	0.05	0.04	0.00	0.03	0.05	0.06	0.40
Childbearing Age (15-40)	0.38	0.08	0.19	0.34	0.38	0.41	0.79
Female	0.55	0.05	0.24	0.54	0.56	0.58	0.69
Pregnant	0.01	0.01	0.00	0.01	0.01	0.01	0.04
Observations (Counties)	159						

Table 2: Proportions by County of Pregnancy Outcomes and Covariates in Georgia, 2019

Variables	Mean	SD	Min	25th Percentile	Median	75th Percentile	Max
Preterm Births	0.12	0.03	0.05	0.10	0.12	0.14	0.23
Live Births, All	0.99	0.01	0.88	0.99	0.99	1.00	1.00
Fetal Deaths	0.01	0.01	0.00	0.00	0.01	0.01	0.12
Preeclampsia	0.09	0.04	0.00	0.06	0.08	0.11	0.21
Eclampsia	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Mother Race: White	0.65	0.21	0.08	0.50	0.66	0.81	0.98
Mother Race: Black	0.31	0.21	0.00	0.14	0.31	0.46	0.92
Mother Race: Asian	0.02	0.02	0.00	0.00	0.01	0.02	0.22
Mother Race: NHPI	0.00	0.01	0.00	0.00	0.00	0.00	0.07
Mother Race: American Indian	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Mother Race: Multiracial	0.02	0.02	0.00	0.01	0.02	0.03	0.10
Mother Race: Unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Mother Ethnicity: Not Hispanic	0.90	0.08	0.51	0.88	0.93	0.96	1.00
Mother Ethnicity: Hispanic	0.09	0.08	0.00	0.04	0.07	0.11	0.49
Mother Ethnicity: Unknown	0.01	0.01	0.00	0.00	0.00	0.01	0.04
Observations (Counties)	159						

Table 3: Proportions by County of Pregnancy Outcomes and Covariates in Georgia, 2020

Variables	Mean	SD	Min	25th Percentile	Median	75th Percentile	Max
Preterm Births	0.12	0.04	0.04	0.10	0.12	0.14	0.27
Live Births, All	0.99	0.01	0.96	0.99	0.99	1.00	1.00
Fetal Deaths	0.01	0.01	0.00	0.00	0.01	0.01	0.04
Preeclampsia	0.10	0.04	0.00	0.08	0.09	0.12	0.24
Eclampsia	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Mother Race: White	0.65	0.21	0.13	0.51	0.66	0.80	1.00
Mother Race: Black	0.31	0.21	0.00	0.16	0.30	0.46	0.83
Mother Race: Asian	0.01	0.02	0.00	0.00	0.01	0.02	0.22
Mother Race: NHPI	0.00	0.01	0.00	0.00	0.00	0.00	0.09
Mother Race: American Indian	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Mother Race: Multiracial	0.02	0.01	0.00	0.01	0.02	0.03	0.06
Mother Race: Unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mother Ethnicity: Not Hispanic	0.90	0.09	0.51	0.86	0.92	0.96	1.00
Mother Ethnicity: Hispanic	0.09	0.09	0.00	0.03	0.07	0.13	0.49
Mother Ethnicity: Unknown	0.00	0.01	0.00	0.00	0.00	0.01	0.09
Observations (Counties)	159						

Table 4: Logistic Regression, Preterm Birth by Mother's Race and Year of Pregnancy

Preterm Birth, standardized to White Mother, Year 2019	Odds Ratio (T-statistic)
Black Mother	1.524*** (18.61)
Latinx Mother	0.964 (-1.27)
Asian Mother	0.851** (-3.27)
Year 2020	0.975 (-1.53)
Observations	241627

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

Table 5: Logistic Regression, Preterm Birth by Mother's Race, Year of Pregnancy, and Race-Year Interactions

Preterm Birth, Standardized to White Mother in 2019	Odds Ratio (T-Statistic)
Black Mother	1.538*** (18.34)
Latinx Mother	1.001 (0.03)
Asian Mother	0.911 (-1.49)
Year 2020	0.998 (-0.10)
Black Mother, 2020	0.981 (-0.67)
Latinx Mother, 2020	0.925 (-1.58)
Asian Mother, 2020	0.867 (-1.62)
N	241627

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

Table 6: Logistic Regression, Preterm Birth by Mother's Race, Year of Pregnancy, and PUI Conditions

	Odds Ratio (T-Statistic)				
Preterm Birth	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Black Mother	1.515*** (18.92)	1.530*** (19.83)	1.523*** (16.77)	1.516*** (18.82)	1.513*** (18.87)
Latinx Mother	0.965 (-1.22)	0.968 (-1.09)	0.964 (-1.29)	0.961 (-1.34)	0.969 (-1.11)
Asian Mother	0.852** (-3.23)	0.855** (-2.98)	0.851** (-3.26)	0.848*** (-3.36)	0.856** (-3.24)
Year 2020	0.975 (-1.53)	0.975 (-1.53)	0.975 (-1.53)	0.975 (-1.53)	0.975 (-1.54)
PUI Condition	1.008 (1.34)	0.954 (-0.80)	1.000 (-0.20)	1.005 (1.57)	1.018** (2.83)
N	241627				

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

PUI Condition (county-level rate) is varied in each model as follows: (1) PUI Female, (2) PUI Pregnant, (3) PUI COVID-19 Confirmed, (4) PUI COVID-19 Hospitalized, (5) PUI COVID-19 Death

Table 7: Logistic Regression, Preterm Birth by Mother's Race, Year of Pregnancy, PUI Conditions, and PUI-Year Interactions

	Odds Ratio (T-Statistic)				
Preterm Birth	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Black Mother	1.515*** (18.90)	1.530*** (19.81)	1.523*** (16.76)	1.516*** (18.81)	1.513*** (18.88)
Latinx Mother	0.965 (-1.22)	0.968 (-1.09)	0.964 (-1.29)	0.961 (-1.34)	0.969 (-1.11)
Asian Mother	0.852** (-3.23)	0.855** (-2.98)	0.851** (-3.27)	0.848*** (-3.35)	0.856** (-3.24)
Year 2020	0.692 (-1.15)	1.056 (1.07)	1.097 (1.07)	1.035 (0.80)	0.979 (-0.62)
PUI Condition	1.005 (0.98)	0.993 (-0.13)	1.001 (0.43)	1.007 (1.93)	1.019** (2.66)
PUI Condition & 2020	1.006 (1.07)	0.923 (-1.50)	0.998 (-1.35)	0.995 (-1.50)	0.999 (-0.15)
Number of Observations	241627	241627	241627	241627	241627

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

PUI Condition (county-level rate) is varied in each model as follows: (1) PUI Female, (2) PUI Pregnant, (3) PUI COVID-19 Confirmed, (4) PUI COVID-19 Hospitalized, (5) PUI COVID-19 Death

Table 8: Logistic Regression, Preterm Birth by Mother's Race, Year of Pregnancy, PUI Conditions, and Mother Race-PUI Condition Interactions

	Odds Ratio (T-Statistic)				
Preterm Birth	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Black Mother	0.973 (-0.06)	1.550*** (6.05)	1.356* (2.57)	1.560*** (9.36)	1.565*** (10.10)
Latinx Mother	1.913 (1.16)	0.873 (-1.72)	0.912 (-1.04)	0.986 (-0.33)	0.985 (-0.36)
Asian Mother	2.302 (0.78)	0.718 (-1.39)	0.742 (-1.25)	0.917 (-0.94)	0.898 (-0.98)
Year 2020	0.975 (-1.53)	0.975 (-1.53)	0.975 (-1.53)	0.975 (-1.53)	0.975 (-1.54)
PUI Condition	1.007 (1.03)	0.946 (-0.81)	1.000 (-0.27)	1.007 (1.78)	1.022*** (3.80)
Black Mother and PUI Condition	1.008 (0.95)	0.988 (-0.15)	1.001 (0.62)	0.998 (-0.55)	0.993 (-0.75)
Latinx Mother and PUI Condition	0.988 (-1.23)	1.104 (1.38)	0.998 (-0.92)	0.998 (-0.58)	0.996 (-0.37)
Asian Mother and PUI Condition	0.982 (-0.95)	1.182 (0.83)	0.997 (-0.69)	0.994 (-0.78)	0.989 (-0.54)
N	241627	241627	241627	241627	241627

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

PUI Condition (county-level rate) is varied in each model as follows: PUI Female, (2) PUI Pregnant, (3) PUI COVID-19 Confirmed, (4) PUI COVID-19 Hospitalized, (5) PUI COVID-19 Death

Table 9. Logistic Regression, Preterm Birth by Mother's Race, Year of Pregnancy, Race-Year Interactions, PUI Conditions, PUI Condition-Year Interactions, Mother Race-PUI Condition Interactions, and Mother Race-PUI Condition-Year Interactions

	Odds Ratio (T-Statistic)				
Preterm Birth	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Black Mother	0.765 (-0.52)	1.490*** (3.96)	1.377* (2.41)	1.609*** (8.00)	1.590*** (8.39)
Latinx Mother	1.571 (0.70)	0.791* (-2.36)	0.939 (-0.33)	0.988 (-0.17)	1.021 (0.31)
Asian Mother	13.90 (1.61)	0.525* (-2.55)	0.613 (-1.68)	0.975 (-0.18)	1.125 (0.69)
Year 2020	0.596 (-0.97)	0.976 (-0.36)	1.009 (0.07)	1.076 (1.33)	1.017 (0.45)
Black Mother & 2020	1.653 (0.66)	1.084 (0.76)	1.047 (0.31)	0.939 (-0.95)	0.968 (-0.58)
Latinx Mother & 2020	1.505 (0.43)	1.227 (1.21)	1.362 (1.18)	1.000 (0.00)	0.929 (-0.72)
Asian Mother & 2020	0.0157 (-1.49)	1.895* (2.33)	3.013** (2.86)	0.877 (-0.49)	0.633 (-1.96)
PUI Condition	1.002 (0.41)	0.935 (-0.96)	1.000 (-0.22)	1.010** (2.74)	1.025*** (3.60)
PUI Condition 2020	1.009 (0.97)	1.023 (0.32)	1.000 (-0.09)	0.993 (-1.35)	0.996 (-0.53)
Black Mother & PUI Condition	1.013 (1.33)	1.037 (0.34)	1.002 (0.84)	0.996 (-0.81)	0.991 (-0.67)
Latinx Mother & PUI Condition	0.992 (-0.69)	1.257* (2.37)	1.001 (0.35)	1.001 (0.10)	0.997 (-0.20)
Asian Mother & PUI Condition	0.951 (-1.67)	1.691* (2.43)	1.006 (1.31)	0.994 (-0.48)	0.953 (-1.47)

Black Mother & PUI Condition & 2020	0.991 (-0.69)	0.906 (-0.90)	0.999 (-0.46)	1.004 (0.69)	1.003 (0.25)
Latinx Mother & PUI Condition & 2020	0.991 (-0.51)	0.764 (-1.66)	0.995 (-1.50)	0.994 (-0.68)	0.999 (-0.06)
Asian Mother & PUI Condition & 2020	1.076 (1.43)	0.476** (-3.22)	0.982*** (-3.34)	0.999 (-0.03)	1.076 (1.49)
N	241627	241627	241627	241627	241627

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

PUI Condition (county-level rate) is varied in each model as follows: (1) PUI Female, (2) PUI Pregnant, (3) PUI COVID-19 Confirmed, (4) PUI COVID-19 Hospitalized, (5) PUI COVID-19 Death