The Relationship between Income Inequality and Maternal Mortality for Black and White Mothers

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Abstract

Previous research has suggested that black mothers die more often than white mothers during childbirth, and this may be due to income inequality and structural racism. The purpose of our study is to measure the relationship between the Gini coefficient, a common measure of income inequality, and black and white maternal mortality rates by state and year. In this study, we had to account for the different periods that each state updated its death certificate to include a maternal mortality question. Data were obtained from the American Community Survey and the CDC; we then examined the relationships between the Gini coefficients and the maternal mortality rates for black and white mothers. We found that overall, black women's maternal mortality rate was higher each year between 2003 and 2019. Our first hypothesis was that there would be a positive relationship between the Gini coefficient and the maternal mortality rate by state; this was not supported, and neither white nor black women's rates had a significant relationship with the state's Gini coefficient. Our second hypothesis was that there would be a positive relationship between the race-specific Gini coefficient and black and white maternal mortality rates by year. This was partially supported, a positive relationship was found for the white maternal mortality rate but not for the black maternal mortality rate. Therefore we can conclude that income inequality might affect white women more, but race and income matter overall for black women, considering the clear disparity between black and white mortality rates.

Introduction

In the United States, Black women are 3.3 times more likely to die as a result of pregnancy or childbirth (1). From 2011-2015, Black women died at a rate of 42.8 per 100,000 compared to 13.0 for white women (1). There is not only a difference in race but there is a general increase in maternal mortality across racial groups, rising 26.6% from 2000 to 2014 (2). These statistics make the United States one of the worst developed countries when it comes to maternal mortality (3). Maternal mortality is defined as deaths "related to or aggravated by pregnancy or pregnancy management and which occur during or within 42 days after the end of pregnancy" (3). Income inequality may be one important factor in these differences (4) because things like structural racism and implicit bias disadvantage black women from accessing the same healthcare and financial resources as white women (5). To investigate this topic, we reviewed research on mistreatment during childbirth, general trends in maternal mortality, structural racism, and income inequality.

Inequity and Mistreatment in Childbirth

The way women are treated when they give birth plays an important role in how their birth will go. Researchers did an online survey in which they asked women about the types of mistreatment they received from healthcare providers while they were giving birth. Their research found that one of out every six women experienced mistreatment during childbirth; the increase of mistreatment is directly linked to the context of care (6). Context of care is where the woman gave birth, so the hospital, a birthing center, their home, etc. Women who choose to give birth in the hospital were most likely to be mistreated in comparison to women who gave birth in other places. Mistreatment was experienced by 17.3% of people; with the most common being shouted or scolded at (8.5%), and the least common being patient information being shared without their consent, 1.2% (6). Women of color experienced mistreatment more often than white women; no matter the race of the woman if her partner was black her chances of mistreatment increased (6). This is important because how women are treated during childbirth affects morbidity and mortality. If women are scared or uncomfortable while they're giving birth then they may not feel confident enough to ask for help when they need it. This increases their chances of morbidity which in turn increases their chances of mortality (7).

Trends in Maternal Mortality

In the 21st century, maternal mortality has been steadily increasing in the United States, however, it is uncertain exactly how many women have died due to the United States' inability to keep consistent data on pregnancy-related mortality events. Researchers combed over multiple databases and censuses to see the statistics on maternal mortality throughout the years; they found that between 1999 and 2018 the maternal mortality rate across the U.S increased from 9.9 deaths to 17.4 deaths out of 100,000, respectively (3).

However, this information may not be accurate; an observational study done by MacDorman et al. found that the maternal mortality rate between 2000 and 2014 increased from 18.8 to 23.8 deaths out of 100,000, respectively (2). They also found that California and Texas were different from the rest of the states; California had a decline in maternal mortality rates while Texas had a spike in maternal mortality rates between 2011 and 2012. MacDorman et al.'s information may be more accurate because they applied a correction factor to the maternal mortality data. This was necessary because not all states revised their death certificate to include maternal mortality, even though the U.S. government mandated it in 2003. The correction factor done was 1.932; this means that almost half of the maternal deaths were missing before all the states added maternal mortality to the death certificate (2). Due to the inconsistent data, other researchers must be careful when selecting different states to study. The constant increase in maternal mortality rates is important because most of the deaths are preventable. Studying where, why, and how much they increase can give hospitals and states knowledge on how to stop it; they can put more rules and/or restrictions in place.

There are many maternal morbidities that lead to maternal mortalities. In order to get a grasp of said morbidities, researchers did a study in the state of Wisconsin examining individual patient records. Cabacungan et al. found that black women had a 74% higher risk of infection, a 42% higher risk of preterm labor, a 63% higher risk of antepartum hemorrhaging, and a 39% higher risk of hypertension in comparison to white women (7). This is important because some of these morbidities occur in the hospital and could possibly be the result of mistreatment, which could lead to mortality. However, a lot of these morbidities took place prior to birth, which means that they were happening over time. These structural inequities are the result of implicit biases and the unequal structures upon which women of color live.

Structural Racism and Implicit Bias

Other scholars have argued that the cards were stacked against black women because of historical events (5). The systems and institutions where they give birth were not built nor designed for their safety. Black women's pain is often ignored and devalued by hospitals and doctors; this leads to trauma-inducing pregnancy and birth, and even death (5). The disregard of this pain may not be intentional on the hospital's or doctors' part but it is perhaps a side effect of implicit bias and structural racism. Implicit bias is defined as "the attitudes or stereotypes that affect our understanding, actions, and decisions in an unconscious manner" (1). Structural racism is defined as "a system where public policies, institutional practices, and cultural representations work to reinforce and perpetuate racial inequity" (5). Historically black enslaved women were experimented on; invasive and painful gynecologic surgeries were performed so that doctors could have a good understanding of the female reproductive system. This knowledge was then used for the healing of white women's reproductive injuries and illnesses. While these experiments took place, black women often cried out in pain and desperation; they however were ignored for the benefit of medical understanding (5). Cruel things like this no longer happen but the modern disregard of black women's pain stems from this history, doctors and hospitals don't often listen to black women when they complain or bring up an issue they have and this may lead to disastrous endings.

Given the effect implicit bias has on maternal outcomes (1), researchers Howell et al. argue there are many solutions that could help lower maternal mortality rates (8). The first step is to enhance communication and implement unconscious bias training; one way to do this is to focus on patients and their information individually rather than grouping them with their social group (8). The second step is to implement a disparities dashboard and perform enhanced maternal mortality and severe maternal morbidity reviews. These results should then be reviewed and shared with leadership and staff. The third step is to standardize care on labor and delivery and build a culture of equity by introducing "quality improvement tools such as triggers, protocols, drills, evidence-based practices, policies and procedures, checklists, simulation training," which ensures equal standards of care across hospitals. The fourth step is to develop new models of care across the care continuum by having a judgment-free space where reproductive planning, noncoercive contraceptive counseling, and family planning can be taught. Finally, practitioners must engage key stakeholders; one way to do this is to get everyone involved in birth on one page; everyone has to agree that there is a problem and that it should be addressed (8).

Income Inequality and Maternal Mortality

Expecting mothers often try to do their best for their unborn children, they often try to avoid anything that may bring harm to themselves or their baby. However, there are mothers who want to avoid danger and harm but cannot; these are mothers who are disadvantaged because of their circumstances. Income inequality, or the uneven distribution of income, affects the quality of people's lives and especially their health. It can even affect a woman's actions during pregnancy, with longer working hours and increased stress, which then affects delivery and can lead to death. Researchers Vilda et al. reviewed statistics in the CDC Cause of Death Database and found all maternal mortalities for every state ranging from 2011 to 2015. They found that an increase in the 5-year lagged income inequality rate was directly linked to a 14% increase in pregnancy-related mortality among black women (4). Income inequality is measured by the Gini Index or the Gini Coefficient; this index measures income inequality within a nation or a social group. Larger income inequality rates put lower-income women, who are often women of color, at risk because even if they wanted to be healthier or safer during pregnancy or birth, they are prevented from doing so. They can't afford the medicine, doctors, healthier food, and safe housing, needed in order to have a healthy pregnancy and safe delivery.

The primary way researchers measure income inequality is with the Gini Index (9). The Gini coefficient is calculated by

$$G = \frac{A}{A + B}$$

where A is the area between the line and the curve and B is the area beneath the curve (Figure 1). The index G is the income inequality and it is a decimal in between zero, perfect equality, and one, perfect inequality. This study examined how the Gini index in different states impacts black and white mothers.

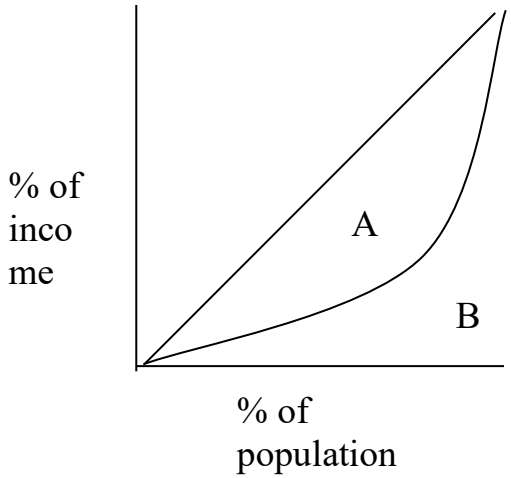

Figure 1. Gini Coefficient. *The graph below shows how the Gini Index is calculated. The horizontal axis represents the % of the population from zero to a hundred. The vertical axis represents the % of the income from zero to a hundred. The diagonal line represents perfectly equal income distribution, this line has a slope of one. For example, the 50th percentile of the population would have 50% of the income. The curve is called Lorenz's curve, this curve represents the actual income distribution. The further away from the line the less even the income, wealthier people earn more of the money.*

Study Design and Hypotheses

Overall, the research says that income inequality affects maternal mortality and contributes to structural racism, maternal mortality has been increasing throughout the years, and that income inequality harms black mothers more than white mothers. This study contributes to an understanding of how the Gini coefficient affects birthing mothers through a review of maternal mortality in all the states that have updated their death certificates to include maternal mortality from the years 2003-2019.

We hypothesized that income inequality and maternal mortality will be positively related and the relationship will be stronger for black mothers than white mothers. This is because research says income inequality affects everyone (4), but black mothers more (4), due to the effects of structural racism (5). First, we hypothesize there is a positive relationship between the Gini coefficient and the black and the white maternal mortality rates across all 50 states and the District of Columbia. Second, we hypothesized a positive relationship between the Gini coefficient and the black and the white maternal mortality rates across the years 2003-2019.

Results Section

The topic of this paper is the relationship between income inequality and the maternal mortality rate for black and white mothers. We wanted to find out how they relate to each other or if they relate at all. Our maternal mortality data came from the CDC WONDER Multiple Cause of Death Database (10) and our Gini coefficient data came from the U.S Census Bureau's American Community Survey (11, 12, 13, 14, 15, 16). We hypothesized that income inequality and maternal mortality across states would be

positively correlated overall and for both black and white mothers; however, because of structural racism and implicit bias we believed that the relationship would be stronger for black mothers than it would be for white mothers. We also hypothesized that there would be a positive relationship between the Gini coefficient and the black and white maternal death rate between the years 2003 and 2019.

First, we explored the overall patterns in maternal mortality. We could only include data from when each state updated its death certificate to include maternal mortality. For example, Florida updated their death certificate in 2005, so the only data we gathered from Florida was between the years 2005-2019. Therefore, different years had differing numbers of states' data included (Appendix A). An independent t-test found that the average black maternal mortality rate was higher than the average white maternal mortality rate ($t(32) = 16.19$, $p < 0.0001$). The black rate ($M = 41.20$, $SD = 6.13$) was consistently higher than the white rate ($M = 16.02$, $SD = 1.82$). This trend is shown in Figure 2.

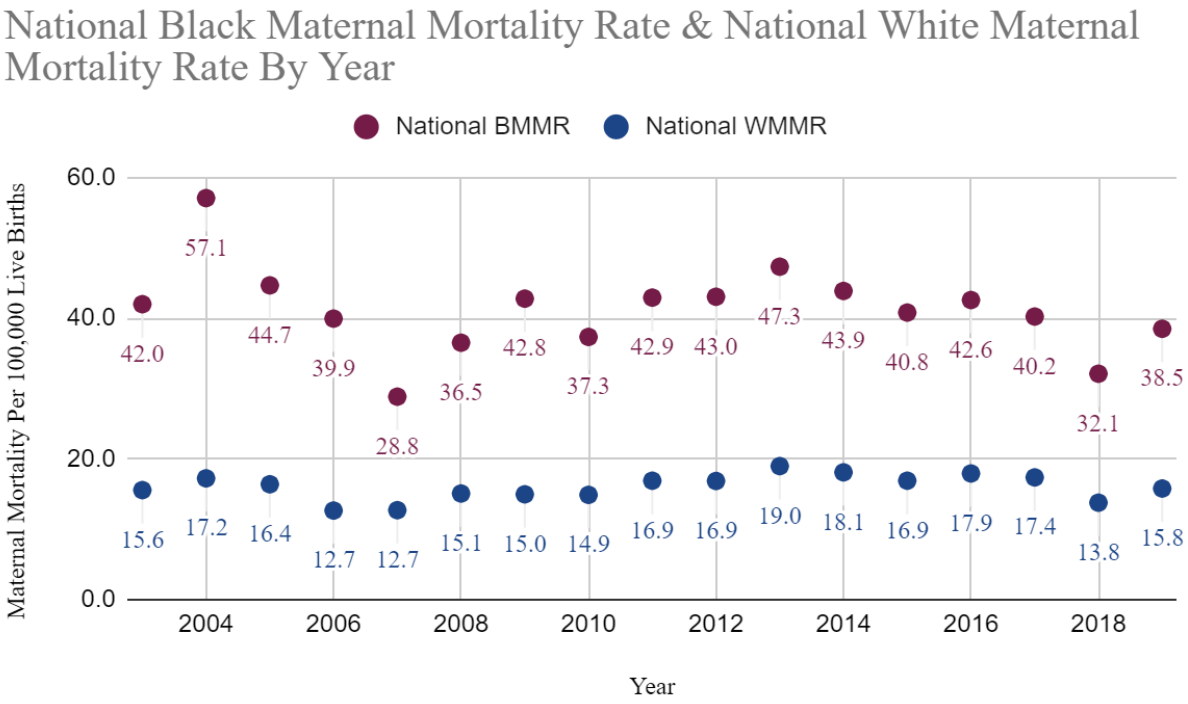

Figure 2. National Black Maternal Mortality Rate and National White Maternal Mortality Rate by Year. *The maternal mortality rates by race and year are displayed above. Rates are calculated by dividing deaths by live births and multiplying by 100,000. For all years, the black rate is higher than the white rate. The black maternal mortality rate is fluctuating between 28.8 and 57.1 and the white maternal mortality rate is more consistent. In the years 2003-2014, only states with updated death certificates are included (Appendix A).*

We hypothesized that there would be a positive relationship between both black and white mothers' maternal death rates and the Gini coefficients for each state. In order to gather this data, we found the Gini coefficients for the years that the individual states updated their death certificate to include questions about pregnancy and matched it with the maternal death and live birth data in the corresponding

years for each state. There were a total of five states, including Washington, D.C, with suppressed white maternal mortality data and there were 19 states with suppressed black maternal mortality data. If data is suppressed, that means that there were less than 1 in 0 deaths in that time period. We found no relationship between the Gini coefficient and the black rate ($r(30) = 0.17$, $r^2 = 0.030$, $p = 0.17$), the white rate ($r(44) = 0.005$, $r^2 = 0.00$, $p = 0.50$), and the black and white rate combined ($r(28) = 0.13$, $r^2 = 0.018$, $p = 0.24$). In summary, our data suggest that there is little to no relationship between a state's income inequality and a state's maternal deaths, although the relationship to the black rate was slightly higher in comparison to the white rate.

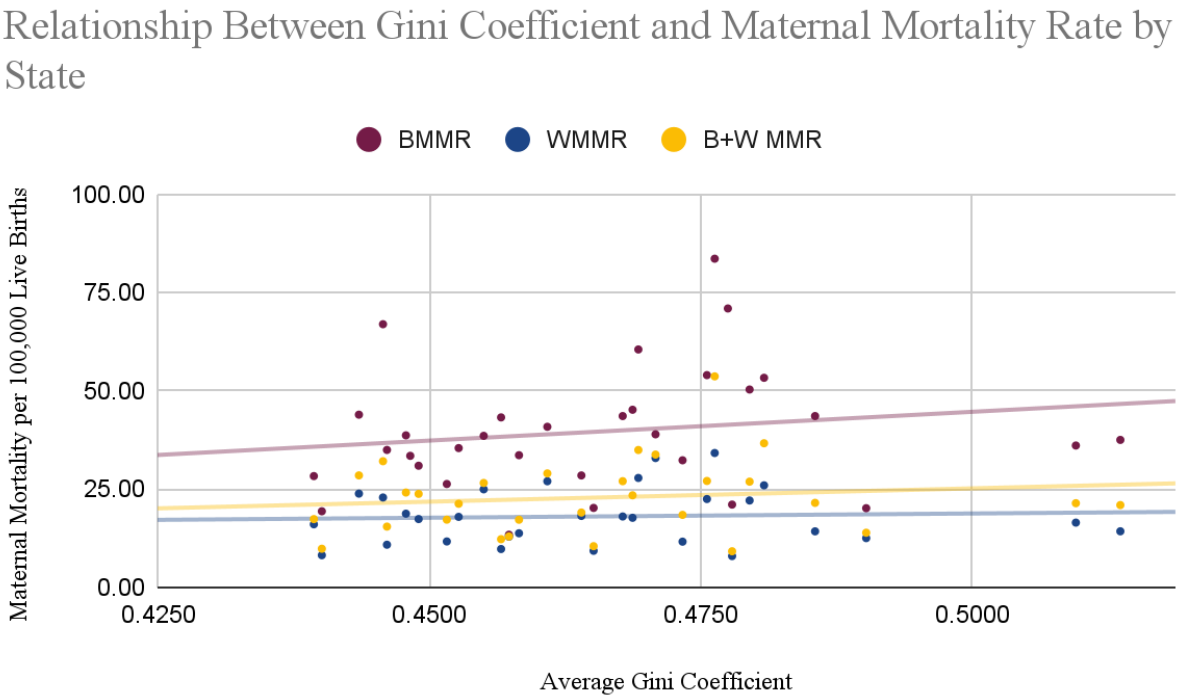

Figure 3. Relationship between Gini Coefficient and Maternal Mortality Rate by State. *The maternal mortality rate by race and state is displayed above. Rates are calculated by dividing deaths by live births and multiplying by 100,000. For the range of Gini coefficients, the black rate is higher than the white rate and the black & white rate combined. There are no significant relationships between the Gini coefficient and maternal mortality by the state for either black or white mothers.*

Second, we hypothesized that there was a positive relationship between the Gini coefficient and the black and white maternal death rate across the years 2003-2019. We pulled race-specific Gini coefficients for each year using only the states in that year that updated their death certificate to include pregnancy-related death. We matched that with the maternal death rate and live birth totals for the year using the same states. We found no significant relationship between the black maternal mortality rate and Gini coefficients across the years ($r(15) = -0.01$, $r^2 = 0.0001$, $p=0.48$). In contrast, we found a significant relationship between the white maternal mortality rate and Gini coefficients across the years ($r(15) =$

0.467, $r^2 = 0.218$, p=0.029). Finally, the black and white combined rate was significant (r(15) = 0.467, r^2 = 0.219, p=0.029) but it is not meaningful due to the non-existing black relationship making the combined results similar to the white results. In summary, years in which income inequality was higher, white mothers had a higher mortality rate but that pattern does not hold true for black mothers; this may be because the black maternal mortality rates seem to be separate from income inequality and are consistently higher than the white maternal mortality rates.

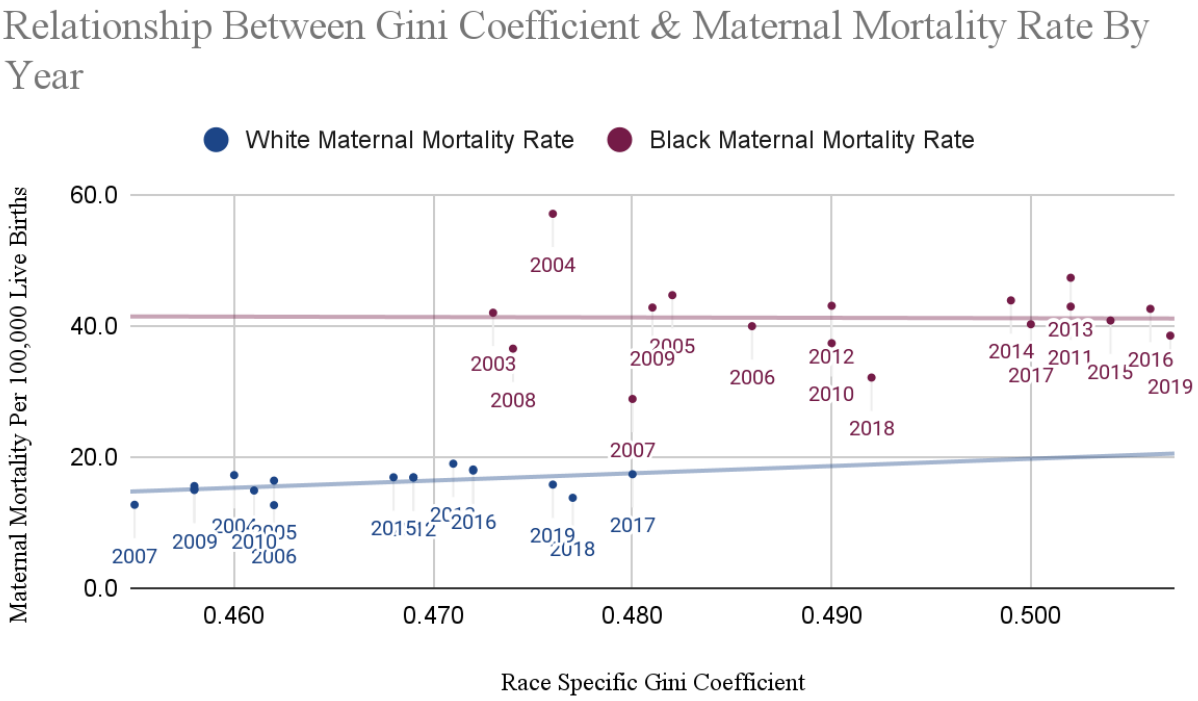

Figure 4. Relationship between Race-Specific Gini Coefficient and Maternal Mortality Rate by Year. *There was a significant relationship between the white maternal mortality rate and the white Gini coefficient. In the years in which the Gini coefficient was higher, the white maternal mortality rate was also higher. However, there was no significant relationship between the black maternal mortality rate and the black Gini coefficients.*

Discussion

Our first hypothesis was that income inequality and maternal mortality would be positively related across the 50 states and Washington DC. This was not supported by our data; our data found that there was no relationship between the Gini coefficient and the black maternal mortality rate, the white maternal mortality rate, and the black and white rate combined (Figure 2). Our second hypothesis was that income inequality and maternal mortality would be positively correlated between the years 2003 and 2019. This was partially supported by our data; our data found that there was no significant relationship between the black maternal mortality rate and Gini coefficients across the years. We did however find a significant positive relationship between the white maternal mortality rate and Gini coefficients across the

years; the black and white combined rate was also significant but it does not matter due to the non-existing black relationship making the combined results extremely similar to the white results (Figure 3).

Our results were consistent with the previous data found by others. Singh found that the maternal mortality rate across the U.S increased from 9.9 to 17.4 deaths out of 100,000 (3) with black women having 2.4 times higher risk of mortality. However, MacDorman et al. found that the maternal mortality rate increased from 18.8 to 23.8 deaths out of 100,000 (2) and their information is possibly more correct because they used a correction factor. Our results are consistent with MacDorman et al's. We found that in 2003 the maternal mortality rate for white women was 15.6 out of 100,000 vs 42.0 out of 100,000 for black women. In 2019 the maternal mortality rate was 15.8 out of 100,000 for white women vs. 38.5 out of 100,000 for black women. The black maternal mortality rate peaked in 2004 at 57.1 out of 100,000 and the white maternal mortality rate peaked in 2016 at 19.0 out of 100,000. Over the course of the years, the black maternal mortality averaged 41.2 out of 100,000 and the white maternal mortality rate was 16.0 out of 100,000. Therefore our results are consistent regarding mortality in general, black women do die more often in childbirth. This is true no matter what years or states are looked at, or with and without a correction factor.

Our results however are inconsistent with the previous data that Vilda et al. found. Vilda et al. found a relationship between the lagged income inequality rate over 5 years and the black maternal mortality rate. We found that there is little to no relationship between a state's income inequality and a state's maternal deaths; in years in which income inequality was higher, white mothers had a higher maternal mortality rate but that pattern does not hold true for black mothers. We believe this may be because the black maternal mortality rate is not determined by income inequality and overall is consistently higher than the white maternal mortality rate. Our results may be different than Vilda et al because our studies were conducted differently (4). We gathered our data by testing between the years 2003 and 2019, they gathered their data by testing between the years 2011 and 2015. We tested regular income inequality and they tested lagged income inequality. We also had to skip certain states due to the fact that not all states updated their death certificate at the same time. We can hereby determine that inconsistency is not an issue; there are two different ways of looking at a complicated issue; the maternal mortality rate is just a hard problem to talk about overall. The issue is confusing and there is poor data when it comes to this subject. Regardless, maternal mortality is still a problem for African-American mothers, and income is likely still a factor in the racial disparity, even if income inequality may not be. Black families in America make less income than white families on average (17) so perhaps the intersection of race and income may make the birth outcomes worse for black women.

The major limitations of our study were that not every state updated its death certificate uniformly and some states had suppressed data. So we had gaps in our data which makes it difficult to

look for a linear relationship. As of 2015, the availability of the data has improved so future researchers can conduct a similar study but start gathering data from 2015 to the present. We also suggest that future researchers expand the factors that might influence maternal mortality beyond income inequality because the Gini coefficients had a small amount of variation from year to year and state to state, which also makes testing relationships difficult.

In conclusion, our research suggests that income inequality matters more for white women than black women. However, it is clear that race and perhaps income matters overall because across years and across states black women have a higher maternal mortality rate overall. Therefore, we agree with researchers Howell et al. who argue that there need to be better standards for birth and that there are clear solutions that would help the problem of maternal mortality. Actions like enhancing communication, publishing data about outcomes, standardizing care, and engaging key stakeholders can reduce racial disparities.

Materials and Methods

Data Sources

The data for maternal death and live births came from CDC WONDER Multiple Cause of Death Database (10). We then calculated the maternal mortality rate per 100,000 live births for white mothers, black mothers, and black and white mothers for each year starting with 2003 through 2019 as well as all 50 states, including the District of Columbia. The Gini coefficients for every state and year came from the U.S Census Bureau and the American Community Survey (11, 12, 13, 14). The Gini coefficients for black and white residents for every year also came from the U.S Census Bureau (15, 16).

Procedure

We examined the relationship between the Gini coefficient and maternal mortality rate for black and white mothers in two different ways; geographically by state and longitudinally by year. In order to gather the geographical data, we identified the year that each state updated the death certificate to include pregnancy-related deaths. This is because previous research (2) suggested that many maternal deaths have gone unrecorded due to poor record-keeping. We then averaged the Gini coefficient for the years after each state had updated its certificate (Appendix A). We located the maternal death rates for the same years as the Gini coefficients of each state using the ICD-10 codes and A34, O01-O95, and O98-99, which are recognized as all pregnancy-related causes of death (3). Live births from the same periods were also collected and the maternal mortality rate was calculated by dividing the number of deaths over the number of births and then multiplying that by 100,000. The national data was found in a similar fashion, we got the deaths and births for each year from only the states that updated their death certificates. In the

national data, we collected the black and white Gini coefficients for each year because this was available only by year and not by the state.

Statistical Analysis

We compared the maternal death rates between black and white mothers between the years 2003 and 2019 using a t-test on VassarStats.net. We also compared the relationship between the Gini coefficients for all the states to the maternal death rate for black, white, and all mothers for all the states using a correlation-coefficient test. We also used a correlation-coefficient test to compare the maternal death rate for black, white, and all mothers across the years 2003-2019 to the black and white Gini coefficients across those years.

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Appendix A: Maternal Mortality Rate per 100,000 Live Births

State	Data Starting Point through 2019	Black Maternal Mortality Rate	White Maternal Mortality Rate
Alabama	2003	32.34	11.64
Alaska	2014	Suppressed Data*	Suppressed Data
Arizona	2010	28.49	18.18
Arkansas	2008	60.53	27.85
California	2003	21.07	7.98
Colorado	2015	43.25	9.77
Connecticut	2005	20.15	12.54
Delaware	2007	33.47	Suppressed Data
Florida	2005	36.10	16.49
Georgia	2008	53.32	25.97
Hawaii	2014	Suppressed Data	Suppressed Data
Idaho	2003	Suppressed Data	20.82
Illinois	2008	34.97	10.86
Indiana	2008	38.95	32.91
Iowa	2011	Suppressed Data	16.70
Kansas	2005	28.32	16.06
Kentucky	2011	38.56	24.96
Louisiana	2013	83.61	34.19
Maine	2011	Suppressed Data	14.12
Maryland	2015	26.31	11.69
Massachusetts	2014	Suppressed Data	10.92
Michigan	2004	45.19	17.71
Minnesota	2012	20.22	9.32
Mississippi	2012	30.95	17.39
Missouri	2010	50.34	22.11
Montana	2003	Suppressed Data	15.58
Nebraska	2005	Suppressed Data	15.14
Nevada	2008	19.37	8.19
New Hampshire	2005	Suppressed Data	13.74
New Jersey	2004	66.95	22.88
New Mexico	2006	Suppressed Data	22.88
New York	2003	43.59	14.27
North Carolina	2014	37.52	14.28

North Dakota	2008	Suppressed Data	12.79
Ohio	2007	35.44	17.95
Oklahoma	2004	40.86	27.00
Oregon	2006	Suppressed Data	11.19
Pennsylvania	2012	33.63	13.78
Rhode Island	2006	Suppressed Data	12.83
South Carolina	2005	43.59	18.04
South Dakota	2004	Suppressed Data	12.09
Tennessee	2012	43.94	23.86
Texas	2006	54.00	22.49
Utah	2005	Suppressed Data	14.54
Vermont	2008	Suppressed Data	Suppressed Data
Virginia	2014	38.68	18.76
Washington	2004	13.41	12.92
Washington DC	2006	70.95	Suppressed Data
West Virginia	2015	Suppressed Data	15.90
Wisconsin	2013	Suppressed Data	10.10
Wyoming	2004	Suppressed Data	23.94

*Time periods with fewer than 10 deaths are suppressed by the CDC