

The relationship between income inequality and maternal mortality for black and white mothers

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SUMMARY

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. 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 maternal mortality 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 concluded 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 because of pregnancy or childbirth compared to White women (1). From 2011 to 2015, Black women died at a rate of 42.8 per 100,000 compared to a maternal mortality rate of 13.0 for White women (1). From 2000 to 2014 there was a general increase of 26.6% in maternal mortality (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 the deaths associated with pregnancy and occurs within 42 days of the end of pregnancy (3). Income inequality may be one important factor in these differences (4). 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.

Other scholars have argued that Black women are at a disadvantage because of historical events (5). The systems and hospitals where they give birth were not historically designed for their safety. Black women's pain is often ignored and devalued by hospitals and doctors leading to trauma-inducing pregnancy and birth, and even death (5). The disregard for this pain may not be intentional on the hospitals' or doctors' part but it is perhaps a side effect of implicit bias and structural racism (1, 5). Implicit bias is defined as the attitudes or ideas that affect our understanding, actions, and decisions in an unknown way (1). Structural racism is a system where policies, practices, and cultural representations reinforce and continue racial inequities (5). Historically Black enslaved women were experimented on; invasive and painful gynecologic surgeries were performed so that doctors could have a better understanding of the female reproductive system (5). 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). The modern disregard for 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 (5).

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 (3). Researchers combed over multiple databases and censuses to determine 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 observed 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 (2). 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 (2). 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 maternal mortality increases can provide hospitals and states with knowledge on how to prevent maternal deaths by implementing more rules and/or restrictions.

The way women are treated when they give birth plays an important role in how their birth will go (6). 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 (6). Their research found that one of out every six women, in general, experienced mistreatment during childbirth; the increase in 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 (6). Mistreatment was experienced by 17.3% of people; with the most common being shouted or scolded at (8.5%), and the least common was patient information being shared without their consent, 1.2% (6). Women of color experienced mistreatment more often than White women, and women's chances of mistreatment increased if their partner was Black (6). This is important because how women are treated during childbirth affects morbidity and mortality (7). 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).

There are many maternal morbidities that lead to maternal mortalities (7). 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 (7). These structural inequities may be the result of implicit biases and the unequal structures that are part of the society in which women of color live.

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, some mothers cannot always avoid danger and harm because of their circumstances. Income inequality 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 (4). 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). Larger income inequality rates may 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 may be prevented from doing so. It is possible they could not 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 (8). 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 (8). This study examined how the Gini index in different states impacts Black and White mothers.

Overall, the literature indicates that income inequality affects maternal mortality and contributes to structural racism: maternal mortality has been increasing throughout the years, and income inequality harms Black mothers more than White mothers (2-4). This study contributes to an understanding of how the Gini coefficient affects birthing mothers but expands our knowledge of this relationship 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 would be positively related, and the relationship would be stronger for Black mothers than White mothers. This is because research suggests income inequality affects everyone, but Black mothers more, due to the effects of structural racism (4, 5). First, we hypothesized there is a positive relationship between the Gini coefficient and the Black and 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 White maternal mortality rates across the years 2003-2019.

RESULTS

The topic of this paper is the relationship between income inequality and the maternal mortality rate for Black and White

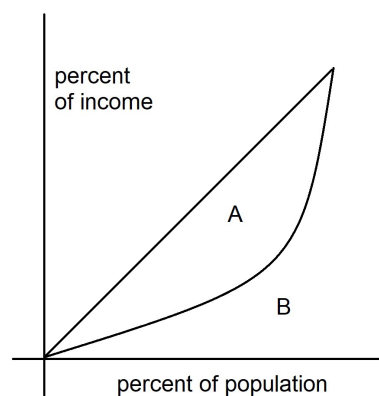


Figure 1: Gini Coefficient (8). The horizontal axis represents the percent of the population from zero to a hundred. The vertical axis represents the percent of the income from zero to a hundred. The diagonal line represents perfectly equal income distribution, this line has a slope of one. For example, 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 income. The section labeled A represents the area between the curve and the section labeled B represents the area beneath the curve.

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 (9) and our Gini coefficient data came from the U.S Census Bureau's American Community Survey (10-15).

First, we explored the overall patterns in maternal mortality. We only included the 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. 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 ($M = 16.02, SD = 1.82$) (Figure 2).

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. We used the Gini coefficients for the years that the individual states updated their death certificate to include questions about pregnancy. We then matched it with the maternal death and live birth data in the corresponding years for each state. There was a total of four states and 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 10 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 ($r(28) = 0.13, r^2 = 0.018, p = 0.24$). 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).

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, the years in which income inequality was higher, White mothers had a higher mortality rate but that pattern does not hold true for Black mothers (Figure 4). One explanation 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.

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,

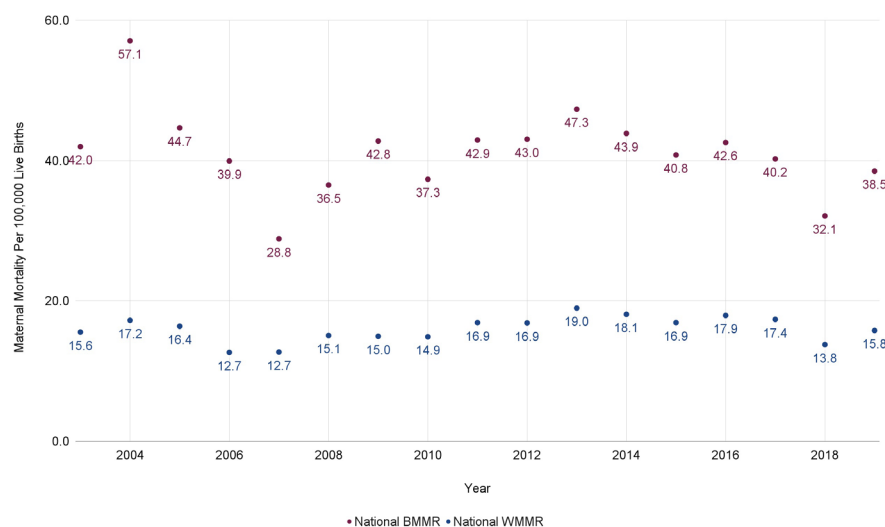


Figure 2: National Black Maternal Mortality Rate (BMMR) and National White Maternal Mortality Rate (WMMR) by Year. Rates were calculated by dividing deaths by live births and multiplying by 100,000. For all years, the Black rate is higher than the White rate. The Black maternal mortality rate fluctuates 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. The average Black maternal mortality rate is higher than the white mortality rate. T-test, $p < 0.0001$.

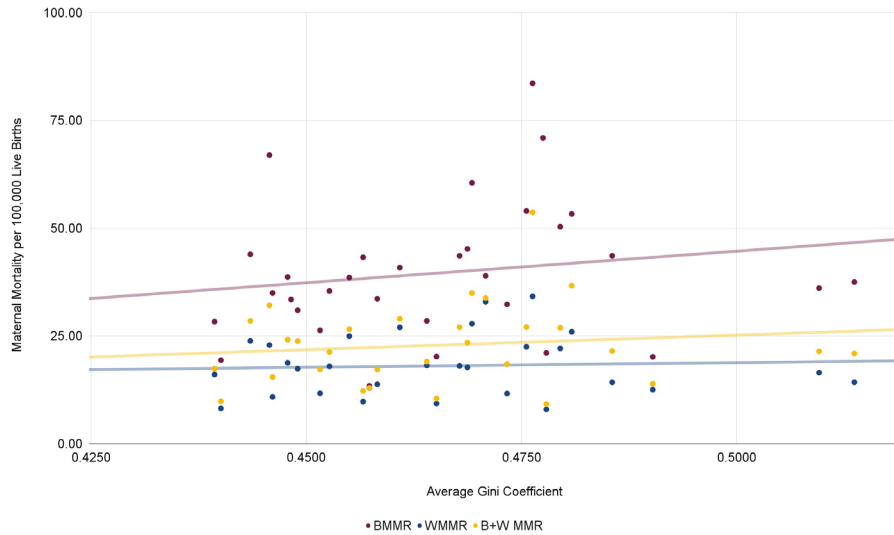


Figure 3: Relationship between Gini Coefficient and Maternal Mortality Rate by State. Rates were calculated by dividing deaths by live births and multiplying by 100,000. For the range of Gini coefficients, the Black rate was consistently higher than the White rate and the Black & White rate combined. There are no significant relationships between the Gini coefficient and maternal mortality by the state for either Black or White mothers, $p > 0.05$.

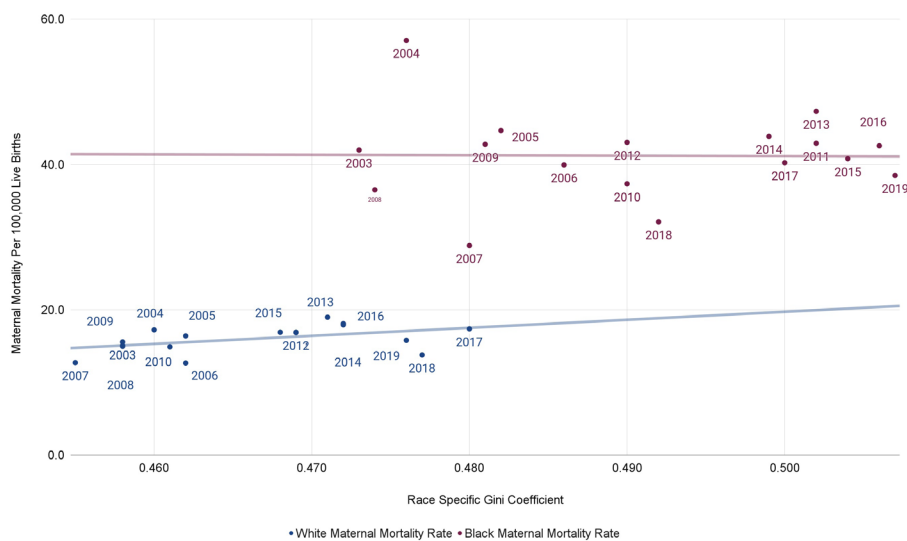


Figure 4: Relationship between Race-Specific Gini Coefficient and Maternal Mortality Rate by Year. There was a significant relationship between the white maternal mortality rate and the White Gini coefficient, $p = 0.029$. In the years in which the Gini coefficient was higher, the White maternal mortality rate was also higher. However, there was no significant relationship between the Black maternal mortality rate and the Black Gini coefficients, $p = 0.48$.

however, due to the non-existing Black relationship, the combined results were 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 from 2000 to 2014 increased from 9.9 to 17.4 deaths out of 100,000 with Black women having 2.4 times higher risk of mortality (3). However, MacDorman *et al.* found that the maternal mortality rate increased from 18.8 to 23.8 deaths out of 100,000 and their information is possibly more correct because they used a correction factor (2). 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 was true no matter what years or states we looked at, with or 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 (4). 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 did 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, while they gathered their data by testing between the years 2011 and 2015. We tested regular income inequality, and they tested lagged income inequality. Lagged income inequality uses income data from five years prior to the mortality data of a given year. We also skipped certain states due to the fact that not all states updated their death certificate at the same time. We can hereby determine that inconsistency was not an 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 Black 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 so perhaps the intersection of race and income may make the birth outcomes worse for Black women (16).

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 made 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 shows a greater statistical impact on White maternal mortality as opposed to Black maternal mortality. However, it is clear that race more than 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 (17).

MATERIALS AND METHODS

The data for maternal death and live births came from the CDC WONDER Multiple Cause of Death Database (9). 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 for all 50 states and the District of Columbia. The Gini coefficients for every state and year came from the U.S Census Bureau and the American Community Survey (11-14). The Gini coefficients for Black and White residents for every year also came from the U.S Census Bureau (14, 15).

We examined the relationship between the Gini coefficient and maternal mortality rate for Black and White mothers in two different ways; 1) geographically by state and 2) 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 suggested that many maternal deaths have gone unrecorded due to poor record-keeping (2). We then averaged the Gini coefficient for the years after each state had updated its certificate. 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.

We compared the maternal death rates between Black and White mothers between the years 2003 and 2019 using a one-tail 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 Pearson correlation-coefficient test on VassarStats.net. We also used a Pearson 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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