RACIAL DISPARITIES IN MATERNAL MORTALITY IN THE UNITED STATES: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

This systematic review sought to collect nationwide estimates of and maternal characteristics (assessed at both the individual and group level) associated with maternal mortality (MM) in the United States from 1995 to 2014 from studies published after 2014. It focused specifically on the racial disparities in maternal mortality to better understand the Black-White persons disparity in this health outcome and to understand the varying factors (e.g., marital status, racism, etc.) that may contribute to these disparities. Results indicated that Black vs. White race were over three times more likely to die from a pregnancy complication. A mother's marital status, access to prenatal care, and prevalence of chronic disease at the state-level were also key factors associated with higher MMR rates.

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CHAPTER ONE
INTRODUCTION AND GENERAL INFORMATION

In January 2020, the National Center for Health Statistics released the first data concerning the United States maternal mortality ratio (MMR) since 2007 [1]. Using the definition of maternal death as “the death of a woman while pregnant or within 42 days of termination of pregnancy”, a MMR of 17.4 deaths per 100,000 live births was reported for the year of 2018. While this increase from 12.7 per 100,000 live births was attributed to a more consistent and accurate method for data collection, racial disparities in the updated MMR were alarming. Black women were approximately 2.5 times more likely to die from pregnancy (i.e., 37.1 per 100,000) than White women (i.e., 14.7 per 100,000) [1].

This disparity may be linked to differences in patient care as over 60% of pregnancy-related deaths are preventable. In 2018, the Building U.S. Capacity to Review and Prevent Maternal Deaths program by the Centers for Disease Control and Prevention (CDC) reported data on the preventability of maternal deaths. Utilizing state and local maternal mortality review committees (MMRCs), preventability was defined as “there was at least some chance of the death being averted by one or more reasonable changes to patient, community, provider, facility, and/or systems factors” [2]. Between 2014-2017, the CDC reported 10.7% of maternal deaths were caused by hemorrhage and 27% were caused by a cardiovascular or coronary condition in the United States [3]. Of these maternal

deaths, around 70% of hemorrhages and cardiovascular/coronary conditions were preventable [2].

Errors on behalf of the provider and the overall healthcare system contribute to this high preventability. For hemorrhage, the main contributing factors to maternal death are missed or delayed diagnosis, ineffective treatments, lack of patient knowledge to seek care, inadequate training of medical professionals, and an absence of policies and procedures. In addition to these, maternal death from cardiovascular or coronary conditions were also linked to lack of provider knowledge, preexisting chronic disease in patients, poor communication amongst providers, and inadequate staff [2].

Because most pregnancy-related deaths are preventable, this systematic review centered around prevalence estimates and factors associated with maternal mortality both on the individual level and group level and aimed to inform strategies to reduce this inequality [3]. This study focused on the United States population from 1995-2014. The rationale for restricting the location is based on the high rate of maternal deaths in the United States and because the degree of disparity varies by country. In 2017, the maternal mortality ratio in the United States was 19 per 100,000 live births in comparison to 10 per 100,000 live births in Canada [2]. Overall, the study aim was to systematically review the literature on the comparison between overall maternal death and Black versus White race, and to tabulate and describe their findings in a manner that would identify prevention strategies.

CHAPTER TWO
METHODS

An extensive search of relevant published literature was conducted for the systematic review after 2014 which identified data between the years 1995-2014. Race terminology was used following the CDC's recommendations [3]. The PubMed electronic database was the sole database used for literature extraction. The criteria for inclusion were: 1) studies published from 2015 onwards, 2) studies with an observational, cross-sectional, or cohort design, 3) studies that were conducted in the United States overall (i.e., not state specific), 4) studies that focused on comparing maternal death overall (i.e. not a specific cause of death), and 5) included estimates for Black and White persons. Exclusion criteria were: 1) published prior to 2015, 2) articles that centered around secondary literature (e.g., summaries of conference proceedings, etc.) or review articles, 3) studies that presented data solely on maternal morbidity, 4) studies that did not present data directly on comparing maternal death by race, 5) studies that presented data on a population other than Black women, 6) studies that focused on a specific state, and 7) studies that focused on a specified cause of death.

The search terms were generated using the Medical Subject Headings (MeSH) thesaurus. The search terms and their arrangement are as follows: ((("Maternal Death"[Mesh] OR "Maternal Mortality"[Mesh]) AND ("African Americans"[Mesh] OR "Race Factors"[Mesh] OR "race" OR "racial" OR "Ethnic

Groups"[Mesh])) AND "Pregnancy"[Mesh] AND "United States"[Mesh]). An initial search was conducted using these terms which returned 160 articles. From this, the articles were screened by publish date (i.e., after 2014) which narrowed it down to 68 articles. These articles were further screened by title and abstract, leaving 5 qualifying studies. Extracted data was organized per study, including results on MMR estimates (overall and by subgroup) and risk factors.

The inclusion/exclusion flow diagram is presented in Figure 1. All tables and figures are located in the appendix. During the abstract and title review, thirteen articles were eliminated because their discussion was centered around secondary literature and did not present any new data. Eleven more articles were ineligible because they were review articles. Two articles were excluded because they focused solely on maternal morbidity rather than maternal mortality. The largest number of articles (n = 15) were excluded because they presented data on a topic (e.g., proposed health frameworks and implementation, focus on COVID-19, etc.) other than overall maternal death by race. Furthermore, three articles were eliminated because they did not include data on Black women. Ten articles were centered around state-specific data; whereas, nine centered around a specific cause of death. Those were not investigated in this systematic review.

CHAPTER THREE
RESULTS

All 5 eligible studies prospectively followed an observational model that relied primarily on registry data. However, each study had a unique way of quantifying their data as well as independent ways of defining maternal death and of achieving their data. Table 1 summarizes the makeup and main findings of each study.

Mogos et al.

Mogos *et al.* used the common maternal mortality rate definition of “the number of maternal deaths per 100,000 live births” as the basis of their study of 7,411 US women from 2002-2014 [4]. Their data was retrieved from the National Inpatient Sample (NIS) database. Maternal race was self-reported. Using this data, Mogos *et al.* calculated maternal mortality rates (MMR) of different comorbidities and races and compared these trends during intrapartum (IP) and postpartum (PP) periods.

Intrapartum

Of their 7,411 sample size, the average MMR during the IP period was 7 per 100,000 live births which is lower than the 2020 national average of 17.4 per 100,000 [1, 4]. However, among Black women, they found the average MMR was 17 per 100,000 which is significantly higher than the rate of White women (5 per 100,000). According to Mogos *et al*, approximately 26.7% of IP maternal deaths

were accounted for by Black women, whereas 30% were among White women [4]. Yet how these rates compare to the overall number of race-specific maternal deaths (i.e. what percentage of maternal deaths were among Black women versus what percentage of maternal deaths were among White women) was unknown. On another note, the authors did find a change in prevalence over time with a 4.7% annual decrease between 2002-2014 of Black persons with maternal death during the IP period [4]. A comparable decrease was not observed for White women.

Postpartum

In the PP period, the average MMR was 226 per 100,000 live births [4]. Among Black women, the rate was 379 per 100,000. The rate among White women was 160 per 100,000. Of PP maternal deaths, 31.7% were among Black women, whereas 28.4% were among White women [4]. Again, how these rates compare to the absolute number of race-specific maternal deaths was unknown.

Creanga et al.

In both articles by Creanga *et al.*, maternal death was defined as “the death of a woman during or within 1 year of pregnancy that was caused by a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy” [5]. Their data was obtained from the Center for Disease Control and Prevention’s (CDC) Pregnancy

Mortality Surveillance System. They obtained their maternal race from the mother's death certificate. Creanga *et al.* calculated mortality ratios and used this form of data arrangement to compare disparities among race, education, and other sociodemographic characteristics. They did not note a change in maternal mortality prevalence over either time period but differences by race were observed [5, 6].

2006-2010

During this time period, Creanga *et al.* found the average MMR was 16 per 100,000 live births. Out of all maternal deaths studied (n=3,358), 35.5% were among Black women compared to 40% among White women. When comparing race-specific maternal mortality, the rate of death among Black women was 38.9 per 100,000. The rate of death among White women was 12 per 100,000. This significant higher prevalence of maternal death among Black women compared to White women is reflected in Figure 2 [6].

Beyond basic MMR rates, Creanga *et al.* dove into specific sociodemographic characteristics to potentially determine factors associated with increased prevalence. According to their research, marital status may be connected to maternal death. 71.4% of pregnancy-related deaths among Black women were unmarried compared to 41.5% of deaths among unmarried White women. In addition to marital status, the absence of prenatal care may also be related to increased MMR rates among Black women. 52.9% of Black women who died as a result of pregnancy never received prenatal care. This contrasts

the 44.7% of White women who died as a result of pregnancy that never received prenatal care [6].

2011-2013

Between 2011-2013, Creanga *et al.* reported an increase in the average MMR from 16 per 100,000 live births between 2006-2010 to 17 per 100,000 live births. Higher prevalence was seen in the percentage of maternal deaths among Black women with 37.9% compared to the steady 40% seen among White women. This was supported by race-specific MM. 43.5 per 100,000 Black women died from pregnancy, whereas 12.7 per 100,000 White women died from pregnancy [5].

As with their previous research, Creanga *et al.* searched further into these significant differences in MMR among races. In Figure 3 [5], they not only showed the higher MMR among Black women, but they also showed how age affects this rate. Black women between the ages of 30-34 are nearly five times more likely to die from pregnancy than White women. Overall, the ratio of death in Black persons compared to White persons increases dramatically with age [5]. Another factor that may again contribute to the differences in MMR by race is marital status. Here, 69.5% of Black women who died from pregnancy were not married compared to 43.5% of White women [5]. This data supported the results of Creanga *et al.*'s previous work.

Moaddab et al.

Moaddab *et al*. used the CDC's definition of maternal death as "a death occurring during pregnancy or within 1 year of birth" [7]. They obtained their data from the National Vital Statistics System. Maternal race was obtained from the birth certificate [7].

Moaddab *et al*. did their data analysis differently than the previous articles discussed. They did a state-based ecological study where they calculated the correlation coefficient of maternal death versus varying demographic and lifestyle information at the group level [7]. From Figure 4 [7], several specific characteristics stand out with their correlation to maternal mortality. Out of all state-level factors, the states with a higher percentage of deliveries from Black mothers were the most strongly correlated with maternal death. Other strongly correlated factors to maternal death were unintended pregnancy, an unmarried mother, and four or fewer prenatal visits [7].

Nelson et al.

Nelson *et al.* defined maternal mortality as "all women who died within 42 days of pregnancy termination in which the pregnancy contributed to the cause of death" [8]. They utilized the data from the National Vital Statistics System to conduct a state-level ecological study. The maternal race was obtained from the birth certificate. These authors also analyzed their research differently than the previous studies discussed by calculating the regression coefficient of maternal mortality compared to varying associated factors [8]. Figure 5 [8] summarizes their findings. They found that states with higher rates of chronic hypertension

had the strongest positively correlated relationship with maternal mortality (+3.82). Other positively correlated factors to maternal death were higher rates of women with diabetes (+1.24), higher rates of women without a high school degree (+0.31), and higher rates of Black mothers (+0.25) [8].

CHAPTER FOUR

DISCUSSION

The data from all five articles analyzed support the hypothesis that Black women are at a higher risk of having a pregnancy-related death than White women. The exact reasoning behind these disturbing findings are unclear but several contributing factors were unveiled that may provide insight. However, a combination of maternal health factors, discrepancies in reporting, and discrimination are likely to lie behind this result.

Mogos *et al.* reported higher rates of maternal mortality among Black women than White women in both intrapartum and postpartum periods. The average rate of maternal death during the postpartum period was 226 per 100,000 live births. When stratified by race, the prevalence was 379 per 100,000 among Black women and 160 per 100,000 among White women. This leads to the belief that Black women are at a significantly higher risk of maternal death during the postpartum period.

In both articles, Creanga *et al.* highlighted the role of marital status in maternal death. Between 2006-2010, 71.4% of pregnancy-related deaths among Black women were unmarried women compared to 41.5% of White women. In support, 69.5% of pregnancy-related deaths among Black women were unmarried women between 2011-2013 compared to 43.5% of White women. With the understanding that Black women are more likely to die postpartum, a possible explanation for the significantly higher rates of maternal death may be

contributed to a lack of familial support, causing elevated stress levels which may trigger other illnesses.

Another shocking statistic was found by Creanga *et al.* Black women are five times more likely to die as a result of pregnancy between the ages of 30-34 than White women. It is difficult to explain this statistic as this age range should not be at risk for age-related poor pregnancy outcomes. One likely explanation is medical discrimination against Black women. Historically, pain tolerance among Black persons has been underestimated. Poor treatment corresponds with White persons receiving better care for their complaints than Black persons [9]. The 30-34 age range is older for reproduction. Older age does mean more exposure to racism and stress which may have negative reproductive effects. This stems from systemic racism and the dismissal of the concerns of Black persons because of the wrongfully held belief that their value is less than White persons.

A less drastic variance in maternal mortality disparities revolved around the lack of prenatal care. Creanga *et al.* found that 52.9% of Black women who died of pregnancy did not receive any prenatal care in comparison to 44.7% in White women. Moaddab *et al*. found a similar result that states with higher maternal mortality rates are correlated with higher instances of women attending four or less prenatal visits. Prenatal care is essential for healthy pregnancy outcomes among all races. However, determining the barriers preventing access to this care is of question.

Finally, Nelson *et al.* found that states with a higher rate of maternal mortality were correlated with higher rates of chronic hypertension and diabetes. A common explanation for medical disparities against Black persons is based on the belief that their biological makeup places them at higher risk of disease. However, this theory fails to address the role of racial discrimination in the prevalence of and progression of illness. The American Psychological Association reported that Black persons have seen large impacts in rates of hypertension and diabetes due to chronic stress caused by discrimination [3]. Besides chronic stress, these diseases may progress to more severe stages due to missed diagnoses or ineffective treatment which were previously established as contributing factors to maternal death [2].

It is important to note the limitations of this study. First, the five studies included did not obtain maternal race from the same source. Most studies obtained maternal race information from the infant's birth certificate, which is typically self-reported. One used self-reporting to identify race. Because race is a social classification, it is essential for race data to be self-reported as assumptions may place mothers under the wrong racial group [3]. If the argument behind racial disparities in MMR involves our perception of race as a social construct, then obtaining race solely from birth certificates may not be concrete way of grouping individuals together. Perhaps, differences in disparities (rather worse or better) may be observed if classification was systematically self-reported.

Another inconsistency among the studies was the definition of maternal mortality. The majority of the studies used a definition that specified pregnancy as a contributing factor to death. However, Moaddab *et al*.'s definition allowed for any death which occurred during pregnancy or up to 1 year postpartum. Although it may be assumed that pregnancy was the cause of death, this definition does not eliminate female deaths which may have occurred as a result of some underlying health concern or other cause. Therefore, using this vague definition may have led to a higher maternal mortality rate that was not representative of the true number of pregnancy-related deaths.

CHAPTER FIVE
CONCLUSIONS

This systematic review summarizes the prevalence of maternal mortality and compares pregnancy-related deaths among Black women versus White women. Many factors contribute to an increased rate among Black women, including marital status, lack of prenatal care, and increased chronic illness. Overall, results suggest these factors may stem, at least in part, from systemic racism and its consequences.

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APPENDIX

Figure 1: Exclusion process for determining eligible studies

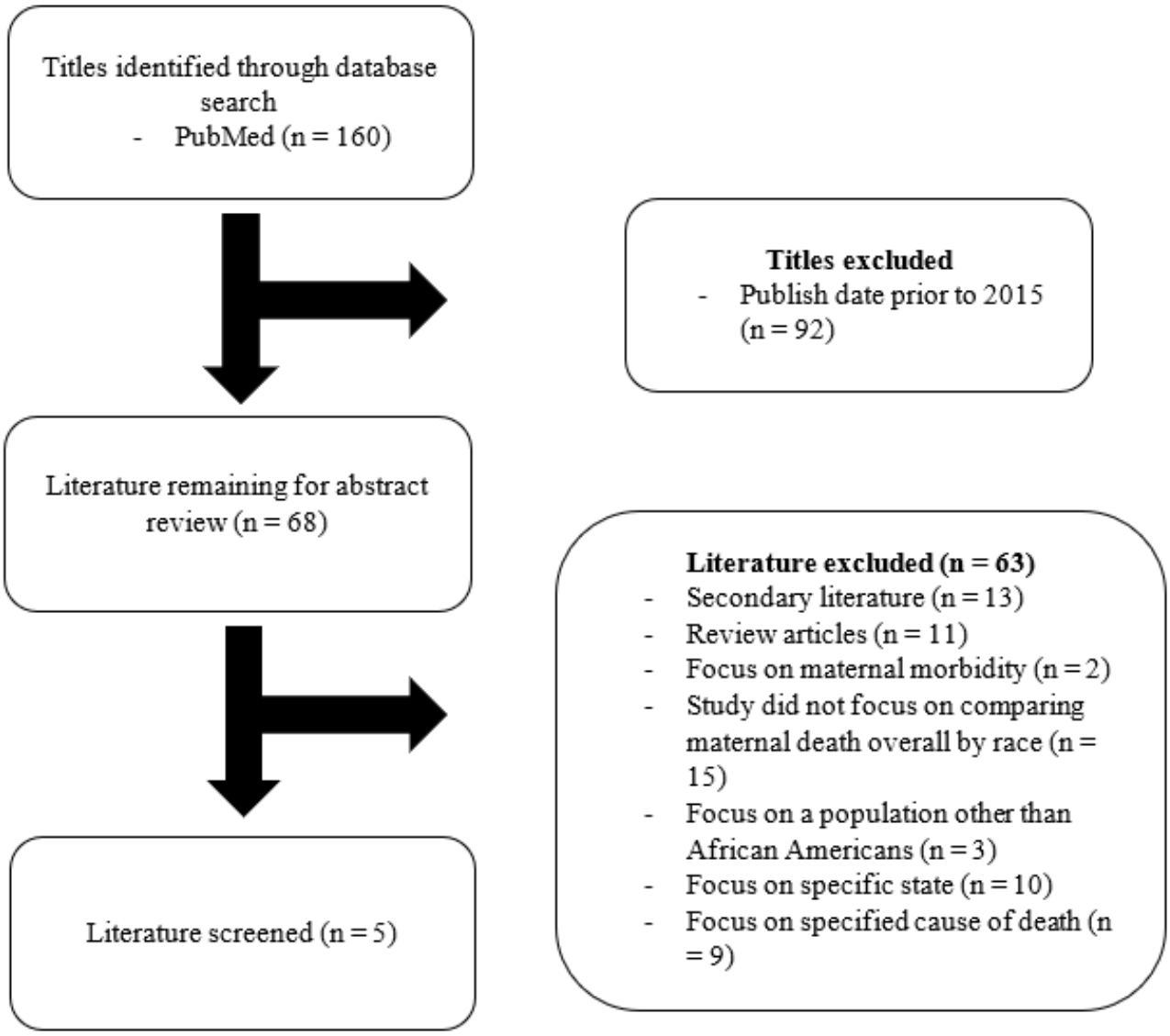


Table 1: Search outcomes including the most relevant statistics and risk factors

Title/Author/Year Published	Study Years/Sample Size	Methods	Definition of Maternal Death	Results (Estimates)	Results (Associated Risk Factors)	Conclusions
"Inpatient Maternal Mortality in the United States, 2002-2014", Mulubrhan F. Mogos, et al.	2002-2014, n=7,411	Cross-sectional analysis of the National Inpatient Sample (NIS) database, maternal race was self-reported	-	Average intrapartum (IP) MMR was 7 per 100,000, IP MMR for non-Hispanic Black women was 17 per 100,000, IP MMR for non-Hispanic White women was 5 per 100,000, 26.7% of IP maternal death was among non-Hispanic Black women, 30% of IP maternal death was among non-Hispanic White women, change in prevalence over time Average postpartum (PP) MMR was 226 per 100,000, PP MMR for non-Hispanic Black women was 379 per 100,000, PP MMR for non-Hispanic White women was 160 per 100,000, 31.7% of PP maternal death was among non-Hispanic Black women, 28.4% of PP maternal death was among non-Hispanic White women, change in prevalence over time	-	Black women are 3 times more likely to die in-hospital than White women.
"Pregnancy-Related Mortality in	2006-2010, n=3,358	Retrospective cohort study with data from	"the death of a woman during or within 1 year of	MMR was 16 per 100,000, 35.5% were among non-Hispanic Black women, 40% were among non-	Marital status and prolonged prenatal care	Non-Hispanic Black women are 3.2 times more likely to die from

the United States, 2006-2010", Andreea A. Creanga, et al.		the CDC's Pregnancy Mortality Surveillance System, maternal race was obtained from death certificate	pregnancy that was caused by a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy"	Hispanic White women, 38.9 per 100,000 were non-Hispanic Black women, 12 per 100,000 were non-Hispanic White women, no change in prevalence over time	contributed to this increase in MMR among Black women.	pregnancy than non-Hispanic White women.
"Pregnancy-Related Mortality in the United States, 2011-2013", Andreea A. Creanga, et al.	2011-2013, n=2,009	Observational cohort study with data from the CDC's Pregnancy Mortality Surveillance System, maternal race was obtained from death certificate	" "	MMR was 17 per 100,000, 37.9% were among non-Hispanic Black women, 40% were among non-Hispanic White women, 43.5 per 100,000 were non-Hispanic Black women, 12.7 per 100,000 were non-Hispanic White women, no change in prevalence over time	A significantly larger number of non-Hispanic White women were married than non-Hispanic Black women.	Non-Hispanic Black women have a 3.4 times higher risk of dying from pregnancy complications, about half of these women were foreign born. Future studies may aim to examine foreign born vs. U.S. born mothers to better understand this statistic.
"Health Care Disparity and	2005-2014, n=7,031	Ecological study from the National Vital Statistics	"a death occurring during pregnancy or	Correlation coefficient was 0.501 for the percentage of deliveries to non-Hispanic Black women	-	A higher MMR was observed among Black women than White women.

Pregnancy-Related Mortality in the United States, 2005-2014", Amirhossein Moaddab, et al.		System published by the CDC for all 50 states and DC, maternal race was obtained from the birth certificate	within 1 year of birth"			
"Population-level factors associated with maternal mortality in the United States, 1997-2012", Daniel B. Nelson, et al.	1995-2014, sample size included all maternal deaths between the above years	Ecological study of data from the National Vital Statistics System for all states and DC, maternal race was obtained from the birth certificate	"all women who died within 42 days of pregnancy termination in which the pregnancy contributed to the cause of death"	Regression Coefficient = +0.25, change increases in prevalence over time	-	Black mothers were positively associated with increased maternal mortality compared to White mothers.

Figure 2: Pregnancy-related mortality ratio by race [6]

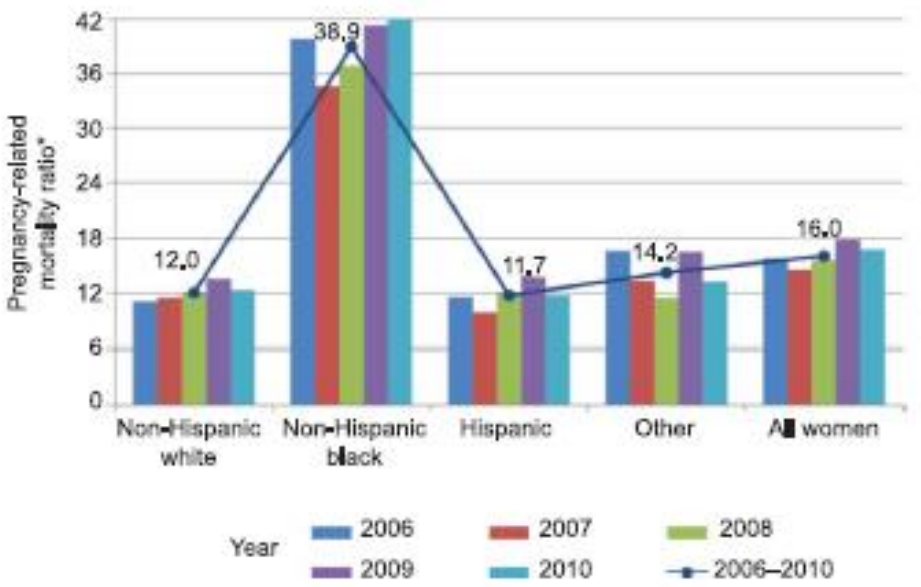


Figure 3: Pregnancy-related mortality ratio by race and age [5]

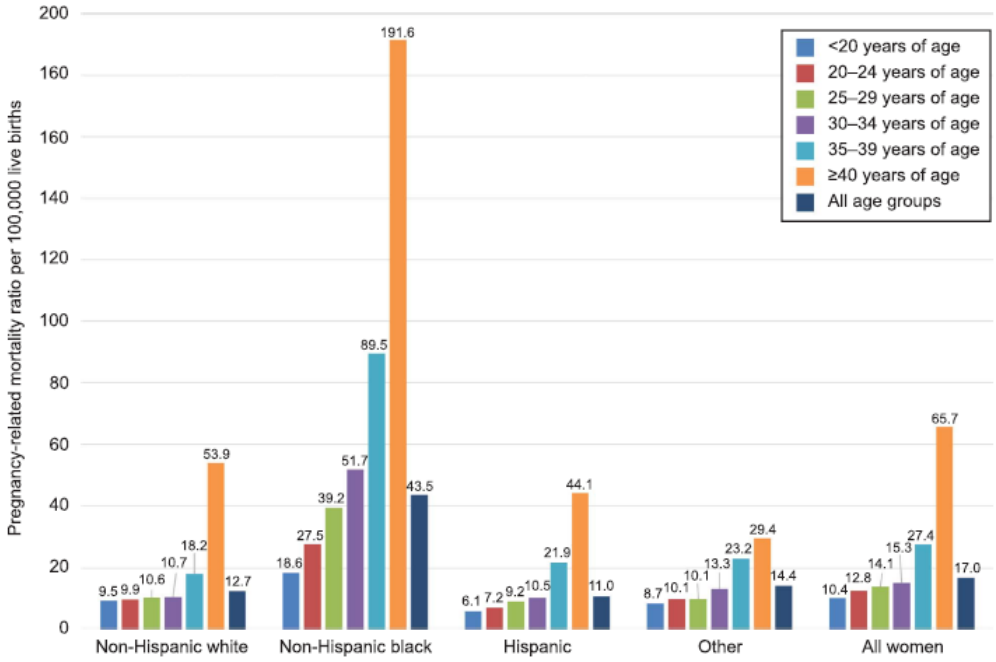


Figure 4: Correlation coefficients between state-specific maternal death and varying sociodemographics [7]

Characteristic	Simple Pearson's Correlation Coefficient	*P*
% deliveries to non-Hispanic black women	0.501	<.001
Unintended pregnancy	0.500	<.001
Unmarried mother	0.423	.002
Four or fewer prenatal visits	0.322	.020
Gestational diabetes	−0.319	.021
Cesarean delivery	0.288	.047
Chronic hypertension	0.069	.627
Pregnancy-induced hypertension	−0.123	.384
Eclampsia	0.003	.982
Diabetes	0.196	.163
Tobacco	−0.094	.510
Obesity	0.163	.249
Maternal education less than high school	0.210	.135
Deliveries paid by governmental insurance	0.282	.050
Women with health care coverage	−0.282	.076
Poverty	0.214	.128
% rural population	−0.069	.624
% deliveries to Hispanic women	−0.006	.964
% deliveries to non-Hispanic white women	−0.254	.069
% deliveries to Native American women	−0.016	.912
% deliveries to Asian women	−0.141	.318
% pregnancies with maternal age older than 45 y	−0.098	.490

Figure 5. Regression coefficients comparing state-level maternal death and varying health and demographic factors [8]

State-Level Variable	Regression Coefficient	95% CI	*P* value
Proportion of births to women with chronic hypertension	+ 3.82	[2.99–4.65]	<.001
Proportion of births to women over 40 years of age	+ 1.82	[0.90–2.74]	<.001
Proportion of births to women with diabetes	+ 1.24	[0.94–1.53]	<.001
Proportion of births to women with pregnancy-related hypertension	+ 0.98	[0.49–1.47]	<.001
Proportion of women of childbearing age with self-reported health status of "Fair" or "Poor"	+ 0.53	[0.37–0.69]	<.001
Proportion of women of childbearing age with BMI ≥ 30	+ 0.38	[0.30–0.45]	<.001
Proportion of births by cesarean delivery	+ 0.35	[0.27–0.42]	<.001
Proportion of women of childbearing age not having completed high school/GED	+ 0.31	[0.18–0.45]	<.001
Proportion of births to African American women	+ 0.25	[0.19–0.32]	<.001
Median household income, in thousands	+ 0.21	[0.15–0.28]	<.001
Proportion of births to Hispanic women	+ 0.17	[0.08–0.27]	<.001
Uninsurance rate among women of childbearing age	+ 0.14	[0.04–0.24]	.007
Proportion of births to women who attended fewer than 10 prenatal visits	+ 0.12	[0.05–0.19]	.001
Proportion of women of childbearing age reporting alcohol consumption in previous 30 days	+ 0.09	[0.02–0.16]	.01
Proportion of women of childbearing age who are current smokers	−0.18	[− 0.27 – − 0.08]	<.001

VITA

Alexandria J. Lamie was born on February 8, 1998. She wrote her senior capstone for the Chancellor's Honors Program on Racial Disparities in Maternal Mortality: A Systematic Review. She graduated in May of 2021 from the University of Tennessee – Knoxville with her BS in Biological Sciences – Microbiology with a minor in public health. She plans to take a gap year for personal development and service work before attending medical school.