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Social determinants of health on maternal mortality outcomes in the Southern United States

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Thesis

**SOCIAL DETERMINANTS OF HEALTH ON MATERNAL MORTALITY
OUTCOMES IN THE SOUTHERN UNITED STATES**

by

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ABSTRACT

The United States (US) spends the most money on healthcare but has one of the highest maternal mortality rates out of all high-income countries. Maternal mortality rate is an indicator of the overall health of a society and social determinants of health play a major part in determining the health of an individual by examining the environment and conditions that they grow up in. Studies have been done in the US that examine the overall relation of social determinants of health (SDOH) to maternal mortality. However, no review focuses specifically on the Southern states and social determinants of maternal mortality. A rapid evidence assessment was done that collated articles found in PubMed regarding social determinants on maternal mortality in the U.S. South. The major findings were that the social determinants of race, insurance type, and income had the most statistically significant associations with maternal mortality rates. Additionally, only five states out of 16 southern states (Alabama, Georgia, Louisiana, North Carolina, and Florida) had articles on SDOH on maternal mortality. These findings identify large gaps in research for the other states that did not have any literature and provide a call to action for an in-depth look into the effects race, insurance, and income have on maternal mortality in the US South.

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LIST OF ABBREVIATIONS

ADI Area Deprivation Index

CDCCenters for Disease Control and Prevention

ICE Index of Concentration at the Extremes

LDULabor Delivery Unit

MMR..... Maternal Mortality Rate

MUAP.....Medically Underserved Area/Population

NHB non-Hispanic Black

NHW..... non-Hispanic White

PCSA..... Primary Care Service Area

PMSSPregnancy Mortality Surveillance System

REA..... Rapid Evidence Assessment

SDOH.....Social Determinants of Health

SMM.....Severe Maternal Morbidity

US United States

INTRODUCTION

Maternal Mortality

Maternal mortality is the death of a woman due to pregnancy or related factors and has been recognized as a public health issue in the United States of America (US) for the past 30 years (Gingrey 2023). The death of mothers due to pregnancy or related factors has long been recognized as an indicator of the how healthy the people of a country are. However, the US as a high-income country has one of the highest maternal mortality rates (MMR) compared to other high-income countries. The US ranks 55th out of all countries in terms of MMR, and out of the high-income countries ranks the lowest.(Crear-Perry et al., 2021) The average US maternal mortality rate was 23.5 deaths per 100,000 live births from 2018 to 2021. However, if one looks at the US southern states, they have higher rates of maternal mortality compared to the rest of the US. For example, Arkansas has the highest maternal mortality out of all the states at 43.5 deaths per 100,000 live births; the other Southern MMRs are listed in Table 5.

Many factors should be considered when examining the unique role MMR takes in the U.S. For example, the demographics of each US region differ vastly, Table 1 shows that the South, West, Midwest, and Northeast have a varied percentage of Black residents as explained by the PEW Research Organization which utilized data from the US Census Bureau's data to tabulate percentages. The US South is home to 56% of the US Black population and research on demographical data on maternal mortality in the US has repeatedly found that non-Hispanic Black women have birth-related deaths at higher rates than non-Hispanic white women (Collier & Molina, 2019). Thus, making the US

South an important region to conduct research on the interplay of maternal mortality with race alongside other social determinants of health (SDOH).

Region of the US	Percentage of Black Population Present
South	56%
Midwest	17%
West	10%
Northeast	17%

Table 1: Percentage of Black population in each region of the US

Social Determinants of Health

When looking at factors that may cause maternal mortality, social determinants of health are important to analyze and investigate in order to find the root cause of maternal deaths. SDOH are the conditions present that affect a person's environment as they are born, live, learn, work, and play which then will affect the health, functioning, and well-being of that person as they move through life (Hahn, 2021). The SDOH can be categorized into five categories, economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context which make up the SDOH framework (Lines et al., 2022)(Figure 1). A few of the individual SDOH are housing, racism, education, insurance, income, resource access, and transportation. These social components of one's life inevitably affect the health of the individual when they are lacking, missing, or in shortage. For example, a lack of health insurance could prevent an individual from going to the doctor for health concerns due to cost; however, due to fewer visits for minor

health issues, major health problems in the future may arise in the future because that individual could not afford preventative care.



Figure 1: SDOH Framework

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Social determinants of health are key drivers of health inequities and health outcomes. Analyzing social determinants of health and understanding the effect that they have on the everyday health of an individual is imperative to understanding the non-medical factors that affect maternal mortality (National Academies of Sciences et al., 2021) . Current literature in the field for the US identifies SDOH such as race, racism, transport, insurance, and income influencing maternal mortality rates. A study by Collier and associates (2019) analyzed the racial inequities prevalent in MMRs and found that non-Hispanic Black women’s mortality rates are reaching nearly 3 or 4 times higher than non-Hispanic white rates. The US Southern region should be considered separately not only due to the states alarmingly high MMR in comparison to the US MMR but also because 56% of the US Black population resides in the South (US Census). In addition, the available systematic literature reviews or assessments look at maternal mortality in the frame of social determinants of health for the US; however, no reviews are available strictly for the Southern US region where such a large percentage of the Black population receive maternal health care. As the scientific community searches for the answer as to why racial disparities occur in the US maternal mortality rates, SDOH affecting health inequity in the US South needs to be analyzed separately and with great care due to the at-risk population. This rapid evidence assessment will help identify existing SDOH literature pertaining to maternal mortality in the US Southern states to collate pieces into one consolidated article and identify potential gaps in the literature of this region.

The History of Maternal Mortality Rates in the US

Maternal mortality has been claimed to be rising drastically over the past 10 years; however, the idea remains that the drastic nearly doubled rate from 2018 to 2021 (17.4 to 32.9 deaths per 100,000 live births) is really due to maternal maternity surveillance changes or maternal medical conditions (Joseph et al., 2024).

The methods for collecting mortality data in the US to calculate maternal mortality rates before 2003 were highly variable state by state and not well documented; however, in 2003 the Centers for Disease Control and Prevention (CDC) gave the recommendation to all US states to add a death certificate checkbox. This checkbox would explicitly document maternal mortality in the cause of death records, improving the identification of maternal deaths. A maternal death would be logged by a physician on the death certificate if the death was within a certain time frame of live birth or pregnancy and fits the criterion for the cause of death. Unfortunately, data registration systems are individually state controlled so the enforcement of the CDC maternal mortality checkbox system in all states was not completed until 2017.

From 2018 to 2021, the National Center for Health Statistics conducted a large data collection on state maternal mortality rate since all the US states were now using a somewhat standardized method of data collection. The primary result of this data collection was that the MMR did not steadily increase over a period of 18 years (2003 to 2021) but rather that the MMR had not been properly calculated previously due to inconsistent data collection methods. In addition to the death certificate checkbox addition several states have set up maternal mortality surveillance systems/review

committees that mirror or expand on the CDCs Pregnancy Mortality Surveillance System (PMSS); however, as of 2017 only 24 out of 50 states had existing laws or pending legislation that required maternal mortality reporting (Adesomo et al., 2017). This anomaly does not explain why the US Southern States have substantially higher maternal mortality rates in the average MMR data from 2018 to 2021, or why the black and white maternal mortality rates have such a large gap.

SPECIFIC AIMS AND OBJECTIVES

In this rapid evidence assessment, the aim is to analyze literature about maternal mortality from the US South that identifies social determinants of health as a factor of maternal mortality. The goal is to identify and summarize the articles specific to this topic from the computerized bibliographic database PubMed (NIH). In this review, the objectives will involve the selection and inclusion of studies that discuss maternal mortality and explicitly refer to social determinants of health in the states of Alabama, Arkansas, Delaware, the District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia, and West Virginia which are counted as the ‘South’ of the United States (Bureau, n.d.).

The objective will also be to identify the breadth of literature that comes from these states to see what literature exists and to find gaps that need to be filled. The interest also lies in finding states that may have minimal or no articles. This search is being done specifically to see what exists in the South which has 56% of the black population who are at high risk of maternal mortality.

METHODS

Search Strategy

A rapid evidence review was done to evaluate the framework of social determinants of health (SDOH) within maternal mortality literature present geographically within the southern states of the United States, i.e., “The South.” Only the computer bibliographic database PubMed was utilized to find literature related to this topic.

The review consisted of one primary search of peer-reviewed literature published from January 2003 to December 2024 with the terms in Table 2 while utilizing Medical Subject Headings (MeSH) and text word search terms. The search was conducted January 2024 by the author. The search included terms that pertained to maternal mortality, the southern states of the US, and social determinants of health as classified by the CDC, such as racism, racial violence, education, unemployment, housing instability, transportation or insurance factors that could influence care. Then, an additional hand search was conducted to cover articles that may have been excluded in the primary search - these search terms are included in Table 2.

Search Terms in PubMed
<p>Main Search Term</p> <p>((("Maternal Mortality"[Mesh]) OR ("maternal mortality") OR ("maternal death")) AND ((("Alabama"[Mesh]) OR ("Arkansas"[Mesh]) OR ("Delaware"[Mesh]) OR ("District of Columbia"[Mesh]) OR ("Florida"[Mesh]) OR ("Georgia"[Mesh]) OR ("Kentucky"[Mesh]) OR ("Louisiana"[Mesh]) OR ("Maryland"[Mesh]) OR ("Mississippi"[Mesh]) OR ("North Carolina"[Mesh]) OR ("Oklahoma"[Mesh]) OR ("South Carolina"[Mesh]) OR ("Tennessee"[Mesh]) OR ("Texas"[Mesh]) OR ("Virginia"[Mesh]) OR ("West Virginia"[Mesh]) OR ("Alabama") OR ("Arkansas") OR ("Delaware") OR ("District of Columbia") OR ("Florida") OR ("Georgia") OR ("Kentucky") OR ("Louisiana") OR ("Maryland") OR ("Mississippi") OR ("North Carolina") OR ("Oklahoma") OR ("South Carolina") OR ("Tennessee") OR ("Texas") OR ("Virginia") OR ("West Virginia") OR ("The South") OR ("Southern United States") OR ("Southeastern United States") OR ("United States South"))) AND ((("Social Determinants of Health"[Mesh]) OR (social determinant*) OR (structural determinant*) OR ("Racism"[Mesh]) OR ("racism") OR ("Systemic Racism"[Mesh]) OR ("Violence"[Mesh]) OR ("violence") OR ("Education"[Mesh]) OR ("education") OR ("Unemployment"[Mesh]) OR ("Socioeconomic Factors"[Mesh]) OR ("socioeconomic factors") OR ("Health Inequities"[Mesh]) OR ("health disparities") OR ("health inequities") OR ("Housing Instability"[Mesh]) OR ("housing") OR ("Transportation of Patients"[Mesh]) OR ("transportation") OR ("Medically Uninsured"[Mesh]) OR ("insurance"))))</p>
<p>Hand Search Terms</p> <p>((("Maternal Mortality"[Mesh]) AND (((("Alabama"[Mesh]) OR ("Arkansas"[Mesh]) OR ("Delaware"[Mesh]) OR ("District of Columbia"[Mesh]) OR ("Florida"[Mesh]) OR ("Georgia"[Mesh]) OR ("Kentucky"[Mesh]) OR ("Louisiana"[Mesh]) OR ("Maryland"[Mesh]) OR ("Mississippi"[Mesh]) OR ("North Carolina"[Mesh]) OR ("Oklahoma"[Mesh]) OR ("South Carolina"[Mesh]) OR ("Tennessee"[Mesh]) OR ("Texas"[Mesh]) OR ("Virginia"[Mesh]) OR ("West Virginia"[Mesh]))))</p> <p>((("Maternal Mortality"[Mesh]) OR Maternal Mortality[Text Word]) AND ("Social Determinants of Health"[Mesh] OR Social determinants of health[Text Word]) AND ("Alabama"[Mesh] OR Alabama[Text Word]))*</p>
<p><i>*Each state was searched i.e.. In place of Alabama each of the other states one by one were put in and searched</i></p>

Table 2: PubMed Search Terms

Inclusion and Exclusion Criteria

The overarching criteria for inclusion were: (1) targeted maternal mortality as a primary or secondary outcome, (2) conducted analyses of data from the southern states of the US, and (3) targeted one of the SDOH as an exposure. For inclusion in the final set of articles, three analysis phases were done - a title analysis phase, an abstract analysis phase, and a full-text analysis phase. For each phase, the criteria were consistent to ensure that the literature was selected properly.

However, in the case that the author was unsure if the article met the criteria, she erred on the side of being more inclusive to create a broader sample of literature. In addition to the broad search, a separate hand search was conducted, which, once the title, abstract and full-text analysis phases were completed with duplicates removed, yielded additional articles. Figure 2 shows the PRISMA Flow Diagram for Study Search and Selection of the search described.

The initial search with the search terms in Table 2 was conducted with a (1) publication year criteria of 2003 to 2024, (2) in the English language, and (3) peer-reviewed journal articles including primary data.

For exclusion criteria, articles that mentioned (1) intimate partner violence, (2) homicide, (3) suicide or (4) drug overdose only were excluded from the search so that the focus remained on social determinants of health and pregnancy-related death rather than pregnancy-associated death or other causes of death (Collier & Molina, 2019). The articles that were noted by the publisher to be withdrawn were also excluded. If the article (5) included data from southern states but was not disaggregated from non-southern states, the article was excluded.

For the title analysis phase, the main themes to screen for were (1) maternal mortality, (2) social determinants of health, and (3) the southern states of the US. After the title exclusion was done, then the remaining articles continued to the abstract analysis phase.

In the abstract analysis phase, articles that mentioned maternal morbidity and maternal mortality were included to ensure that no articles were mistakenly excluded from the next analysis phase. Any articles that were ambiguous about mentioning SDOH were also included so that the full-text review could make the final decision as to whether they were relevant to overarching criteria. After the abstract analysis, the articles went on to the full-text analysis phase.

For the article to be included in the final data set all three main inclusion criteria had to be explicitly mentioned within the article.

Data Extraction

Once articles were selected for the final set, each was reviewed by the author, and information was extracted from each piece. The main data extracted from the papers were (1) geographic location, (2) research and data collection method, (3) maternal mortality definitions, (4) SDOH type, (5) results such as odds ratios or coded themes, and (6) conclusions. Due to the rapid evidence assessment methodology that was conducted, no quality assessment was completed. The extracted information is presented in Table 4.

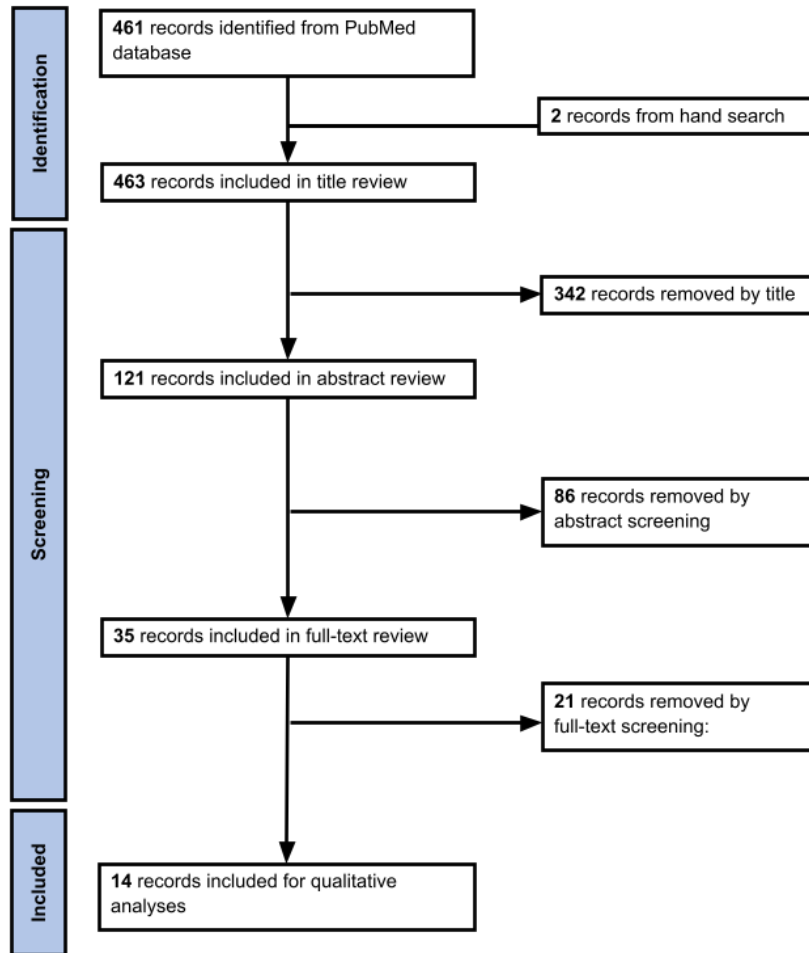


Figure 2: PRISMA Flow Diagram of Rapid Evidence Assessment

RESULTS

Search Yield

The search yielded a total of 463 articles. Of these, 342 articles were removed due to not fitting inclusion criteria in the title screening, and 121 records remained. Once abstracts were screened, 35 records were included in the full-text review. Once the full-text review was done, 14 articles remained to be included in the final data extraction and qualitative analyses.

From this search, only five out of 16 states in the South had empirical maternal mortality literature tied back to social determinants of health outcome: Alabama, Georgia, Louisiana, North Carolina, and Florida. The 11 states without articles from this search are Arkansas, Delaware, District of Columbia, Kentucky, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Of those 16 articles, 12 articles examined race, eight articles mentioned income/SES, four mentioned transport, five mentioned insurance, two mentioned resource insecurity, three mentioned education, two mentioned neighborhood type, and two mentioned cultural competencies. Specific article details are laid out in the extraction table (Table 4). The table includes state association, methods, rural or urban study, SDOH mentioned, and research outcomes for each article. Table 3 shows which articles focused on specific SDOH.

States

Alabama

Interestingly, Alabama had four articles that tied social determinants of health to maternal mortality. All the articles discussed racial disparities and insurance. The studies by Frolich and colleagues (2014) as well as Tipre and colleagues (2022) were quantitative retrospective electronic health record (EHR) studies, while the studies by Richardson and colleagues (2023) and Toluhi and colleagues (2023) were qualitative interviews with stakeholders in the maternal health field. Three of the four articles (75%) stated that maternal mortality is related to racial disparity in comparison to non-Hispanic white women. Each found a strong increased odds association between non-Hispanic Black women and maternal mortality (Tipre et al., 2022) or highlighted racial bias as one of the driving factors for maternal mortality in the qualitative studies (Richardson et al., 2023; Toluhi et al., 2023). The retrospective EHR study by Frolich and colleagues (2014) was the only study of the four that found an adjusted odds ratio of 1.46, increased for Black women in comparison to white women but was counted as nonsignificant ($p>0.05$) most likely due to their small sample size of $n=231$.

In terms of insurance as an SDOH, Frolich and colleagues (2014) did not see insurance as a factor in maternal mortality, while the other Alabama articles found increased odds for maternal mortality for patients who held Medicaid insurance or no insurance compared to private health insurance holders (Tipre et al., 2022) or a lack of care due to a limit to health care coverage qualitatively (Richardson et al., 2023). Overall,

the articles within Alabama were all conducted in an urban setting and had no rural-based studies.

Georgia

Georgia had three articles that examined the relationship between maternal mortality and social determinants of health. Every article noted racial disparities and insurance/policy as social determinants of health affecting maternal mortality. Two out of the three articles (67%) used mixed-method approaches, and one (33%) was an ecological study. Two of the articles focused on maternal mortality in rural settings, while one other study focused on maternal mortality in an urban setting.

Overall, the trend of these articles identified that Black women had higher maternal mortality rates than white women (Armstrong et al., 2021), that rural women had almost two times less access to an OB-GYN compared to the average Georgia resident (Armstrong., 2021) and through qualitative methods culturally appropriate care is lacking within Georgia urban delivery units (Sayyad et al., 2023). The authors of these articles suggested the following changes: increase rural hospital funding and increase provider incentives while also broadening Medicaid programs (Daymude et al., 2022), changing policy so that it facilitates doula care for marginalized communities (Sayyad et al., 2023) and increasing cultural competency training to address implicit bias and racism (Armstrong-Mensah et al., 2021).

Louisiana

Louisiana had the most articles in the dataset with five relating social determinants of health to maternal mortality. Four of five articles examined racial disparities as one of the SDOH affecting maternal mortality. Out of the five articles, one referred to urban neighborhoods while one pertained to mixed urban and rural neighborhoods, the other three did not have data on the specific neighborhoods they were pulling from or did not apply to the topic that they were analyzing. All the studies were retrospective studies and extracted data from either the Louisiana Department of Health, the Louisiana Pregnancy-Associated Mortality Review, or from a specific hospital database.

The main takeaways presented by the studies in this state were changing policy and programs so that they invest in non-white communities (Dyer et al., 2022), to increase research that understands why racial inequity in maternal mortality is beyond just health care access and also needs to address structural racism (Wallace et al., 2021), have insurance cover prenatal care and prevention of high-risk surgeries (Morong et al., 2017), conduct broader maternal mortality reviews that incorporate SDOH (Mehta et al., 2020) and make sure to do data linkage to have correct data of maternal mortality and how deaths are happening (Tran et al., 2011).

North Carolina

There was one paper from North Carolina that came from the rapid evidence assessment by Harper and associates (2004). The article focused on race, education, and SES through the lens of a retrospective observational study that utilized North Carolina's

Pregnancy-related Mortality Surveillance to find pregnancy-associated deaths from 1992 to 1998. The primary outcome from this study showed that African American women had a higher odds ratio vs white woman for maternal mortality (OR 3.07).

When comparing the estimated income for African American women vs white women, there was an increased odds (OR = 2.93) of maternal mortality. In addition, these women were dying at nearly four times the rate due to hemorrhage compared to white deaths (Harper, 2004). The suggested action by this article was to have epidemiological research done on racial health disparities specifically looking at how socioeconomic disadvantage is affecting maternal mortality rates in African Americans.

Florida

For Florida, one paper was found in the search and focused on racial disparities for its SDOH by Bernet and colleagues (2020). The primary results of this study showed that the Black maternal mortality rate average from 2001 to 2014 was 40.7 out of 100,000 live births, while for white mothers the average maternal mortality rate was 15.736 out of 100,000 live births. From their statistical models, they deduced that a 10% increase in pregnancy-related spending could potentially reduce the Black-white maternal mortality gap by nearly 20%. Their suggested course of action involved increasing spending not just broadly on public health but specifically on pregnancy-related objectives to decrease the maternal mortality rates in Florida per their statistical models (Bernet et al., 2020).

Social Determinants of Health

Race/Racism/Racial Disparities

Out of 14 articles, 12 articles highlighted race or racial disparities as a social determinant of health that was of concern regarding maternal mortality. This SDOH was mentioned the most often among articles. Table 3 outlines the articles associated with each SDOH. For example, Tipre and colleagues (2022) from Alabama said that there was a strong increased odds association between non-Hispanic Black women and SMM/MM while Daymude and colleagues (2022) from Georgia highlighted that a majority of labor delivery units that closed in their rural area had 34% increased odds of serving black women. Wallace and colleagues (2020) from Louisiana looked at maternal care deserts and stated that regardless of individual-level factors, black women died at a 2.2-time rate than white women in maternal mortality.

Another result from these studies highlighted those Black women faced racism or bias when receiving care. Toluhi and associates (2023) in Alabama conducted a qualitative interview study and spoke to stakeholders in the maternal health field such as physicians and doulas who were aware of healthcare professional biases being a health risk to Black patients. This was due to not only explicit and implicit racial bias but also to a lack of communication, cultural sensitivity, and patient-provider relationships.

Armstrong and colleagues (2021) in Georgia conducted another qualitative study that found African American women were being ignored by providers and receiving low-quality care from their clinics due to racial bias. One study conducted by Frolich and colleagues (2014) when comparing African American women and white women stated that the unadjusted odds ratio of maternal death was 0.66 and that the proportion of

African American women in the case (maternal death group) vs the control signified insufficient evidence to suggest racial disparity with a $p=0.23$.

Across the studies, eight articles found strong associations or increased odds for non-Hispanic black women to be at risk for maternal mortality compared to white women. One study did not find any significance between race and maternal mortality while three studies either did not mention the significance between maternal mortality and income or mentioned it in a qualitative frame.

SDOH	ARTICLES	
Race/Racism	Harper et al., 2022 Bernet et al., 2020 Wallace et al., 2020 Mehta et al., 2020 Armstrong et al., 2021 Dyer et al., 2020	Tran et al., 2010 Frolich et al., 2014 Tipre et al., 2022 Richardson et al., 2023 Toluhi et al., 2023 Sayyad et al., 2023
Income/Salary/SES	Frolich et al., 2014 Tipre et al., 2022 Richardson et al., 2023 Daymude et al., 2022	Armstrong., 2021 Dyer et al., 2020 Wallace et al., 2020 Harper et al., 2004
Transport	Frolich et al., 2014 Daymude et al., 2022	Armstrong et al., 2021 Wallace et al., 2020
Insurance	Frolich et al., 2014 Tipre et al., 2022 Richardson et al., 2023	Daymude et al., 2022 Morong et al., 2017
Resource Insecurity	Richardson et al., 2023	Dyer et al., 2020
Education	Dyer et al., 2020 Wallace et al., 2020	Harper et al., 2004 Armstrong et al., 2021
Neighborhood Type	Dyer et al., 2020 Wallace et al., 2020	Tipre et al., 2022
Cultural Competence	Toluhi et al., 2023 Sayyad et al., 2023	Armstrong et al., 2021

Table 3: Social Determinants of Health paired with Articles

Income/Salary/Socioeconomic Status

For socioeconomic status, eight out of 14 articles mentioned it as having a hand in affecting maternal mortality in their area. This SDOH was the second highest mentioned within the articles. For example, Tiple and colleagues (2022) conducted a retrospective cohort study that said residency in the highest deprived neighborhoods led to increased odds for SMM/MM (this study utilized a combined term for both maternal mortality and severe maternal morbidity) and residences in a medically underserved area/population (MUAP) led to a strong statistical association with SMM/MM. For Harper and colleagues (2004) when comparing the incomes of African American women and white women as a predictor in their stepwise logistic regression, there was a 2.93 increased odds ratio for estimated income, meaning African American women who had lower incomes were at an increased risk of experiencing maternal mortality.

On the other hand, Daymude and colleagues (2022) from Georgia analyzed the amount of labor delivery units (LDUs) that closed within rural areas and found that household income was not tied to the closure of those units in fact, other factors to be discussed were more indicative of why LDUs closed. Frolich and colleagues (2014) also found that income had no significant effect on maternal mortality per their logistic regression model. Across the studies three articles found a strong association or increased odds for income's effect on maternal mortality, two studies did not find any significant association between income and maternal mortality while three studies either did not mention the significance between maternal mortality and income or examined the relationship qualitatively.

Insurance

When looking at insurance's relation to maternal mortality seven articles out of 14 mention insurance as having a role in effecting maternal mortality. As the third highest SDOH in article count, insurance gave results that were mixed in response similar to income and race.

Looking at Tiple and colleagues' (2022) article, the labor delivery units that closed in rural areas had a lower proportion of patients with private insurance than the ones that remained open. In the article, the qualitative aspect of the study analyzed news articles from rural areas and identified that closures came about due to low payments from Medicaid reimbursement leading to the shutting down of rural hospitals. Morong and colleagues (2016) conducted a retrospective study within their hospital group analyzing maternal deaths that occurred and could be identified as preventable or unpreventable. In this article, the insurance status of only eight deaths could be tracked. Out of eight, six had Medicaid while two were uninsured. The authors indicated that those who had private insurance had a significant association ($p=0.003$) with the preventability of maternal mortality.

On the other hand, Frolich and colleagues (2014) found that for insurance, in their secondary logistic regression model case-control analysis for African Americans and Caucasians there was no significant association of mortality with insurance ($p>0.18$). Across all the articles that mentioned insurance, three mentioned insurance and said that there was a significant statistical relation with maternal mortality, one article said that

there was no statistical significance relating insurance to maternal mortality and three could not be quantified in this way due to being qualitative interview studies.

Education

Education was mentioned in four articles out of 14 and primarily focused on the level of educational attainment rather than the accessibility to education. Dyer and colleagues (2022) focused on the percentage of women who died of maternal death from 2016 to 2017 and found that 34.82% of maternal deaths occurred in women with only a high school education. For women who had less than a high school education, some college/associate or bachelor/higher they had percentages of 26.79%, 27.68%, and 10.71% of maternal deaths respectively.

Overall, the significance value for education as a factor of maternal mortality was $p=0.0007$. For Wallace and colleagues (2021) among 112 verified cases of death, those with less than a high school education had a high pregnancy-associated mortality ratio; although they mentioned that wide confidence intervals and ratio estimates indicated a small number of deaths in the stratification. Out of the four articles, three articles highlighted high school education with the largest percentage of maternal mortality occurring, while one article highlighted less than high school as having the highest mortality ratio.

Resource Insecurity

Two out of the 14 articles specifically mentioned resource insecurity with maternal mortality. One was a qualitative interview study, and the other was a quantitative study. For the quantitative study, Dyer and colleagues (2022) found that in their ICE (Index of Concentration at the Extremes) statistics, the mothers who lived in areas with concentrated deprivation and less resources (lowest tertile), were at a 2.68 higher mortality risk when compared to mothers who lived in areas that had less deprivation and more resources (higher ICE tertiles). The qualitative study by Richardson and colleagues (2023) said that participants/stakeholders in the field discussed how resource insecurity impacts communities such as predominantly black neighborhoods disproportionately.

Neighborhood Type

As for neighborhood type three out of the 14 articles mentioned that the type of neighborhood mothers lived in affected maternal mortality. Tipre and colleagues (2022) found that the most deprived neighborhoods in an urban setting had increased odds for SMM/MM. Wallace and colleagues (2020) found that mothers living in maternity care deserts in urban areas increased the risk of death during pregnancy and one year after pregnancy by 91% (associated risk ratio=1.91). Finally, Dyer and colleagues (2022) identified that compared to mothers who lived in privileged areas, those who lived in areas of deprivation had a 2.68 increased risk of maternal mortality. All the articles that

mentioned neighborhood type indicated that where mothers lived increased the risk of maternal mortality.

Cultural Competence

As for cultural competency, three out of the 14 articles mentioned cultural competency in relation to maternal mortality. Toluhi and colleagues (2023) conducted qualitative interviews and one of the major themes was that the addition of cultural competence training for maternal health professionals would improve racial bias and respectful care for mothers. Sayyad and colleagues (2023) conducted a cross-sectional mixed methods study with surveys and interviews of doulas who cared for mothers and found that cultural training for doulas in the community would assist in caring for mothers of color. Finally, Armstrong and colleagues (2021) with an ecological study noted that cultural training could reduce racial bias and prevent low-quality care and ignorance of culture that may occur. Each study noted that cultural training in the field would aid in mitigating the factors of maternal mortality.

Extraction Table

Author, Year	State(s) and Urban (U), Rural (R) or Mixed (M) area	Research Design	Methods	Sample Size	Maternal mortality definition utilized	SDOH mentioned	Research Outcomes
Frolich et al., 2014	Alabama U	Case-control Study	Retrospective EHR Review from University of Alabama Hospital from 1990 to 2010. The search was done to identify maternal deaths and then match them with two other women who delivered at a time closest to maternal death who were of similar age \pm 3 years. Then statistical analyses were run to compare controls vs cases.	n = 77 maternal deaths n = 154 control mothers	All females with discharge status expired or autopsied in the electronic uniform billing database	Race, Salary, Transportation/distance, Insurance type	<p>Results: This study states that there was insufficient evidence to suggest racial disparity affects maternal mortality. The study looked at insurance status, income, race, and transportation social determinants of health. For African American women 57% were in the maternal death group while 61% were in the control group. The estimated unadjusted odds ratio for African American to Caucasians was 0.66, then for the secondary analyses, there was no significance of mortality in relation to insurance, income, BMI, marital status, or parity. There was a significant difference in transportation to the hospital, lack of prenatal care, gestational age, fetal survival, duration of hospital stay, lack of prenatal care, and cesarean delivery rate ($P < 0.042$). For distance, African American women lived statistically significantly closer to the hospital compared to Caucasian women. This was in the unadjusted model, however, once the calculations were adjusted for distance, the point estimate and CI of the odds ratio for maternal death for African American to Caucasian race changed from 0.66 to 1.46.</p> <p>Discussion: The odds ratio unadjusted suggested lower odds of death for African American women however when adjusted for transportation increased to 1.46. The direction of the point estimate changed to suggest higher odds of death for African American women even though the odds ratio was not statistically significant.</p> <p>Takeaway/Suggested Action: Since the data did not support the hypothesis a women's access to care may be more indicative of maternal mortality than disparities. Health care delivery outside of tertiary care hospital settings needs to be addressed and eliminating access barriers to health care for all women.</p>
Tipre et al., 2022	Alabama U	Retrospective cohort study	Retrospective EHR Review, from the University of Alabama Birmingham from January 1, 2010, to December 31, 2020,	n = 32,909 live-birth deliveries	PMSS Definition: Death during pregnancy or up to 1 year postpartum	Racial Disparities, Race, Insurance, Socioeconomic Status, Urban Health	<p>Results: For this study 26 out of 32,909 deliveries resulted in maternal mortality. The study also analyzed individual and neighborhood-level factors. 61% of the deliveries were women who lived in medically underserved areas or were part of a medically underserved population. Increased ADI was associated with increased odds of SMM/MM, the women who lived in the most deprived neighborhoods according to ADI had</p>

Table 4: Article Extraction Table

			to identify severe maternal morbidity and maternal mortality cases. Associated individual and neighborhood-level factors were also pulled. Severe maternal morbidity and maternal mortality were grouped into one odds value.	n=26 maternal deaths			<p>an increased odds of SMM/MM in unadjusted and adjusted analyses (adjusted for spatial autocorrelations). SMM/MM odds were close to two times higher for NHB women compared to NHW. The odds for SMM/MM for women with government insurance were 37% higher than those with private insurance. The odds of SMM/MM were slightly higher for women living in MUAP and no difference was found between women living in metro areas vs non-metro areas.</p> <p>Discussion: The hypothesis supported that women who live in the highest deprivation neighborhoods were associated with increased odds of SMM/MM. There was also a strong association between NHB race, government insurance, residence in MUAP and, SMM/MM composite. The hospital primarily served an urban population. This cohort's MMR was 72.9 per 100,000 live births which is 3 times higher than the US national average of 23.8 deaths per 100,000 live births and twice as high as Alabama's state average. The higher rates at this hospital were likely due to the classification of the hospital as being a tertiary hospital.</p> <p>Takeaway/Suggested Action: Neighborhood deprivation may be independently associated with maternal morbidity, ADI could be utilized to screen and treat high-risk patients, and underlying factors of neighborhood deprivation need to be analyzed for further research. The study also proposed standardization of SDOH definitions for individual and area-level factors that may contribute to maternal mortality.</p>
Richards on et al., 2023	Alabama U	Qualitative Interviews	Qualitative in-depth interviews with stakeholders in the maternal health field ranging from doulas and public health officials to physicians who were asked open ended questions about disparities in severe maternal morbidity and mortality	n=20 Stakeholders interviewed	N/A	Racial disparities, Policy/Insurance, Socioeconomic status, Resource Insecurity(transportation, nutrition, housing)	<p>Results: This qualitative study identified themes that maternal health stakeholders identified as being associated with maternal mortality. The themes that arose were racism, unjust laws and policies, poverty and, lack of community infrastructure. Systemic racism was identified as one of the main factors behind racial disparities in maternal health by stakeholders with laws and policy contributing to the racial disparities that mothers faced. Components that affect health such as health insurance and paid parental leave are affected by policy and impact women when they are pregnant. Depending on what health insurance a mother has there may be a lack of insurance coverage postpartum, restrictions on choice of provider or facility, lack of coverage for alternative services, lack of insurance for undocumented people and disturbance to providers that would accept the insurance. Additionally inflexible abortion laws lead to pregnancies that are undesired and chemical endangerment laws criminalize pregnant people and could potentially prosecute</p>

							<p>them with substance use disorder. Once incarcerated no rehabilitation or assisted therapy would be provided. The article also mentioned that poverty and resource insecurity disproportionately affects specific communities in Alabama leading to a difficulty for pregnant women to comply with provider recommendations and resulting in a delay of care. Additionally food deserts and lack of transportation impact maternal health. All of these themes arose when asked about maternal health and maternal mortality.</p> <p>Discussion: All stakeholders made a point to mention the need for approaches that were evidence-based and modeled after other states. Participants identified that systemic racism drives inequities in maternal health in Alabama. A supporting point was made by a stakeholder that even black families with high socioeconomic status experienced inequities in SMM. Many states in the U.S. South did not expand Medicaid which would give dental coverage for pregnant individuals as well as postpartum coverage for up to 1 year after delivery rather than just 60 days after delivery. The reimbursement rates for maternity care professionals would also have been increased, supporting rural doctors and doctors in low-income communities.</p> <p>Takeaway/Suggested Actions: Additional steps that can be taken to reduce this revolve around increasing access to care for black pregnant individuals by enacting system-level interventions. incorporating care into communities, social services, expanding health coverage and having equity-centered policies.</p>
Toluhi et al., 2023	Alabama U	Qualitative Interviews	Qualitative in-depth interviews with stakeholders in the maternal health field ranging from doulas and public health officials to physicians to comment on maternity services and health care practitioner relationships	n=20 Stakeholders interviewed	N/A	Racial Disparities, Cultural Competence, Insurance,	<p>Results: Participants had a consensus that health care professional racial bias posed a serious health risk to black patients. The main themes that arose in association with maternal mortality or maternal healthcare were implicit and explicit racial bias, lack of communication, lack of good patient-practitioner relationships, lack of cultural sensitivity, variations in clinical knowledge/experience, lack of continuity and coordination of maternity care, discriminatory maternity health facility policies like random drug screenings on black people, health care practitioner trainings, and evidence based interventions.</p> <p>Discussion: Health care practitioners particularly mentioned racial bias and racism, lack of cultural sensitivity, poor coordination of care, workforces shortages and the need for a racially diverse and interdisciplinary maternity care workforce. Nonclinical practitioners like doulas suggested more community-based interventions such as home visits. Black stakeholders were more likely to say that Black patients were not</p>

							<p>listened to or that concerns were dismissed. The participants also perceived that black patients were racially discriminated against by clinical health care practitioners and nonclinical staff in equal measures. Participants described that health care practitioner racial and cultural concordance may promote better quality and more respectful care for black mothers alongside group prenatal care for black patients. In addition, insurance types create a boundary for patients.</p> <p>Takeaway/Suggested Actions: Stakeholders in the state of Alabama understand the effect racial bias and cultural competency have on care for black patients. Cultural insensitivity and bias pose a risk to maternal health and maternal mortality especially in the black population where racial discrimination could affect the quality of care received for pregnant individuals.</p>
Daymude et al., 2022	Georgia	Mixed-Methods Approach : Quantitative and Qualitative approach	An analysis of quantitative data from labor delivery units that closed and information from relevant new articles on those labor and delivery units in the state of Georgia from 2011 to 2016. Regional-level measures, distance analysis, payor groups and OB equivalents per labor delivery unit were the variable measures.	n= 6 labor and delivery unit closures	N/A	Racial Disparities, Household income, Transportation (Distance), Insurance	<p>Results: In Georgia from 2012 to 2016, 24 rural labor and delivery units (LDUs) continued services while 6 hospitals discontinued service. Black women made up a higher proportion of patients of LDUs that closed and made up a higher proportion of residents in the primary care service areas (PCSAs) where the LDU closed. LDUs that closed had 34% higher odds of having black birthing patients than LDUs that remained open. When you look at the proportion of patients with commercial/employer based insurance LDUs that closed it had a lower amount of these patients than those that were still open. On the qualitative side of the study, news sources that were analyzed over the years would report that LDUs closed due to costly obstetric services which then received inadequate reimbursement due to Medicaid reimbursements being lower than private/employer insurance reimbursements. Georgia in 2015 rejected Medicaid expansion and the Affordable Care Act cut care funding to rural hospitals so these rural hospitals lost money in this process. In articles published in 2015 low birth volume was cited as a reason for LDU closures as well as a loss of local patients going to local LDU's due to Level III Neonatal Intensive Care Units (which were not rural) increasing midwifery care and birth care classes to attract new patients. LDUs that closed also had significantly fewer OBs and those OBs according to newspapers left due to financial difficulties because they could not afford to stay in Georgia. Income did not correlate with a LDU closing near their area.</p> <p>Discussion: The study confirmed national trends of hospital closure related to birth volume and financial difficulty. The odds of having a black female Georgia resident of reproductive age was 7% higher in regions where labor delivery units closed. This suggests that Black women could have been more reliant on</p>

							LDUs that closed or were less able to access care in the ones that remained open, thus indicating that black women may be disproportionately affected by rural LDU closure. Takeaway/Suggested actions: To increase funding to rural hospitals, incentivize obstetric care providers to serve rural communities and develop new models of maternity care so that rural labor delivery units can be preserved. The article also suggested increasing physicians that accept Medicaid, providing transportation to visits, and detecting high-risk complications early. State Medicaid programs should increase reimbursement benefits, address provider supply and report the quality care for rural residents. To address high rates of maternal mortality in Black women, legislators and healthcare systems need to increase political priority for sustaining rural Georgia hospitals and LDUs. The focus of care should be on Black women and women who rely on Medicaid in rural communities.
Sayyad et al., 2023	Georgia U	Cross-Sectional Mixed Methods Approach : Qualitative data collection and analysis and community based participatory research	A community-engaged mixed methods study with qualitative interviews and surveys given to doula stakeholders in Georgia for opinions on challenges to providing care	n=20 doulas	N/A	Racism, Racial Disparities, Insurance/Policy	Results: The demographics of the doulas interviewed were 40% white, 45% Black, and 5% Latinx. The Doulas retold experiences of primarily medical racism when describing interactions that their patients had been through. The behavior shown ranged from lack of basic etiquette to clear changes in attitude. When physicians were told that mothers were recovering from substance abuse their attitudes changed and that behavior they portrayed to patients was clearly different. Another doula explained that clear differences in care arose with different races of patients and that white women were treated well while black women had things explained to them as if they were children. The doulas also explained that the ongoing medical racism causes distrust of the medical system among black birthing people. Doulas know that their black clients are at risk and work to maintain mechanisms to protect them, they have told clients to consider hospitals and clinics that have people of color working in the clinic and the doulas try their best to humanize their clients in front of health care professionals so that they can attempt to mediate the possible discrimination. They also understand the risk that maternal mortality poses to their black clients and during the pandemic doulas saw an increase in black maternal mortality rate and clients recognized that more deaths were happening. Discussion: Doulas of all races described a strong desire to protect Black clients from possible discrimination, recognized that Asian and Latinx communities had a specific cultural and language needs and recognized that more training can be done to prepare them to meet the cultural needs of their clients.

							Takeaways/Suggestion Action: (1) More community research on doulas in the southeast to understand how doulas facilitate care for marginalized communities (2) Trainings for doulas of color to provide culturally appropriate care for birthing mothers and recognize maternal mortality risks (3) Policy change to facilitate doula care for marginalized communities
Armstrong et al., 2021	Georgia R	Ecological Study	An Ecological study of the relationship between SDoH and maternal mortality in Georgia Social Determinants of health were identified through literature and the maternal mortality in Georgia was taken from the Georgia Department of Public Health	Pregnancy related and pregnancy associated deaths n=85 in 2012 n=79 in 2013	WHO Definition: Death During pregnancy up to 46 days postpartum Pregnancy-related maternal mortality: Excludes violent deaths, accidental deaths or any deaths outside of the hospital setting	Transportation, Socioeconomic status, Racial Disparities, Cultural Competency, Education, Insurance	Results: In 2015 46 out of 159 counties in Georgia had labor and delivery units and in 2019 93 out of 109 rural counties in Georgia did not have a hospital labor and delivery unit. 75 of those 109 rural counties did not even have OB/GYNs. In addition, 83% of the women in rural Georgia who had a birthing facility close to their home now have to travel long distances to other counties to access prenatal care and hospital delivery services due to closures. The loss of time during travel may lead to birthing complications such as to C-sections or induced birth increasing odds for death. In Barrow and Jackson county of Georgia there is 1.2 and 1.4 OB-GYNs per 100,00 residents respectively for each of the counties. When compared to the regular number of 12.6 OBGYNs per 100,000 residents you can see that there is quite a shortage in rural Georgia counties. When looking at women with low SES, the study found that these women were unaware of the relationship between the lack of prenatal and postnatal care to negative outcomes of maternal health. In the article poor patient health care provider communication has been linked to delayed or discontinued prenatal care behavior and delayed referral of high-risk patients to specialists. The lack of access to health insurance negatively impacts MMR in Georgia since in Georgia Medicaid coverage was chosen not to be expanded to uninsured populations in 2015. Due to racism African American women are ignored by healthcare providers and receive low quality care during pregnancy and delivery, thus maternal mortality rates are higher in the African American population than other races. Takeaways/Suggested Action: All women in Georgia regardless of their socioeconomic status, location and race should have access to resources for a positive pregnancy. To do this Medicaid coverage needs to be expanded, implicit bias, racism and discrimination experienced by African American women should be addressed through cultural competency training and access to maternal care in rural areas need to be remedied to reduce Georgia's maternal mortality rate.
Dyer et al., 2022	Louisiana M	Retrospective analytic	Data on verified cases of pregnancy-associated death was	n= 112 maternal deaths	PMSS Definition: Death during pregnancy or	Education, Availability of Resources, Neighborhood	Results: From the ICE analyses conducted by Dyer and colleagues it showed that 33% of the pregnant women from 2016 to 2017 had a high school education and 85% of them lived in an urban area. The estimated bi-variate associations

		cohort study	obtained from the Louisiana Department of Health for 2016 and 2017 and verified by the Bureau of Family Health Regional Maternal and Child Health Coordinators. Then for the cases that were successfully linked the addresses were geocoded to then calculate the Index of Concentration and the Extremes (ICE) for the maternal deaths. Utilized a Poisson regression model with generalized estimating equations to find the relative risk of death associated with residence in the lowest and middle tertiles of the ICE relative to the top.		up to 1 year postpartum Pregnancy-associated maternal mortality (includes violent deaths, accidental deaths or any deaths outside hospital setting)	d (urban vs rural), Race, Socioeconomic Factors	between maternal death and race/ethnicity, educational-attainment and the ICE were found to be statistically significant. From the results, 45% of the 112 maternal deaths fell into the bottom tertile of the ICE which were made up of neighborhoods that were the most deprived (defined utilizing the census tracts). In addition, 60% of the 112 maternal deaths were NH Black women. Those in areas of concentrated deprivation were at 1.73 times the risk for maternal death after controlling for covariables and excluding maternal race. If maternal race was added the ICE association was taken away and there was a 1.17 times risk. Racial differences were found in pregnancy-associated mortality and concentrated privilege vs deprivation of resources however there was no magnitude of association between them. Black women had two times the risk of pregnancy-associated mortality at both ends of the ICE spectrum when compared to white women. There were also large racial differences in the population that lived in the areas of concentrated deprivation. 63% of black women resided in these areas while only 12% of white women lived in those areas. Additionally pre-pregnancy chronic disease diagnoses for women in areas of concentrated deprivation increased mortality risk by more than two fold (2.68) When looking at the natural direct effect, even if women from concentrated privilege areas had the same prevalence of chronic conditions there would still be a 51% higher risk of death. Discussion: Compared to women living in privileged areas those in areas of deprivation had a significantly greater risk of death during pregnancy and post-partum. Black women were significantly more likely to be living in the deprived areas and were at an increased risk of maternal mortality compared to white women at all three ICE tertiles. The primary independent variable of ICE indicates that structural racism itself is a predictor of health risks. Takeaways/Suggested Action: There needs to be a change in policy and programs that support investing in non-white communities and redistributing resources such as access to food, zoning restrictions on liquor stores or increasing residential greening to improve birth outcomes and maternal mortality of these communities.
Wallace et al., 2020	Louisiana U	Retrospective Cross-Sectional Study	Data on verified cases of pregnancy-associated death was obtained from the Louisiana Department of	n=112	PMSS Definition: Death during pregnancy or up to 1 year postpartum	Transportation, Race, Educational attainment, Socioeconomic Status,	Results: In this study 84% of the women lived in urban areas and 51.6% were non-Hispanic white and 36.6% non-Hispanic Black. 24% of the women were in counties that had a lack of or no maternity care access and 9% were living in a maternity care desert. From the 112 cases of death the pregnancy-associated mortality rate was highest in women that were non-Hispanic Black, had less than a high school education, lived in rural

			Health for 2016 and 2017 and verified by the Bureau of Family Health Regional Maternal and Child Health Coordinators. The information was then geocoded to identify the parish of residence (county) that the deceased resided in and analyzed access to care		Pregnancy-associated maternal mortality (includes violent deaths, accidental deaths or any deaths outside hospital setting) and Pregnancy-related maternal mortality	Neighborhood type	<p>areas, and lived in maternity care deserts. The unadjusted mortality ratio for NHB women was 2.9 times higher than the mortality ratios for all other races/ethnicities. Fifty-four out of the 112 total deaths were pregnancy-related. The women who lived in a maternal care desert had a 91% increase in risk of pregnancy-associated death in comparison to areas that had access to maternity care. Residents in a maternity care desert had a three-fold increased risk of pregnancy-related mortality. When you controlled for individual level factors/variables there was still a 2.2 times increased risk for NHB women compared to white women.</p> <p>Discussion: Women that live in areas lacking maternal care access had an increased risk of death during pregnancy up to 1 year postpartum. Additionally, there was a 2-fold greater risk for Black women regardless of their residency in a maternal care desert or not.</p> <p>Takeaways/Suggested Action: Research is needed that will aim to understand why racial inequity in maternal mortality extends beyond healthcare access and how structural racism keeps resources and access to power from Black people.</p>
Morong et al., 2017	Louisiana N/A	Retrospective Study	Retrospective study was done within OHS, a multi-hospital medical record system for Southeast Louisiana and the Gulf Coast, from January 1, 1995, to December 31, 2013. The chart search was done to identify maternal deaths then a patient profile was generated for each identified case. The patient profile was analyzed by a multidisciplinary team made up of 10 professionals in the maternal health field. Each case was then classified as preventable or not preventable, if there	n=16 maternal mortalities	<p>WHO Definition: Death during pregnancy or up to 42 days after pregnancy</p> <p>Pregnancy-related mortality: excludes violent deaths, accidental deaths, or any deaths outside the hospital setting</p>	Insurance	<p>Results: Out of the 16 maternal deaths identified in the study, four were deemed as not preventable and twelve were deemed as potentially preventable deaths. From the preventable deaths 9 were tied to provider-based failures, 9 were tied to systems-based failures and 6 were seen as patient failures (prenatal visits etc.) in terms of how they could have been prevented. For insurance status 8 of the maternal deaths had information on their insurance status, two of the mortalities had no insurance and 6 had Medicaid. The maternal mortality rate for the Medicaid group was 58.3 deaths per 100,000 live births while for the Uninsured group, it was 249 deaths per 100,000 live births. There was also a significant statistical association in the incidence rate of having Medicaid to maternal death. The women who had private insurance had a significant statistical association with the prevention of maternal mortality.</p> <p>Discussion: Maternal mortality cases that were deemed preventable had an association with insurance type. Uninsured or Medicaid individuals had higher maternal mortality rates.</p> <p>Takeaways/Suggested Action: Having insurance is linked with prenatal care and the prevention of high-risk surgeries. Hospitals should analyze current practices to be able to screen for possible poor maternal outcomes.</p>

			was a degree of provider failure, system failure, patient failure or all of the above and if when the woman entered her pregnancy whether she was healthy, had minor morbidities or major morbidities.				
Mehta et al., 2020	Louisiana N/A	Retrospective observational secondary analysis	A secondary analysis was conducted on the data produced by the Louisiana Pregnancy-Associated Mortality review from January 1, 2011 to December 31, 2016. The maternal deaths were linked with vital records birth and fetal death certificates and cross referenced with Louisiana pregnancy Mortality surveillance system data. Then the death was analyzed to see if it is pregnancy-associated. A case synopsis was made of each case that fit the criteria. Each case was then assessed with the following questions 1) Was the death pregnancy related? 2) If pregnancy-related, what was the underlying cause of death? 3) Was the	n=187 identified maternal mortality n=47 pregnancy related death cases	WHO Definition: Death during pregnancy or up to 42 days after pregnancy Pregnancy-related mortality: Excludes violent deaths, accidental deaths, or any deaths outside the hospital setting	Racial Disparities	Results: Out of 187 maternal deaths identified through the ICD 10 codes, 47 were confirmed to be truly pregnancy-related deaths based on the internal maternal mortality review. About 70% of those were non-Hispanic Black women and 62% of those deaths were from women that were insured through Medicaid. Additionally, 32% of the deaths were antepartum while 45% occurred postpartum. For non-Hispanic Black women there was a 4.1 times increase in pregnancy-related death compared to non-Hispanic white women. Of the deaths 59% were determined to be preventable for non-Hispanic Black women while 9% were preventable for non-Hispanic white women. In addition, 63% of non-Hispanic Black women died at maternal level III or IV facilities while 45.5% of non-Hispanic white women experienced a death at a level III or level IV facilities. Discussion: When looking at the data from 2011-2016 the percentage of pregnancy-related deaths that were preventable was higher in non-Hispanic Black women when compared to non-Hispanic white women. This study found a major disparity in preventable death when focusing on pregnancy-related deaths occurring during pregnancy up to 42 days postpartum in a 6 year period. Takeaways/Suggested Action: The suggested action going forward for this study was that a broader structure for maternal mortality reviews is needed that will incorporate expertise on communities that are affected, address social determinants of health, and highlight the negative impacts of policy. Members of the review board need to represent the gender, race, and ethnicity that are affected the most by maternal mortality.

			<p>death preventable? 4) If there were chances to alter the outcome, what were they? 5) What were the contributing factors to the death? 6) What specific and feasible recommendations for actions should be implemented to prevent future deaths? The Louisiana birth facility designations were also identified for the hospitals that the women attended.</p>				
Tran et al., 2010	Louisiana N/A	Retrospective Data Analysis	<p>This study utilized enhanced linkage procedures to improve data collection of deaths from 2000 to 2005 from the Louisiana Pregnancy Mortality Surveillance System. The deaths were then underwent data analysis to see whether mortality trends for the state would change whether the CDC classification or the WHO classification was used.</p>	<p>n=345 maternal deaths with CDC classification n=163 maternal deaths with WHO Classification</p>	<p>PMSS Classification: Death during pregnancy or up to 1 year after pregnancy] WHO Classification</p>	Racial Disparity	<p>Results: From the years 2000 to 2005 the Louisiana Pregnancy Mortality Surveillance System reported 158 deaths of women residents within 90 days of pregnancy from Louisiana's death certificate data. Once the death certificate review and data linkage was conducted the final number of deaths occurring within 90 days increased to 194 deaths. Fifty-seven deaths were defined as WHO maternal deaths and 67.3% deaths were Black women and 30.8% of deaths were white women. The overall maternal mortality in this article was 13.4 per 100,000 live births and for Black women it was 3 times higher than the maternal mortality ratio for white women ie. 22.1 vs 7.3.</p> <p>In the study there were 163 pregnancies that occurred within 42 days of pregnancy and were deemed as pregnancy related deaths. 62% were Black while 36.8% were white. For this definition the maternal mortality ratio was 42 deaths per 100,000 live births. For the mortality ratio, Black women had a ratio over twice as high versus white women. More than 1/3 of the deaths in Black women were during pregnancy or 42 days after delivery. If you used the CDC/ACOG pregnancy definition where it was death during pregnancy and within 1 year of pregnancy, 57 deaths were identified and 68.4% were Black deaths while 28% were white deaths. The total mortality ratio when accounting for race indicated that the mortality ratio for Black women was 3.4 times higher than white women.</p> <p>Discussion: The difference between the WHO pregnancy-related deaths and the CDC/ACOG pregnancy</p>

							<p>associated death ratios strongly decreased between 2000 and 2005 in black women however there was still a large difference in numbers between black and white women.</p> <p>Takeaways/Suggested Action: Data linkage helps ensure quality of information is retained for the reported maternal mortality. Further research needs to be done to help explain why there is such a disparity between maternal mortality ratios for black and white women regardless of which definition of death you utilize.</p>
Harper et al., 2004	North Carolina	Retrospective observational analysis	<p>The North Carolina Pregnancy-related Mortality Surveillance System was used to find pregnancy-associated deaths from 1992 to 1998. To identify deaths ICD9 codes were used, annual records were electronically matched with live birth and fetal death files, and an inpatient hospital discharge database was used to identify discharges that related to pregnancy and deceased status. Accidental injuries were removed and the remaining potential pregnancy-related deaths were reviewed by a panel of three obstetricians. Only Black and White non-Hispanic records were kept in the study. Controls were selected randomly</p>	<p>n=400 pregnancy associated n=107 pregnancy-related deaths of Black and White non-Hispanic race</p>	<p>PMSS Classification: Death during pregnancy or up to 1 year after pregnancy</p> <p>Pregnancy-associated death: Includes violent death, accidental deaths, or any deaths outside a hospital setting</p> <p>Pregnancy-related death: Excludes violent deaths, accidental deaths, or any deaths outside the hospital setting</p>	<p>Race, Education, Income/Socioeconomic Status</p>	<p>Results: This study found 400 pregnancy-associated deaths and reviewed them to identify factors that affected the death. The maternal mortality ratio was 54.7 per 100,000 live births across the deaths. Once the panel review was done, 151 of the cases were deemed to be pregnancy-related deaths. The deaths were then controlled for race by including only African American and white maternal deaths which led to 107 cases identified in the end and 3404 controls, controls were not matched to cases but rather spread equally across the seven-year period so that results would not be skewed. The unadjusted odds ratio for increased risk of pregnancy-related mortality among African-American women was 3.07 when compared to white women. Every one of the socioeconomic risk factors (ie. estimated annual income, education level, percent of population beneath poverty level) p-values indicated significance statistically when related to mortality and race. In the study lack of pre-natal care was more common among the cases rather than controls, and among more common among African-American women than white women. Forward stepwise logistic regression analyses for the two clusters of predictors, socioeconomic and medical factors were utilized to assess the importance of race as a predictor of pregnancy-related mortality within each cluster.</p> <p>For estimated median annual income as a predictor the odds ratio for African American women vs white women was 2.93. Cases and controls were grouped into tertiles of risk according to the probability of pregnancy-related death. The odds ratio in the lowest risk tertile for African American women compared to white women was 5.02. For the highest risk tertile the odds ratio was 1.91. The intensity of race times mortality relationship decreased as the estimated risk of other pregnancy-related factors of death increased. African American women compared to white women had significantly higher ratios of death from cardiomyopathy, hemorrhage and respiratory complications.</p>

			from the 7-year period.				<p>Discussion: In this study African American women were likely to be socioeconomically disadvantaged at higher rates when measured by education level and estimated income. The study hypothesis was that if you adjusted for medical and socioeconomic factors the magnitude of observed increased risk would decrease however that was not the case. If you looked at hemorrhage there were more than 4 times as many African-American deaths compared to white deaths.</p> <p>Takeaways/Suggestion Action: The epidemiological research identified that racial health disparities and maternal mortality needs to be looked at through a lens where socioeconomic disadvantage, lack of adequate care and, differences in medical risk factors are accounted for.</p>
Bernet et al., 2020	Florida		The FLHealthCHARTS.com publicly available data was used to pull counts of maternal deaths from all 67 Florida counties for the years of 2001 and 2014. Public health spending was the main independent variable for the study and analyzed pregnancy related spending using the following services 1) The Maternal Health and Improved Pregnancy Outcomes 2) The Healthy Start Program 3) Women, Infants, and Children. Control Variables used were demographic characteristics, unemployment rate, personal income per capita, percentage of births covered by medicaid and	N/A	Maternal deaths: female deaths due to complications during pregnancy, childbirth or the period immediately following childbirth PMSS definition: Death during pregnancy or up to 1 year after pregnancy	Racial Disparities	<p>Results: In Florida the Black maternal mortality rate is higher than white maternal mortality rate and both have increased from 2001 to 2014. The average MMR was 19.429 per 100,000 live births and the MMR was 40.7 deaths per 100,000 live births for black mothers and 15.736 deaths per 100,000 live births for white mothers. In the models that were calculated the dependent variable is overall MMR and white MMR, black MMR and the gap between the two as well. The fixed-effects OLS regression model presented a large significant negative coefficient for the black maternal mortality rate when looking at a fixed county, year and pregnancy-related spending. The two-step GMM model suggests that with a 10% increase in targeted public health spending there would be a 0.765 decline in MMR which would improve rates by 3.9%. Among black mothers, each 10% increase in pregnancy-related public health spending would have a significant 5.5 death decline in maternal mortality rate while everything else is constant. The targeted spending would also lead to a 5.366 reduction in the black-white maternal mortality gap thus leading to a decline of 20%. This model had the most conservative estimates and would be the best-supported model.</p> <p>Takeaways/Suggested Action: Using the statistical models shows us that maternal mortality disparities where black mothers experience death from pregnancy at 3 to 4 times higher rates than white mothers could benefit from increasing service-specific public health expenditures. These models also showed that total public health expenditures do not necessarily improve specific health outcomes.</p>
			number of physicians and hospital beds per 100,000 people.				

DISCUSSION

Through this rapid evidence assessment (REA), the author was able to analyze different SDOHs and their relation to maternal mortality geographically in the US South. The United States maternal mortality rate is unusually high when compared to other high-income countries (Collier & Molina, 2019). For example, in 2020, the US mortality rate was 21 deaths per 100,000 live births, while in Canada the mortality rate was 11 deaths per 100,000 live births - nearly half that of the United States rate (WHO et al., 2023). In maternal mortality rankings, the United States is 55th, the lowest ranking among developed countries (Collier & Molina, 2019). These numbers paint the picture that the U.S. is lacking in terms of maternal health.

When one views the United States maternal mortality rates from 2018 to 2021, 23.8 deaths occurred per 100,000 live births (Hoyert, 2023). For the U.S. South, the maternal mortality rate for the individual states were higher than the US average rate for 2018 to 2021. For example, Mississippi's MMR was 43 deaths per 100,000 live births, other states are listed in Table 5. This indicates that there are factors in the southern states different from the other regions of the U.S. that need to be analyzed.

From the articles within this assessment, the maternal mortality rates ranged from 19.429 deaths per 100,000 live births all the way to 72.9 deaths per 100,000 live births (Tipre et al., 2022; Bernet et al., 2020), indicating that the cohorts and states analyzed in these studies had a variation in the MMRs that were being recorded.

State	MMR per 100,00 live births	State	MMR per 100,000 live births
Alabama	41.4	Virginia	29.1
Georgia	33.9	Kentucky	38.4
Louisiana	39	Maryland	21.2
North Carolina	26.5	Mississippi	43.0
Florida	26.3	Oklahoma	30.3
Arkansas	43.5	South Carolina	32.7
Texas	41.7	Tennessee	41.7
District of Columbia	N/A	Delaware	N/A
West Virginia	N/A		

Table 5: US Southern States Maternal Mortality Rate Averages- 2018 to 2021

US Southern States

Specifically in the US South, maternal mortality rates are high, with some states nearly double the national rate (Table 5). However, there is a lack of literature looking at the ties that SDOH have with maternal mortality. Only five out of 17 states had literature that included SDOH as a factor to be considered in maternal mortality. The other states had maternal mortality articles; however, they were explicitly looking at what caused the mortality medically, such as pre-eclampsia, rather than looking at social determinants and causes leading up to the death. The remaining 12 states that did not have research come up in the REA have high if not higher mortality rates than the ones with articles.

Therefore, there is a gap in literature and research regarding SDOH's relation to maternal mortality in those states. Without the research being conducted, data-informed interventions cannot be utilized to address these preventable deaths. Intentional actions such as community-based health centers in states with the highest rates, culturally appropriate care guidelines, and population-specific primary care focusing on maternal

health are unable to be initiated due to a lack of information of possible causes of high maternal mortality rates.

Social Determinants of Health

In the United States, 3 in 5 maternal deaths are preventable, and African American, Native American, and Alaska Native women are almost three times more likely to die of pregnancy-related causes (Crear-Perry et al., 2021). Social determinants of health are ingrained into our environments and help identify and name barriers to receiving care. From the studies found in the search, racial disparities, insurance, and income were the top three determinants that were listed within articles. The other determinants, education, transport, resource insecurity, neighborhood type and cultural competence were not mentioned nearly as often indicating that these areas will need more attention in future research.

Race/Racism/Racial Disparities

Twelve out of 14 articles listed racial disparities, race or racism as a main SDOH affecting maternal mortality. In the studies that mentioned race, a majority of them found significant statistical results or increased odds for maternal mortality for non-Hispanic Black (NHB) women (8 out of 12 articles). The highest rate mentioned in this study was NHB women dying at a 4.1 times higher rate than white women (Mehta et al., 2020) while the lowest mentioned rate was a 2 times higher rate than non-Hispanic white (NHW) women (Dyer et al., 2022).

At the national level, racial disparities are reflected in hospitals with non-Hispanic Black women dying at 2.5 times higher rates when compared to non-Hispanic white

women (Joseph et al., 2021). Race, racism and racial disparities need to be addressed by identifying how this factor plays a role within maternal health care. From physician bias during Black mothers' visits to black communities having limited access to physicians, analyzing these components of racism and structural racial disparities is imperative to reducing the black-white gap in maternal mortality.

Insurance

Insurance was also mentioned as a factor for maternal mortality in seven out of 14 articles. Three out of eight mentioned a strong statistical association between having Medicaid, no insurance, or self-paid and an increase in maternal mortality risk.

Insurance had a large influence on rural areas and physician availability. Medicaid (public), self-pay, and no insurance hospital and physician payouts result in a lower reimbursement of money to hospitals than private insurance thus causing labor delivery unit closures in rural areas that primarily served low-income and black populations (Daymude et al., 2022).

Affordable Care Act (ACA) funding being cut to rural areas also caused the closure of units for underserved populations. Eliason (2020) conducted a study where the effect of the ACA was analyzed in states where it was expanded vs where it was not expanded. The states that expanded the ACA were significantly associated with a lower maternal mortality by 7.01 maternal deaths per 100,000 live births (Eliason, 2020). Wang and colleagues (2020) on the national level found that Medicaid or no insurance coverage was tied to a higher risk of maternal mortality risk in 21 studies across the U.S.

Income

When the articles looked at income, eight out of 14 articles listed it as an SDOH that would potentially affect maternal mortality. Out of those articles, three found a significant statistical association between low income and an increased risk of maternal mortality. In the study done by Tiple and colleagues (2022), women who lived in the neighborhoods that were the most deprived of resources had increased odds of maternal mortality and a similar study conducted by Fang and colleagues (2000) found that neighborhood income was strongly associated with maternal mortality.

These studies go to demonstrate that income and socioeconomic status are indicators of maternal health wellness and ability to receive care for pregnancy. Mothers who have a low income are less likely to go to prenatal and postnatal care which act as preventative factors for maternal mortality. Even just one visit will lower the risk of death (Harper et al., 2004).

When a systematic literature review was done for the entirety of the US most of the studies suggest that Black race, lack of insurance, and lower education are statistically significant and associated with higher maternal mortality risk (Wang 2020). The U.S. South contains 56% of the United States Black people and when social determinants of health are related to maternal mortality this information needs to be considered when crafting solutions for the region ((*Facts About the U.S. Black Population* / *Pew Research Center*, n.d.)).

Variability in Maternal Mortality Data Collection and Definitions

Due to each state having its own system of analysis and definitions of maternal mortality, differences in data collection and interpretation can be seen across states. Some states will have maternal mortality review committees that will capture data on timing of death, preventability of death and/or conduct data linkages of death certificates to hospitals to ensure that maternal deaths were caused by pregnancy while some states will have no standardized course of review outside of the pregnancy checkbox available on death certificates (*NVSS - Maternal Mortality - Evaluation of Changes, 2020*). One will see the cause of this variation, especially within the definitions of maternal mortality that each article utilizes.

All 14 studies were not consistent when it came to how maternal mortality was defined. There are four different ways to classify maternal mortality. The first is to classify maternal mortality within a time frame either by saying that the death happened within 42 days postpartum, which is the standard set by the World Health Organization, or that the death happened within 1 year postpartum which is the standard set by the CDC Pregnancy Mortality Surveillance System (PMSS).

The other two are cause of death classifications. The first is pregnancy-associated mortality, where the death occurs within one of the two previous timelines but could have occurred in any way including violent and accidental deaths or that the death occurred outside the hospital setting. The second is pregnancy-related, which also must occur within one of the previous timelines but does not include violent, accidental or out-of-hospital deaths, focusing only on deaths that occur related to pregnancy.

Within the studies there was a wide variation in the definitions that were used, some studies utilized the WHO-associated timeline of within 42 days of birth however chose to screen for pregnancy-associated deaths and vice versa among the many combinations that authors could use.

Some studies, for example, Frolich and associates (2014), chose to create their own definition of what counts as a maternal death. Studies also occasionally did not specify whether they were classifying their maternal deaths as pregnancy-associated or pregnancy-related. In the authors' study screening process, deaths that only covered maternal homicides, drug overdoses, or motor vehicle accidents were taken out to avoid skewed data.

Although these definitions and timelines are different, the study by Tran and colleagues (2010) manipulated the maternal mortality data by each definition and reported on how maternal mortality rates differed depending on the definition or timeline. They found that although MMR and the significance of numbers changed between definitions, the black-white MMR gap remained prevalent regardless of what timeline was utilized. Overall, this variation signals that further studies need to clarify their definition of maternal mortality and the timeline of maternal deaths so that research can be easily replicated and reproduced.

Strengths and Weaknesses

The strengths of this study were that the maternal mortality rate was viewed in the framework of SDOH specifically in the U.S. South which is novel in the maternal health field. This study also identified how specific populations (racial/ethnic groups or low-

income individuals) are being disproportionately affected by maternal mortality and highlights the importance of considering targeted approaches to help these communities.

Since this REA pulled information on health disparities rather than simply focusing on the medical cause of maternal death, it was able to compile studies of a different form that can add to the current literature. This paper synthesizes literature across studies in the U.S. South as a geographic location allowing similarities to be found based on region which has not been done before. Due to the special nature of the analyses, it captures thousands of people within the 17 states that it searches while highlighting the specific disparities that these populations may face.

Within a rapid evidence assessment usually quality assessment is conducted on the pieces to qualify them to be a part of the study, however, this was not done. Alongside a quality assessment, a second reviewer was also not a part of this study which could lead to potential bias in the overall article inclusion process. In this assessment, only one bibliographic database was utilized (PubMed) limiting the scope and breadth of the papers that were available to be searched and consecutively analyzed. In addition, no non-peer-reviewed articles such as white papers or opinion pieces were included in the analysis potentially excluding additional information that could have assisted in forming the overall picture of maternal mortality. Finally, in the search term, the maternal mortality definitions (WHO timeline, pregnancy-associated maternal mortality, etc.) were not included, signifying a weakness within the study.

Future Research

For future research, more computer bibliographic databases need to be utilized in the search to ensure that all literature relating SDOH to maternal mortality can be collected. In addition, a quality assessment needs to be conducted on each article so that bias can be analyzed, and the research results can be confidently reported. To avoid author bias in the future a second researcher needs to be included to review subsequent literature.

In addition, maternal mortality-specific terms need to be included to fully search the databases and avoid missing literature. This study opens the discussion to conduct further literature searches with individual specific SDOH, the author suggests looking into race/racism/racial disparities, insurance, and income individually with maternal mortality as a further avenue for research. Finally, from these initial findings conducting analyses of how maternal mortality is defined, how the maternal mortality rate is determined, and if there exists a maternal mortality surveillance system or other organization state by state, will help ascertain whether a state's maternal mortality data can be compared to national or other state data.

CONCLUSION

Maternal mortality rate is an indicator of the overall health of a society while social determinants of health are integral in determining the health of an individual. From the articles found in the rapid evidence assessment regarding social determinants on maternal mortality in the US South, the major findings about the social determinants of race, insurance type, and income all indicate an additional need for in-depth research on each of the determinant's individually to see how they affect mothers within their geographical boundary. This study also found that there are gaps in literature for 11 out of 16 southern states did not have any articles examining social determinants of health to maternal mortality. These large gaps in research allow preventable deaths to occur at higher rates and neglect informing steps that could be taken to mitigate maternal mortality. Intentional actions such as community-based health centers in states with the highest maternal mortality rates, culturally appropriate care guidelines, population-specific primary care focusing on maternal health, and structural and individual level racial policy changes are unable to be initiated due to a lack of information of the social determinants that cause high maternal mortality rates. This assessment serves as a call to action for increased research to lower maternal mortality rates in the US South.

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CURRICULUM VITAE

