

RACIAL DISPARITIES IN MATERNAL HEALTH OUTCOMES IN THE U.S.

MATERNAL MORBIDITY & MORTALITY ACROSS RACE

CU-VIRT-DATA-PT-12-2023-U-LOLC PROJECT1
GROUP 7

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PROBLEM
SIGNIFICANCE



50,000 WOMEN IN THE
UNITED STATES (U.S.) SUFFER
FROM PREGNANCY
COMPLICATIONS ANNUALLY

Black women are *at least* **3x**
more likely to die due to a
pregnancy-related cause when
compared to White women

PROBLEM STATEMENT



Black women in the United States (U.S.) **disproportionately experience adverse pregnancy outcomes**, including **maternal mortality**, compared to women of other racial and ethnic groups

PROJECT OVERVIEW

OUR PROJECT

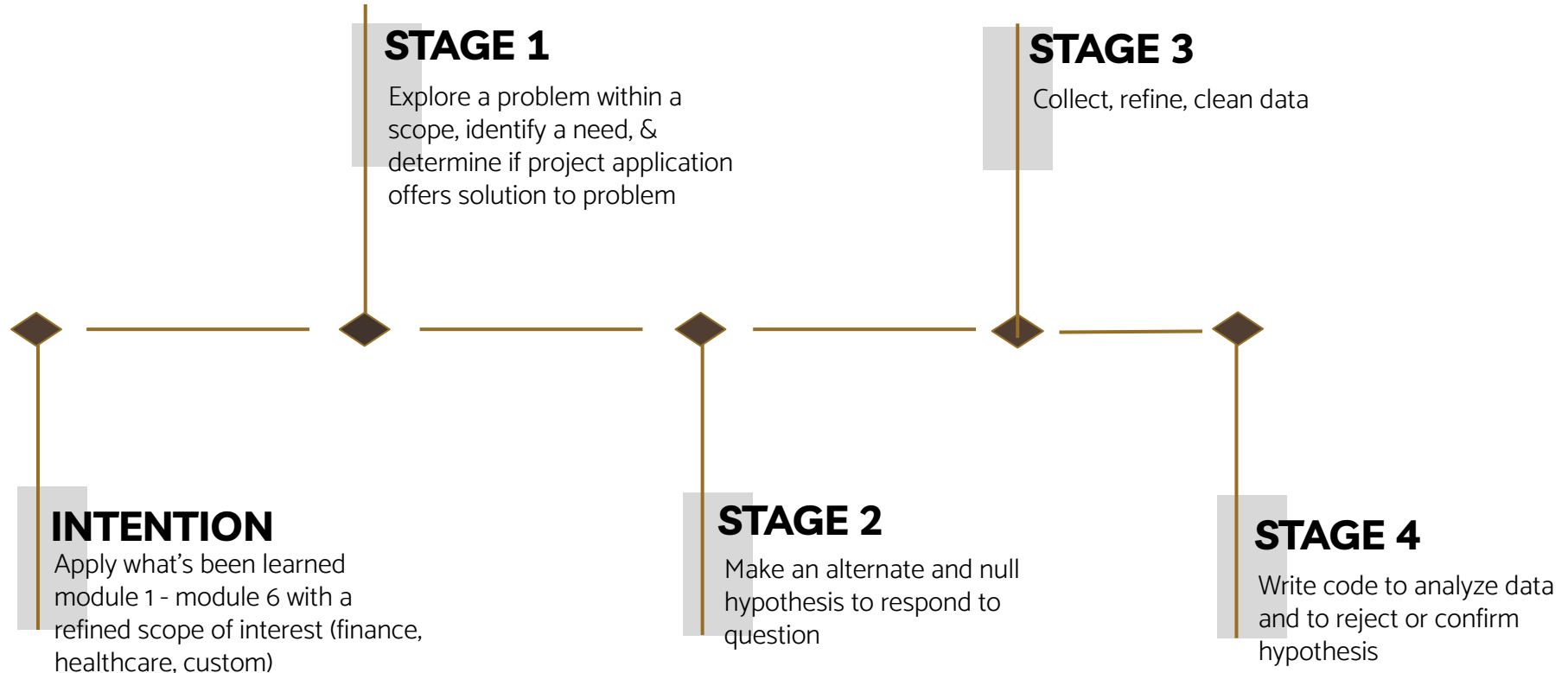
GOAL

investigate the disparate
treatment of minority
identities in the field of
medicine

Healthcare

SECTOR

PROJECT COMPLETION WORKFLOW



HYPOTHESIS

PROBLEM STATEMENT & RESEARCH QUESTION

DO BLACK WOMEN IN THE UNITED STATES (U.S.)
DISPROPORTIONATELY EXPERIENCE ADVERSE
PREGNANCY OUTCOMES, INCLUDING MATERNAL
MORTALITY, COMPARED TO WOMEN OF OTHER RACIAL
AND ETHNIC GROUPS

?

NULL HYPOTHESIS

No. There is no correlation between the rate of incidence of maternal mortality or morbidity and race. Black women in the united states (u.s.) experience adverse pregnancy outcomes, including maternal mortality, **proportionately** to women of other racial and ethnic groups

ALTERNATE HYPOTHESIS

Yes. There is a correlation between the rate of incidence of maternal mortality or morbidity and race. Black women in the united states (u.s.) **disproportionately** experience adverse pregnancy outcomes, including maternal mortality, compared to women of other racial and ethnic groups

RESEARCH QUESTION EXPANDED

If black women in the united states
(u.s.) **do** disproportionately
experience adverse pregnancy outcomes,
including maternal mortality, compared
to women of other racial and ethnic
groups, **what might be considered**
factors of influence
?

HYPOTHESIZED FACTORS OF INFLUENCE

INVESTIGATE THE IMPACT OF THE FOLLOWING FACTORS ON MATERNAL MORBIDITY AND MORTALITY



GENETIC
SUSCEPTIBILITY



IMPLICIT BIAS



SOCIAL
DETERMINANTS of
HEALTH



HEALTHCARE ACCESS & QUALITY



EDUCATION ACCESS & QUALITY



ECONOMIC STABILITY



SOCIAL & COMMUNITY CONTEXT



NEIGHBORHOOD & BUILT ENVIRONMENT



SOCIAL DETERMINANTS OF HEALTH



SOCIAL DETERMINANTS OF HEALTH



NEIGHBORHOOD & BUILT ENVIRONMENT



ECONOMIC STABILITY



NEIGHBORHOOD & BUILT ENVIRONMENT



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NEIGHBORHOOD & BUILT ENVIRONMENT



SOCIAL DETERMINANTS OF HEALTH

DATA

DATA SOURCES



WHO leads global efforts to expand universal health coverage. Explored this source because of their commitment to accountability

CDC is the nation's leading science-based, data-driven, service organization that protects the public's health



Kaggle allows users to find datasets they want to use in building AI models, publish datasets, work with other data scientists and machine learning engine

DATA SOURCES

The U.S. **Department of the Interior** provides scientific information the Nations natural resources and is affiliated with minority identities



The **NIH** Data Book (NDB) provides basic summary statistics, strategic plans, policy studies, and program evaluations

DATA SELECTION

WONDER.CDC

CDC.GOV

DATA GLOSSARY

Variable Name	file	Purpose	source	method / filter	created by	date
live_births_edu_df	US_Live_Births_Race_Edu.csv	Live births segmented by education			owiggs	2/9
maternal_death_df	VSRR_Provisional_Maternal_Death_Counts_and_Rates_20240207.csv	Dataframe created from the VSRR_Provisional_Maternal_Death_Counts_and_Rates_20240207.csv	https://wonder.cdc.gov/mod.html	on pregnancy related deaths	owiggs	2/9
mm_merged_df		Dataframe created from merged live_births_edu_df and maternal_death_df left joined on Education Factor			owiggs	2/9
md_location_df	mm_urban_rural_99-20.csv	To Calculate Maternal Mortality by Location	http://wonder.cdc.gov/mod-icd10.html	Dataset: Multiple Cause of Death, 1999-2020 Query Parameters: Gender: Female UCD - ICD-10 Codes: O00-O99 (Pregnancy, childbirth and the puerperium); P00-P96 (Certain conditions originating in the perinatal period) Group By: Year, Race; 2013 Urbanization Calculate Rates Per: 100,000	owiggs	

DATA GLOSSARY

Variable Name	file	source	method / filter
live_births_edu_df	US_Live_Births_Race_Edu.csv	http://wonder.cdc.gov/wonder/help/Natality.html	Query Parameters: Title: Maternal health by age and education Year: 2022 Group By: Mother's Single Race; Mother's Education Show Totals: True Show Zero Values: True Show Suppressed: False Calculate Rates Per: 1,000
maternal_death_df	VSRR_Provisional_Maternal_Death_Co unts_and_Rates_20240207.csv	https://wonder.cdc.gov/mcd.html	on pregnancy related deaths
md_location_df	mm_urban_rural_99-20.csv	http://wonder.cdc.gov/mcd-icd10.html	Dataset: Multiple Cause of Death, 1999-2020 Query Parameters: Gender: Female UCD - ICD-10 Codes: O00-O99 (Pregnancy, childbirth and the puerperium); P00-P96 (Certain conditions originating in the perinatal period) Group By: Year; Race; 2013 Urbanization Calculate Rates Per: 100,000

DATA VARIATION DISCRETION !!

DATA CHALLENGES

Access to, and use of, restricted versions of national vital statistical files require research-proposal review and approval by the National Center for Health Statistics (NCHS).

Research often relies on data that categorizes individuals based on assigned sex at birth, potentially excluding experiences of transgender and non-binary individuals.

DATA BIAS

DATA EXPLORATION PROCESS

DATA CLEANUP

HOW DID WE CLEAN? WHAT DID WE MERGE ON?

- Crawled the web key words: maternal health, maternal mortality, live births, race, urban v. rural health outcome
- Downloaded csvs from CDC and created dataframes from the associated data
- Filtered rows where race demographic is 'black/african american'
- Removed extraneous rows like "Mother's Single Race Code", "Notes", "Mother's Education Code", etc.
- Renamed column names when appropriate
- Replace NaN values with 0
- Leveraged matplotlib to create visualizations



DATA EXPLORATION WORKFLOW DELEGATION



MIA METNI

Role: Biomedical Engineer, Product Design & Development
Experience: Undergraduate BME, research in device tech and physiology, product development, introduction to Spectroscopic Optical Imaging



MILES M

Role: Advisor, Biomedical Engineer, Product Design & Development
Experience: Principal Investigator of Ji-Xin Cheng Group at Boston University. Specializes in manipulating photons for precision medicine; developed label-free optical imaging tools at Purdue University.



KHADIJA

Role: Advisor
Experience: clinical specialist @Medtronic, experience aiding in Pulmonary Vein Isolation and Cardiac Ablation procedures, field expert, end-user



CHRIS WIGGS

Role: to help expand, validate, and actuate design idea

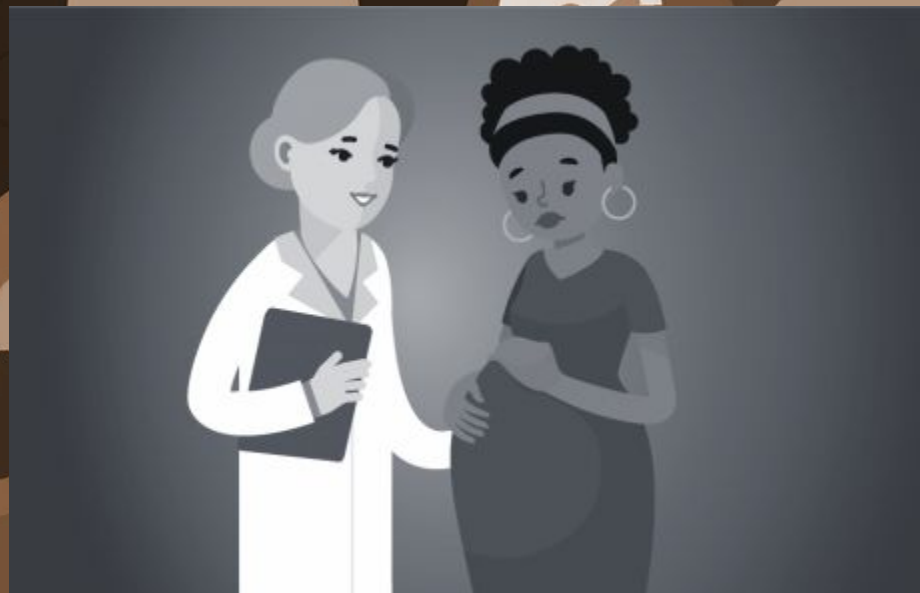
FINDINGS & CONCLUSIONS

IMPLICIT BIAS FINDINGS

Do implicit biases have an impact on maternal morbidity and/or mortality in the U.S.?

FINDING

Implicit racial bias has been reported in the health care system and can affect patient-provider interactions, treatment decisions, patient adherence to recommendations, and patient health outcomes



GENETIC SUSCEPTIBILITY FINDINGS

Does genetic susceptibility have an impact on maternal morbidity and/or mortality in the U.S.?

FINDING

genetic susceptibility can contribute to disparities in disease incidence, prevalence, and severity between different racial and ethnic groups

 | Published 2018



SDOH FINDINGS

Do social determinants of health have an impact on maternal morbidity and/or mortality in the U.S.?

FINDING

social determinants of health including income, employment status, geographic location, and education, have an impact on and/or a relationship with the rate of incidence of maternal mortality and morbidity.

SDOH RESEARCH QUESTIONS ON LOCATION

1.

Does geographic location impact maternal mortality and morbidity within the united states?

2.

What relationship does the influential factor of geographic location have on different ethnic/racial groups?

SDOH LOCATION FINDINGS

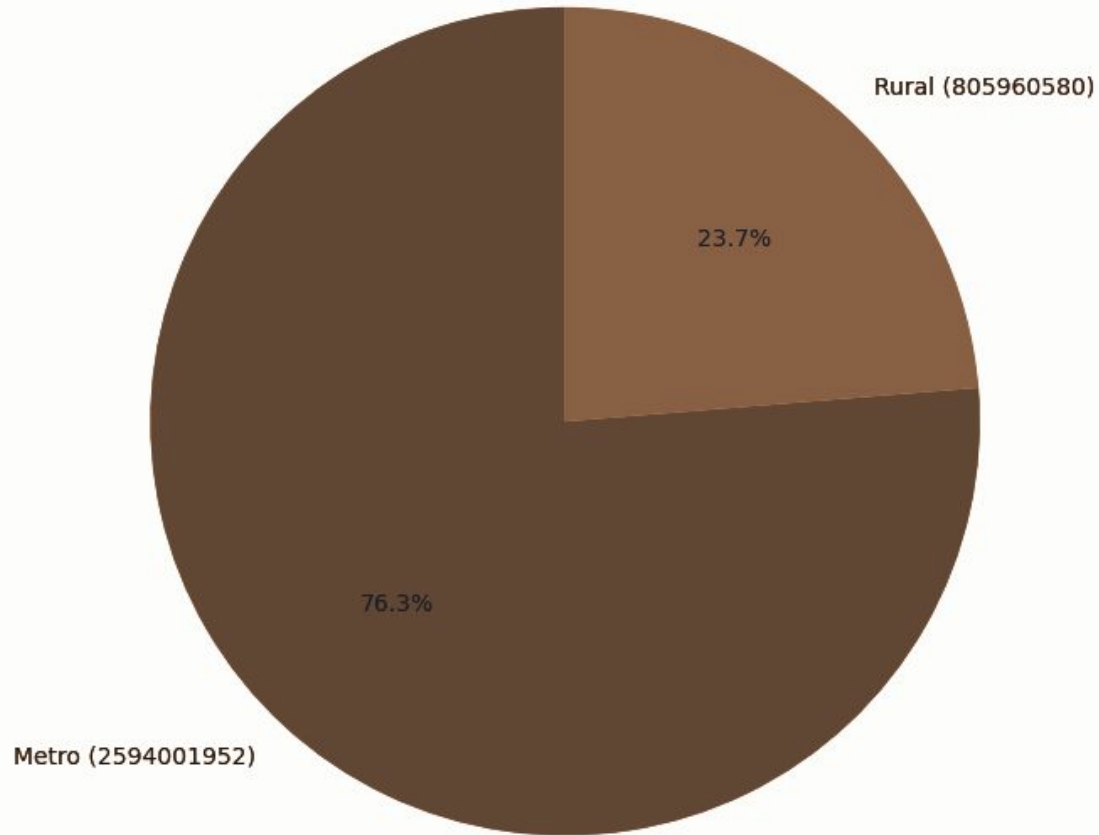
1.

Does geographic location impact maternal mortality and morbidity within the united states?

FINDING

Yes. More than half of pregnancy-related deaths happened in large metropolitan areas (76.3% - urban v. 23.7% - rural)

Pregnancy-related Mortality Ratio by Urban-Rural Classification



NEIGHBORHOOD & BUILT ENVIRONMENT

SDOH LOCATION FINDINGS

2.

What relationship does the influential factor of geographic location have on different ethnic/racial groups?

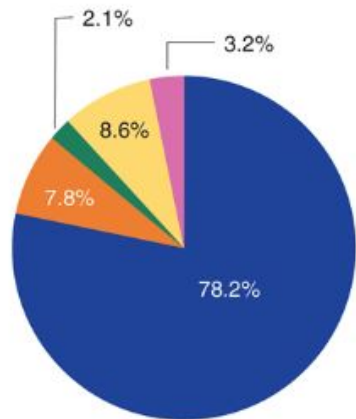
FINDING

While more than half of pregnancy-related deaths happened in large metropolitan areas (76.3% - urban v. 23.7% - rural), the risk of dying from pregnancy-related causes is higher in rural areas. These disparities were found across urban and rural communities, and also varied across race/ethnicity.

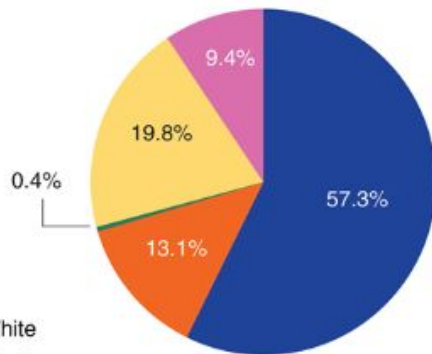
Percent of rural (nonmetro) and urban (metro) populations by race/ethnicity, 2018



Rural population shares, 2018



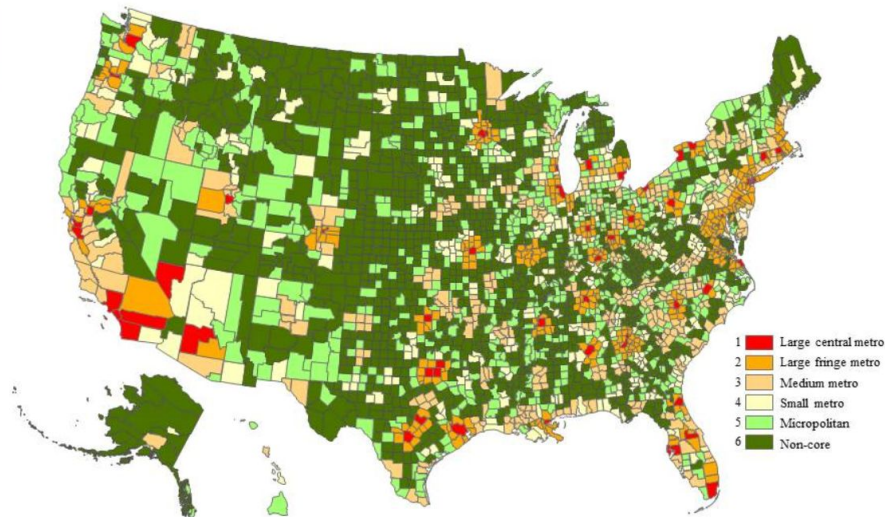
Urban population shares, 2018



■ White
■ Black
■ American Indian
■ Hispanic
■ Other

Notes: Statistics for Whites, Blacks, and American Indians include only non-Hispanic residents. Residents included in the Hispanic category may be of any race. Groups with relatively few residents (Asians, Pacific Islanders, and those reporting multiple races) are combined into a single "Other" category.

Source: USDA, Economic Research Service using data from the U.S. Department of Commerce, Bureau of the Census, Population Estimates Program.



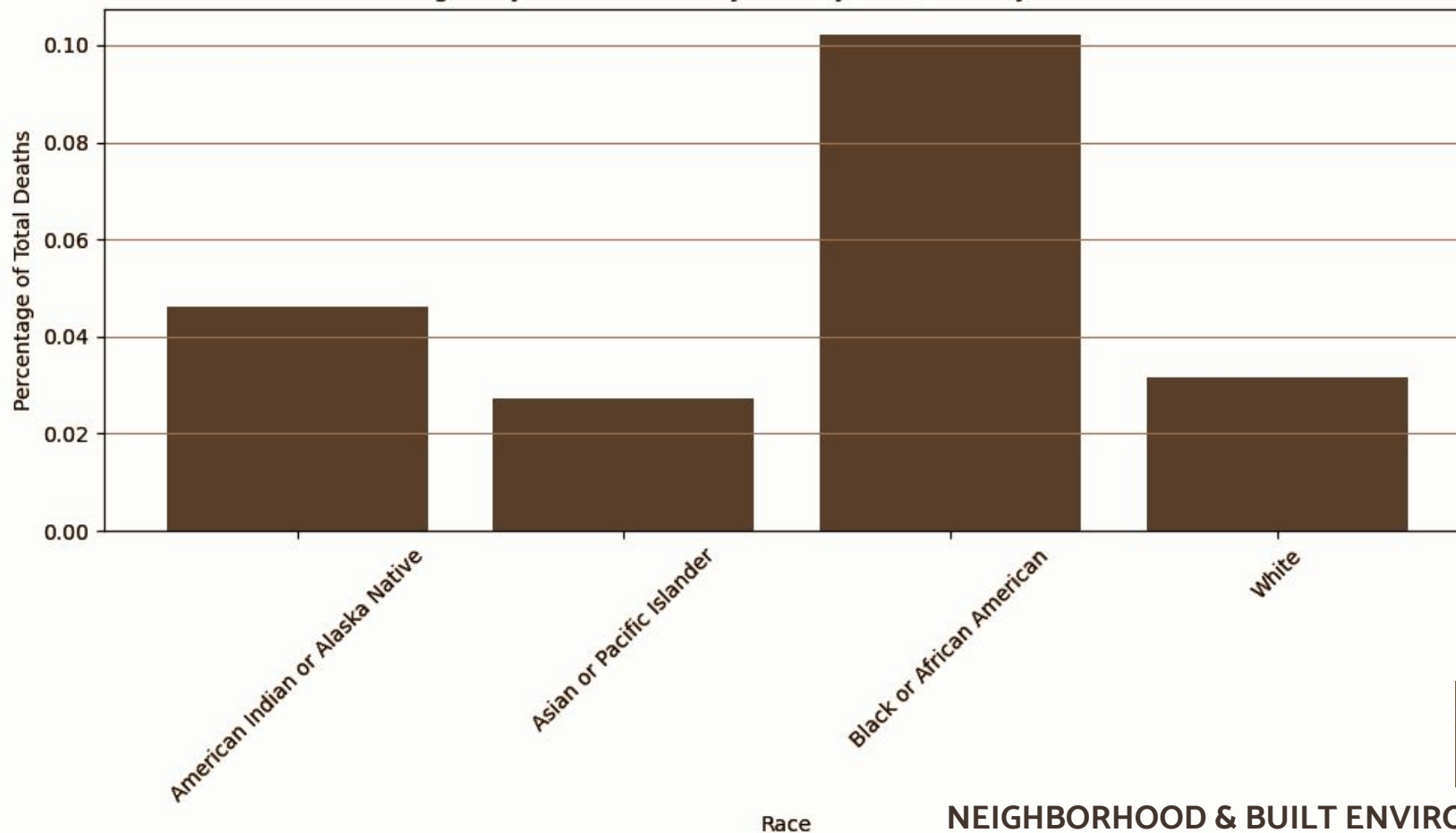
1 Large central metro
 2 Large fringe metro
 3 Medium metro
 4 Small metro
 5 Micropolitan
 6 Non-core

https://www.cdc.gov/nchs/data_access/urban_rural.htm



NEIGHBORHOOD & BUILT ENVIRONMENT

Pregnancy-related mortality ratio by race/ethnicity: 1999-2020



NEIGHBORHOOD & BUILT ENVIRONMENT

SDOH LOCATION ADDITIONAL CONSIDERATIONS

HOUSING

ACCESS TO FOOD AND SAFE
NEIGHBORHOODS

ACCESS TO PRENATAL CARE



SDOH RESEARCH QUESTIONS ON EDUCATION

1.

Does level of education attained impact maternal mortality and morbidity within the united states?

2.

What relationship does the influential factor of geographic location have on different ethnic/racial groups?

SDOH EDUCATION FINDINGS

1.

Does level of education attained impact maternal mortality and morbidity within the united states?

FINDING

the patterns observed in education levels across different racial groups can give us insights into potential disparities in maternal health outcomes. Higher education levels within each racial group may indicate better overall health and potentially lower rates of maternal mortality and morbidity.

FINDING

SDOH EDUCATION FINDINGS

2.

What relationship does the influential factor of geographic location have on different ethnic/racial groups?

FINDING

IDK

FINDING

SDOH RESEARCH QUESTIONS ON INCOME

1.

Does income impact maternal mortality and morbidity within the united states?

2.

What relationship does the influential factor of income have on different ethnic/racial groups?

SDOH INCOME FINDINGS

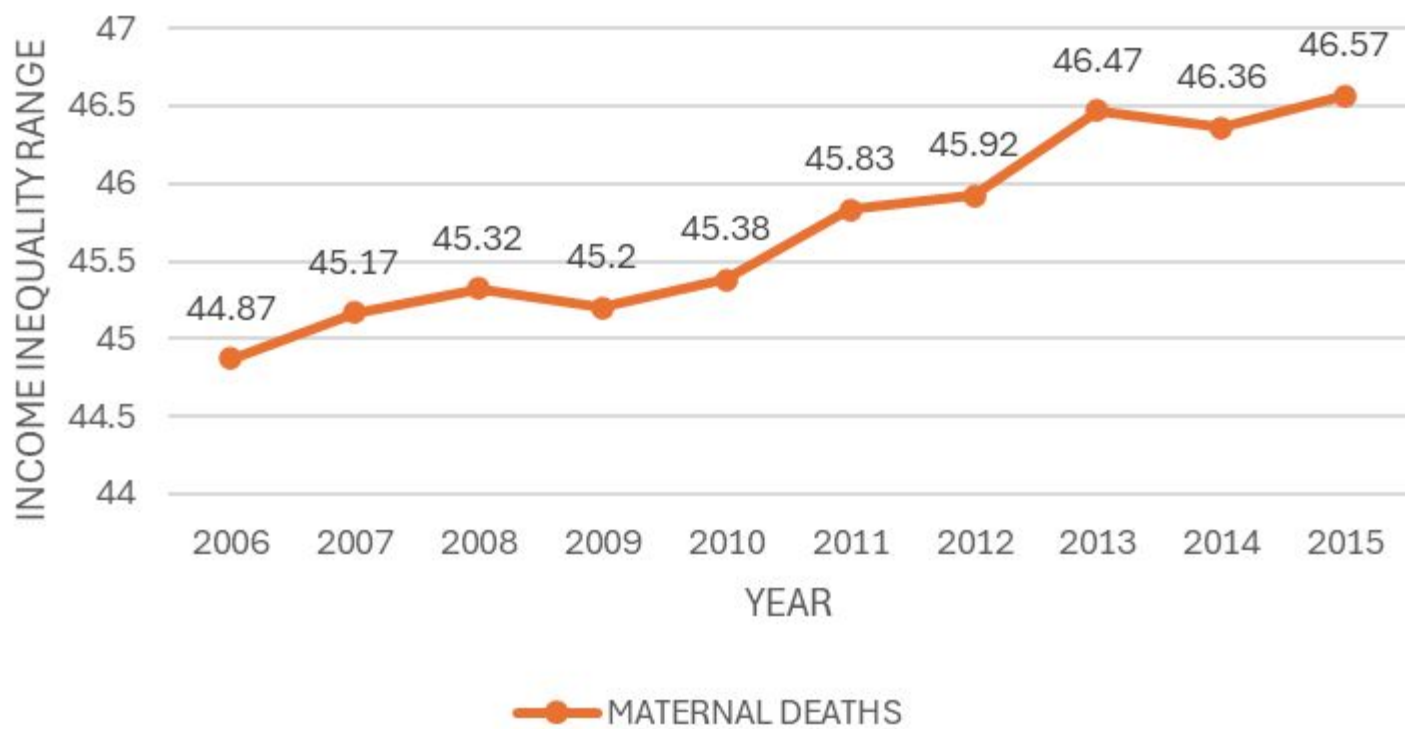
1.

Does income impact maternal mortality and morbidity within the united states?

FINDING

YES. State income inequality is linked to increased pregnancy racial mortality across the United States.

INCOME STATUS



SDOH INCOME FINDINGS

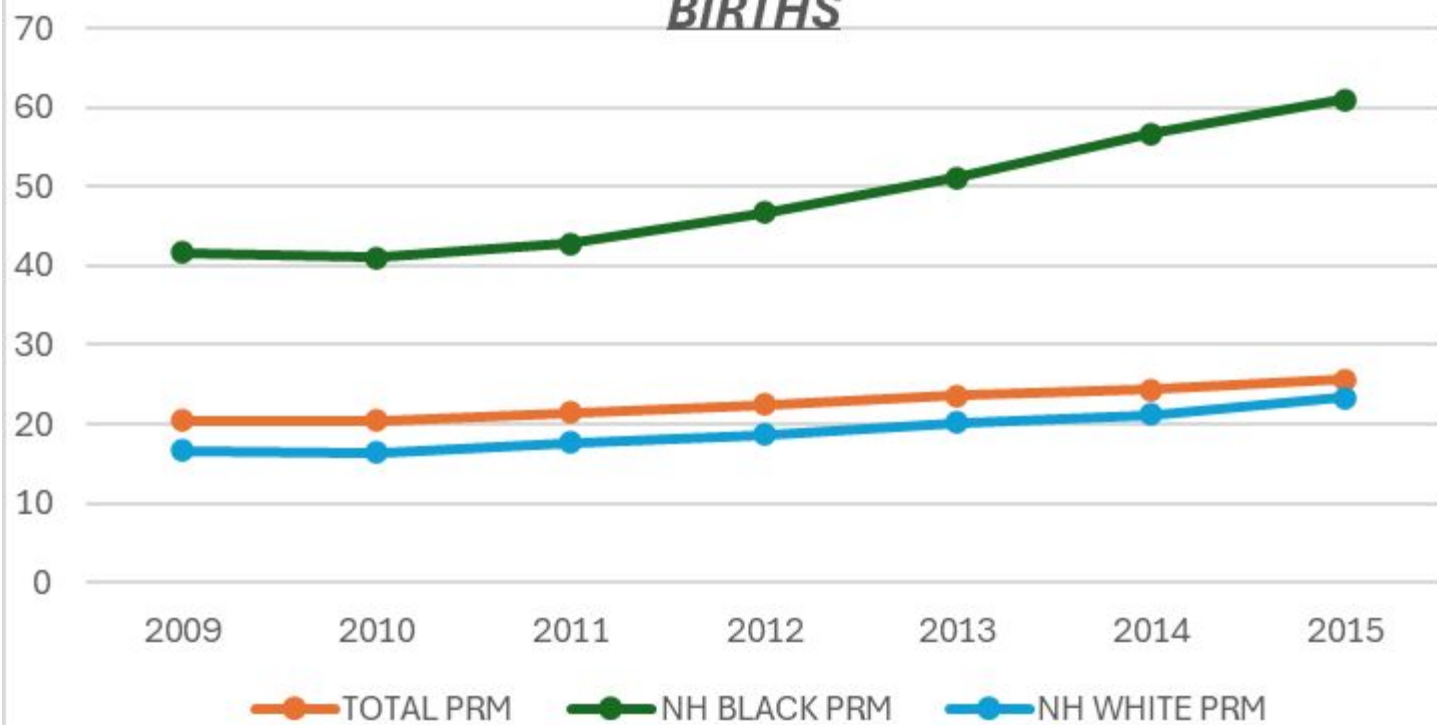
2.

What relationship does the influential factor of income have on different ethnic/ racial groups?

FINDING

YES. State income inequality is linked to increased pregnancy racial mortality across the United States.

***PREGNANCY-RELATED DEATHS PER 100,000 LIVE
BIRTHS***



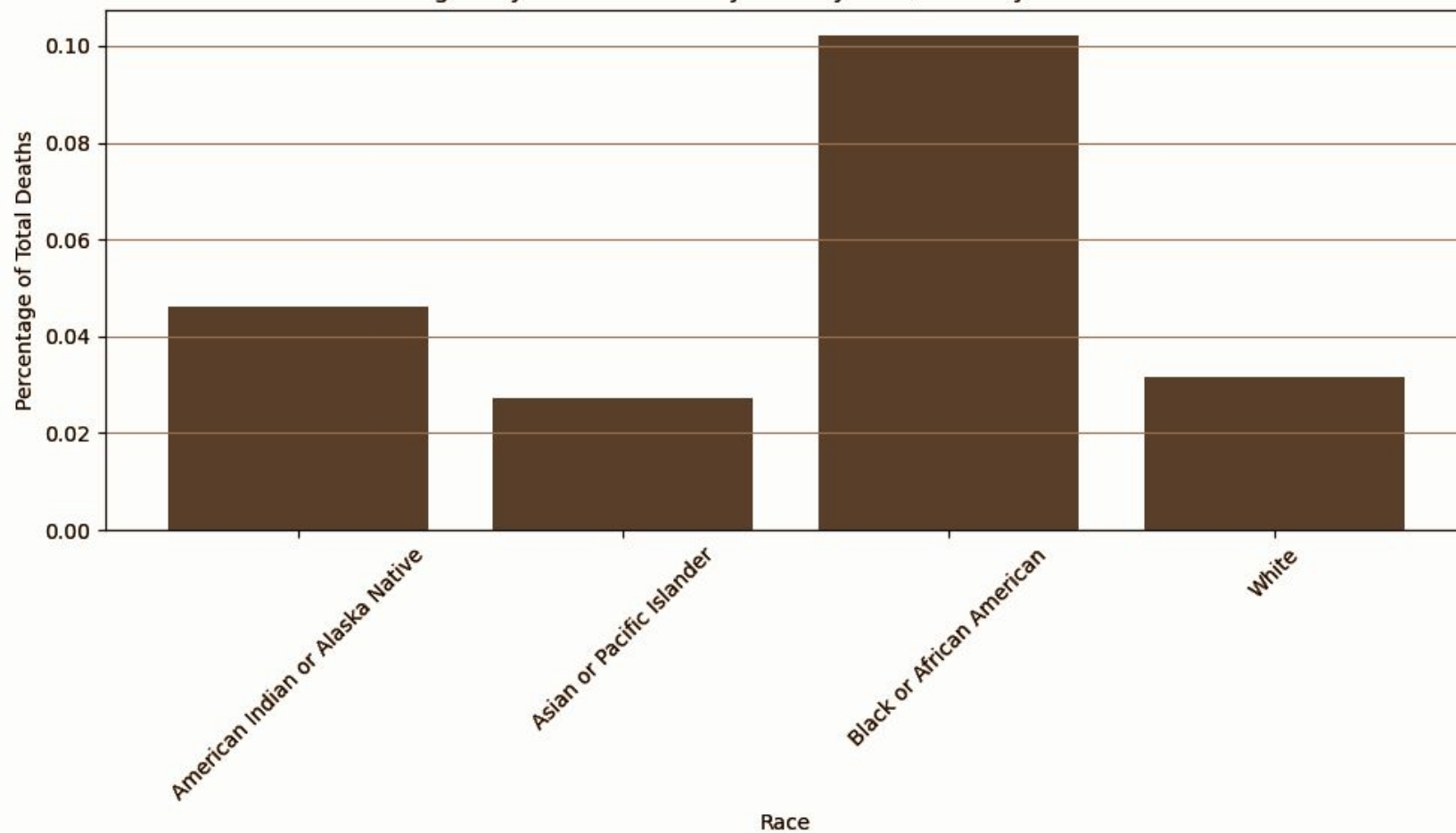
DISPARATE TREATMENT OF RACIAL GROUPS IN MEDICINE

Do black women in the united states (u.s.) disproportionately experience adverse pregnancy outcomes, including maternal mortality, compared to women of other racial and ethnic groups?

FINDING

yes. Black women in the united states (u.s.) disproportionately experience adverse pregnancy outcomes, including maternal mortality, compared to women of other racial and ethnic groups. Our results suggest a strong correlation between rate of incidence of maternal mortality and race (the racial and ethnic groups comprised of minority identities (non-white) experienced higher rates of maternal mortality and morbidity consistently over the past half century)

Pregnancy-related mortality ratio by race/ethnicity: 1999-2020



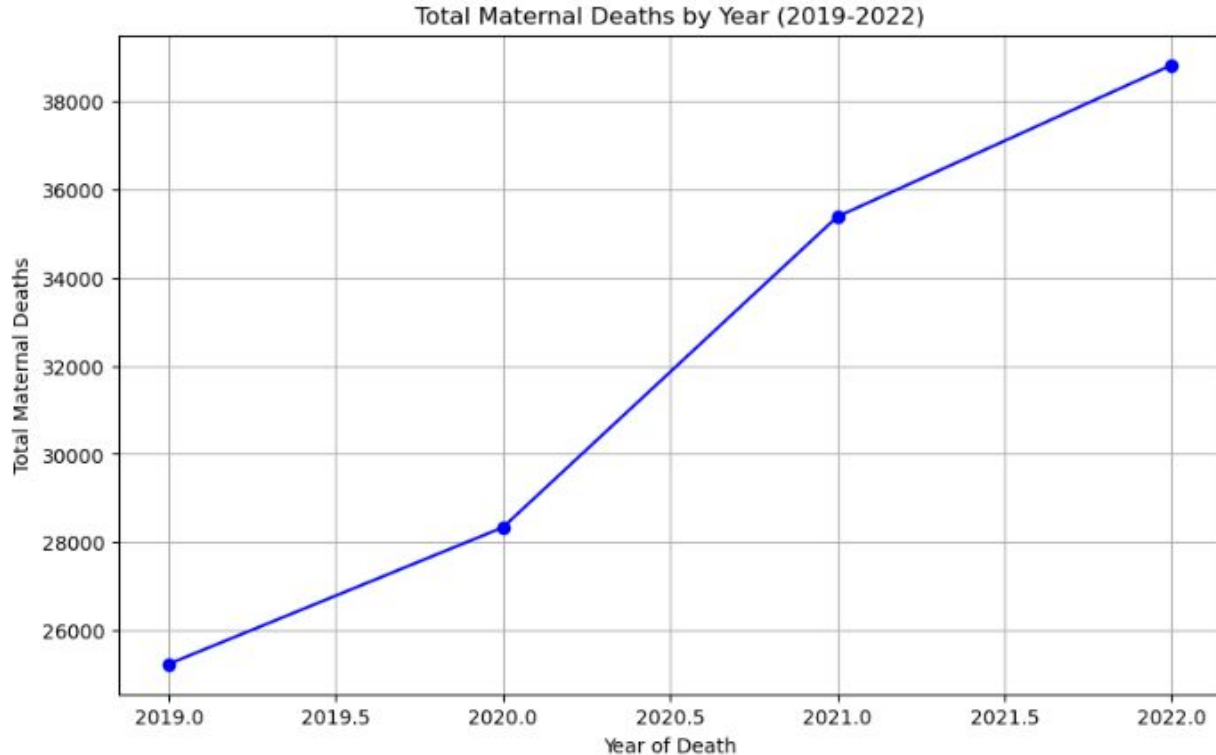
DISPARATE TREATMENT OF RACIAL GROUPS IN MEDICINE OVER TIME

Has the rate of incidence of maternal mortality and morbidity decreased over time (past half century) adjacent to the advancement of medicine and technology?

FINDING

No. Despite the relatively progressive advancements in technology and medicine, maternal mortality and morbidity rates of women in the U.S. have, on average, increased over time with a moderately strong relationship between the two variables (rate of incidence of mm and mm and time)

MATERNAL MORTALITY RATES ON THE RISE



Slope of the line: 4777.8999999984435

Correlation coefficient (r):

0.9876323129145643

IN CONCLUSION

Race affects rate of incidence of maternal mortality

Rate of incidence of maternal mortality has not decreased over time

Implicit bias, genetic susceptibility, and certain SDOH affect rates of incidence across different racial groups

factors of influence \neq causal factors

THANK YOU



ALTERNATE HYPOTHESIS

EXPANDED

Genetic susceptibility, implicit biases, and social determinants of health including income, employment status, geographic location, and education, have an impact on and/or a relationship with the rate of incidence of maternal mortality and morbidity.