Differences in the Utilization of Doppler Ultrasound Contribute to Racial Disparities in Pregnancy Outcomes

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2025

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Racial disparities in maternal and infant health outcomes have been a persistent and troubling feature of healthcare systems across the world, particularly in the United States. African American women, as well as American Indian and Alaska Native (AIAN) women, experience significantly worse pregnancy-related outcomes compared to their White counterparts, with rates of maternal mortality, fetal growth restriction (FGR), and preterm births disproportionately affecting these groups (Hill et al., 2022). According to the Centers for Disease Control and Prevention (CDC), Black women are three to four times more likely to die from pregnancy-related complications than White women, and this trend persists even when controlling for factors such as education and income level (Hill et al., 2022). Similarly, AIAN women are more likely to experience poor pregnancy outcomes, including higher rates of preterm birth and low birth weight (Hill et al., 2022).

These statistics raise several questions about the underlying causes of racial disparities in pregnancy outcomes. While social determinants of health such as socioeconomic status, access to care, and exposure to stress are often cited as contributing factors, these explanations do not fully account for the persistent nature of these disparities. One crucial, but often overlooked, factor is the role of medical technologies in shaping pregnancy outcomes. Doppler Ultrasound (DUS) is one of the most widely used technologies in modern obstetric care, helping to assess fetal well-being by measuring blood flow in the umbilical artery, the fetus's heart, and placental blood flow. These measurements are essential for detecting conditions such as FGR, placental insufficiency, and preeclampsia, which are key determinants of poor pregnancy outcomes. Despite its potential to save lives and improve pregnancy outcomes, the utilization and

interpretation of DUS is not equally distributed across different racial and socioeconomic groups, potentially contributing to the disparities observed (Peterman et al., 2022).

In this paper, I explored how differences in the application of Doppler Ultrasound (DUS) contribute to racial disparities in pregnancy outcomes, with a focus on Black and AIAN women. I examined how various factors—including historical, systemic, and clinical practices—shape the use and effectiveness of DUS, and ultimately, maternal and infant health outcomes. I aimed to uncover the intersections of technology, healthcare access, and racial bias, and to understand how these forces may work together to exacerbate disparities in maternal health.

Methods

I employed a mixed-methods approach, combining historical analysis, literature review, and qualitative interviews with clinicians. The objective is to explore the various dimensions of DUS utilization and how it relates to racial disparities in pregnancy outcomes, with a focus on both the social and technological aspects of the issue.

Review of Literature and Scientific Research

I first conducted historical research to explore how race and healthcare intersected historically to produce current racial disparities. In exploring the topic, I turned to works like *Medical Apartheid* by Harriet Washington and *Killing the Black Body* by Dorothy Roberts, which trace the history of medical experimentation and exploitation of African Americans in healthcare. I included several of these texts based on recommendations from STS advisor Professor Joshua Earle. I found others by exploring published journal reviews on PubMed, focusing on how Black Americans—particularly women—were victims in unethical medical

practices such as the case of Fannie Lou Hamer. I was able to examine how the legacy of such practices has fostered a deep mistrust of medical institutions through these sources.

Next I synthesize existing studies on racial disparities in maternal health outcomes, focusing specifically on the use and effectiveness of Doppler Ultrasound. I found scientific studies on Google Scholar and PubMed. They cover a range of topics, including racial biases in medical practice, the accessibility of prenatal care, the accuracy of fetal growth assessments, and the role of technological interventions in addressing or worsening healthcare disparities.

Clinician Interview

I conducted a qualitative interview with Dr. Christopher Ennen who is an obstetrician-gynecologist affiliated with University of Virginia Medical Center. His daily practices involve prenatal care, including obstetricians, maternal-fetal medicine specialists, and ultrasound technicians. I aimed to understand how clinicians navigate the challenges of interpreting ultrasound results in a way that minimizes racial bias through this interview.

The interview took place in UVA Health Science Library on February 20th in 2025 with both Dr. Ennen and two undergraduate engineering students present (Carol Wu and Anita Kau). Dr. Ennen was asked to reflect on his experiences using Doppler Ultrasound in prenatal care, particularly in relation to racial disparities in care. Questions asked during the 30-minute in-person interview are listed below:

1. In your experience, have you noticed any differences in pregnancy-related outcomes among patients from different racial or ethnic backgrounds at UVA hospital?
2. Have you observed any challenges that certain groups of patients seem to face more often during pregnancy care?

3. For the ultrasound estimate of fetal weight, some hospitals assess it using a personalized growth curve based on factors specific to the pregnant individual such as maternal height, weight, parity and race. Is that the case at UVA?
4. Are there other maternal or fetal health metrics that, in your experience, seem to vary by race or ethnicity in the way they are assessed or interpreted at UVA?

History of Medical Racism

The historical context is crucial for understanding why African Americans and other minority groups may be hesitant to engage with modern healthcare technologies, including prenatal care technologies like DUS. The Study of Untreated Syphilis in Negro Male, for instance, is a scientific tragedy that stemmed from the concept of "Race Medicine" which still impacts clinical practice and medical research today. The study started off to examine how syphilis differed in "the Negroes vs. the White," which assumes the Black people are so biologically different from the White people that the disease would affect the two racial groups differently (Brawley, 1998). One of the pseudoscientific racist beliefs is that it is the "frighteningly powerful sexual drives" that doomed the black people to chronic syphilis infection (Washington, 2008). However, family histories and clinical assessments revealed that more than 60 percent of the true syphilis cases in Macon County were congenital, nonvenereal syphilis that are not contracted through sexual activities. Medical researchers at the time deliberately ignored this fact in their published work and reported sexual profligacy as the main cause of syphilis in the black people. Furthermore, physicians involved in the Tuskegee Syphilis Study defended their failure to offer therapy to the black patients by putting the blame on the black people. They insisted that black people would never voluntarily seek treatment, while they conducted the study

that targeted economically disadvantaged African American men under the pretense of providing free medical care. Many physicians involved in the trial further believed that it was an unique opportunity to examine the natural progression of syphilis through restriction on giving patients treatments. The second phase of the study enrolled 399 men with syphilis who mostly come from poor education backgrounds (Brawley, 1998). The men were told they were in a study that will give free medical treatment for “bad blood”; however, the subjects of the studies were not informed that they had syphilis and were not given treatment of penicillin even when the medication was available. This mistrust contributes to lower rates of engagement with medical care and reluctance to trust medical authorities among the Black communities.

Indeed, the untreated syphilis study is just one example of medical racism among millions of other incidences throughout American History. The injustice that Fannie Lou Hamer endured is an example of unethical medical treatments specific to Black Women. Hamer entered the hospital to remove a knot on her stomach which is most likely a benign uterine fibroid tumor in 1961 (Washington, 2008). The surgeon removed her uterus along with the tumor without informing her or acquiring her consent. Although Hamer was enraged by the fact that she could never have babies of her own, she clearly knew that a lawsuit against a white surgeon was doomed. When she tried to redress the injustice through political means, she was rejected at the polling booth for the right to vote and kicked out from the plantation that was her home for almost twenty years. Hamer was not the only victim of eugenic control of African American Reproduction. The history of forcible sterilization fed suspicions that birth-control clinics financed by the government were attempts to erase the black presence in America. By 1972, the American Journal of Public Health reported that forty percent of surveyed blacks expressed a

deep distrust of sterilization programs, abortion clinics, and any birth-control programs run by whites (Washington, 2008).

The historical context also reveals how healthcare systems have been built on structures that prioritize White populations and marginalize people of color (Roberts, 1997). Responses from medical trainees in a 2016 study still show the persistent belief of the 19th century slave owner Dr. Thomas Hamilton that African American have “thicker” skins, less nerve endings and more tolerance for pain (Akinlade, 2020). Currently, pain management is at the discretion of the clinicians’ diagnosis that varies for different patients. In addition, the media emphasizes the substance abuse in African American and other minority groups, which perpetuates the stereotypes associating African American patients with substance abuse. Clinician biases towards the African American such as the distorted beliefs of pain tolerance can lead to lack of treatment for Black patients and result in catastrophic consequences. For similar reasons, institutional racism in healthcare has resulted in a system that fails to meet the needs of minority women, leaving them vulnerable to poorer health outcomes. An alarming 22% of Black women who have been pregnant or given birth reported being denied pain medication they believed necessary, a figure that is approximately double the rate reported by White women, underscoring significant racial disparities in maternal healthcare (Hill et al., 2022).

It is clearly too simplistic to attribute African Americans’ distrust of the medical system to any single event. Through historical analysis, I explored how specific instances of mistreatment—such as deceptive promises of treatment, forced sterilizations, and false beliefs about Black pain tolerance—have shaped today’s healthcare climate. Instead of blaming minority communities for avoiding medical care, society must acknowledge that trust must be earned through genuine, systemic reform of the medical system.

Interpretation of Doppler Ultrasound Results

Race-based Growth Standards contribute to Disparities

Historical inequities continue to shape the experiences of Black and AIAN women in the healthcare system today. Data from 2020 has shown that 55 deaths per 100,000 live births were reported for Black women, compared with 19 per 100,000 for White women and 18 per 100,000 for Hispanic women (Hill et al., 2022).

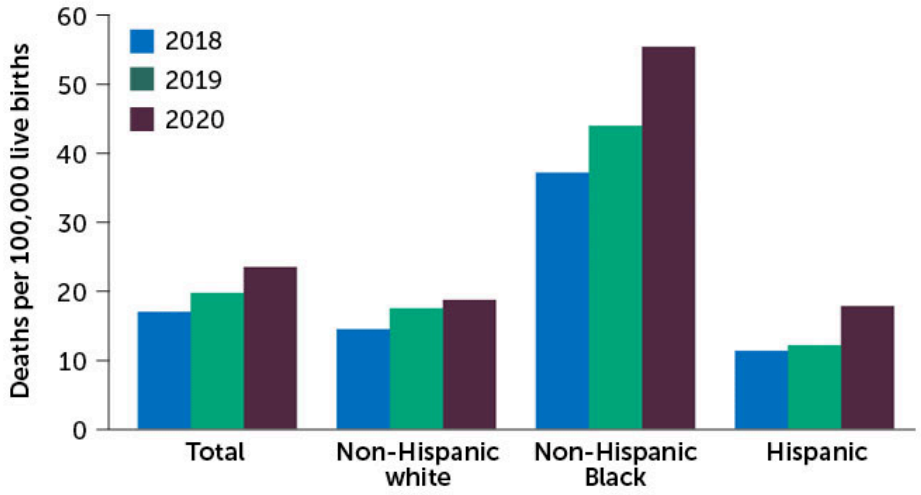

Figure 1. The maternal mortality rate for Black women is about three times the rate for White women and for Hispanic women, according to the U.S. Centers for Disease Control and Prevention. Source: National Vital Statistics System, Mortality/National Center for Health Statistics.

The lack of access to quality healthcare is a multifaceted issue not limited to geographical availability. In fact, hotspots of point-of-care ultrasound are urbanized counties with more Black representation who have less likelihood to be uninsured (Peterman, et al., 2022). Even with the premise of private health insurance and equal access to physician care, non-White women with twin pregnancies still have an increased risk of adverse outcomes compared to the White, including higher rates of preterm birth <32 weeks (12.5% versus 6.7%, p=0.022), cesarean

delivery (78.1% versus 14.5%, p=0.029), and gestational diabetes (23.3% versus 7.3%, p< 0.001) (Soffer, et al., 2017). Consequently, unequal access to healthcare and medical technologies would not explain the disparities observed in the minority women with pregnancy alone.

The significant disparities in the mortality rate and adverse outcomes for pregnant Black women lie partially in the use and interpretation of DUS across racial lines. Race-based growth standards are benchmarks developed to assess fetal and child development within specific racial or ethnic groups, acknowledging that genetic, environmental, and cultural factors can influence growth patterns. For instance, the NICHD Fetal Growth Studies found significant differences in fetal growth among various racial and ethnic groups, leading to the creation of tailored growth charts to improve assessment precision. However, the use of race-based standards has been debated, with concerns that they may overlook the complex interplay of socioeconomic and environmental factors influencing growth. Recent discussions advocate for more individualized assessments that move beyond racial categorizations to more accurately reflect individual growth trajectories.

Black women, for example, are more likely to be misdiagnosed with fetal growth restriction (FGR) based on race-based growth standards. FGR is a condition where a developing fetus grows more slowly than expected for its gestational age. Specifically, it is diagnosed when the fetus's weight, length, or head circumference falls below the 10th percentile for its gestational week. Different factors in the mother can cause or contribute to FGR, including but not limited to high blood pressure, anemia, diabetes; various factors in the fetus can also cause FGR, such as being one of a twin or triplets, infections, birth defects or problems with genes. Typically, one estimate of fetal weight derived by ultrasound would be performed at 24-41 weeks to prescreen for potential health problems in maternal bodies and fetuses. In a 2022 retrospective

cohort study at Magee-Womens Hospital in Pittsburgh, researchers compared rates of fetal growth restriction (FGR) among fetuses identified as small for gestational age (SGA) at birth. They assessed estimated fetal weight (EFW) using two standards: A) CUST-race: A customized standard incorporating fetal sex, maternal height, weight, parity, and race. B) CUST-no race: A similar customized standard excluding race. The study found that excluding race from the customization improved the recognition of FGR in Black patients without negatively affecting other groups. Notably, the CUST-race is the standard practice used at MWH from 2012-2021. Of the 9,378 patients enrolled in the study, 15.6% were Black, and 7.8% delivered small gestational age newborns, of which 23.6% were Black. With the CUST-no race standard, the percentage of Black patients with small gestational age newborn that meet criteria for FGR at the time of ultrasound would increase to 40.7%.

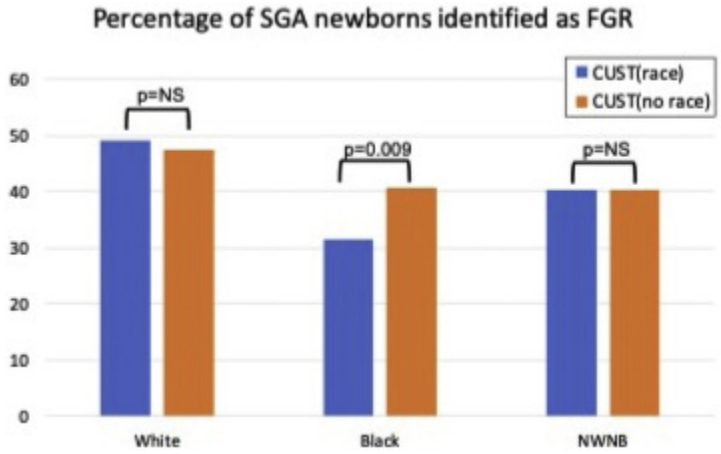

Figure 2. The percentage of Black patients with small for gestational age newborns that meet criteria for FGR would increase from 31.4% with the CUST-race standard to 40.7% with the CUST-no race standard (p=0.009). Source: Ramesh, P., & Larkin, J. (2022). Race-based customization of fetal growth standards—What is the impact on disparities? *American Journal of Obstetrics & Gynecology, 226*(1), S61–S62.

Exclusion of race in the customization of fetal growth standards improves recognition of FGR for Black patients without negative effects (Ramesh, et al., 2022). Misdiagnosis and failed

recognition of FGR could lead to unnecessary interventions, such as cesarean sections, which can have negative consequences for both mother and child. The finding underscores the role of implicit bias among healthcare providers in shaping the use and interpretation of DUS. Studies have shown that healthcare providers often rely on race-based assumptions when interpreting ultrasound results, leading to inaccurate diagnoses and lack of prompt intervention or treatments.

Systematic Structural Inequalities Impact Racial Disparities

Dr.Ennen reported that clinicians in the field of obstetrics and gynecology are often aware of racial disparities in pregnancy outcomes but feel constrained by systemic factors such as time restraints and the number of patients' visits. When the patients arrive at the University of Virginia hospital, they will be subject to the same and fair treatment. The problem often arises when patients cannot come to the hospital to receive frequent monitoring or prompt treatment due to working for three or more jobs, lack of insurance, or their inherent mistrust in the medical institutions. Therefore, racial disparities in pregnancy outcomes reflect a systemic issue rather than the result of any one doctor's ignorance or ill intent.

Dr. Ennen further emphasized that the reliance on race-based growth standards for estimating fetal weight in clinical settings is a practice that, while rooted in tradition, may not necessarily be beneficial. The use of these standards requires significant additional effort to adjust individual metrics for each patient, but research has shown that it does not lead to substantial improvements in prediction accuracy. More concerning is that this method may inadvertently contribute to overdiagnosis, potentially leading to unnecessary medical interventions such as early inductions or cesarean sections. These interventions, while sometimes well-intentioned, can have negative consequences for both the mother and the baby, including

increased risks associated with surgical procedures or preterm birth. Dr. Ennen noted that at the University of Virginia hospital, race-based growth standards are not used, recognizing that they do not offer tangible benefits in clinical decision-making.

Dr. Ennen's comments reflect a broader systemic issue in healthcare, where well-intentioned clinicians may still be constrained by institutional biases and external pressures. Limited resources, the influence of insurance companies, and the broader structural inequalities in healthcare systems continue to hinder the delivery of truly equitable care. Addressing these challenges will require a multi-faceted approach, including dismantling institutional biases, providing adequate resources, and creating systems that prioritize the well-being of all patients equally. This will ensure that all women, regardless of race or socioeconomic status, have access to high-quality prenatal care and are not subject to biased practices that perpetuate health disparities.

Discussion

Through this study, I found that systemic issues–such as the mistrust minority communities feel toward medical institutions–and the way clinicians use Doppler Ultrasound (DUS) play a major role in the ongoing racial disparities in pregnancy outcomes. Through the research of historical medical racism, I used race critical theory to examine how racism as a social construct directly impacted the national medical system. Race has been considered not as a social construct but rather a biological factor in giving treatments to patients from different racial and ethnic backgrounds. While some pregnancy-associated complications such as uteroplacental vascular insufficiency and small gestational age for birth do vary by ethnicity, some pseudoscience on racial differences still permeates the current medical system in the United

States. One of the most common implicit biases is the myth of high pain tolerance for the African American population, which originated from the belief of a 19th century physician Dr. Thomas Hamilton that African American patients were biologically different from the White. Even after two centuries, African American patients that received treatments at the most renowned medical institution such as Johns Hopkins would encounter scenarios where physicians refuse to give enough pain killer medicine due to the systematic implicit bias and stereotypes of the prevalent drug abuse associated with the African American population. Medical mistrust in the minority group community is also impacted by the unethical precedent of clinical studies. In both the untreated Syphilis study and the case of Fannie Lou Hamer, African American patients were denied information about their conditions and were never asked for consent to receive appropriate treatment. This long-dated injustice of the medical system impacts both the patients from different ethnicities in seeking prompt prenatal care and the physician's judgment in providing the best care tailored to the needs of the minority patient group.

I used the race critical theory again to determine the role of DUS in racial disparities among adverse pregnancy outcomes. I discovered that, contrary to the common belief, multiple barriers including socioeconomic factors such as lack of insurance, geographic location, and limited access to healthcare facilities equipped with high-quality ultrasound technology are not the main factors that contribute to this disparity. One major factor that contributes to this disparity is racial biases in the interpretation of DUS results, creating a situation where Black and American Indian/Alaska Native (AIAN) women are disproportionately affected by poor pregnancy outcomes. DUS results are often subject to race-based growth standards, which introduce an additional layer of bias into the clinical decision-making process. For example, Black women are more likely to be diagnosed with FGR based on these race-adjusted standards,

which are not universally applicable to all populations. This leads to a higher rate of false-positive diagnoses, resulting in unnecessary medical interventions such as early inductions and cesarean deliveries. These interventions carry risks of maternal and fetal complications, contributing to the overall poor pregnancy outcomes among Black and AIAN women.

To effectively address this disparity in prenatal care, a multi-faceted approach is required, involving policy interventions, changes in clinical practice, and the dismantling of systemic biases that permeate healthcare systems. A crucial aspect of addressing these disparities is the removal of race-based growth standards in the interpretation of DUS results. These race-adjusted standards often contribute to the misdiagnosis of conditions like FGR. Continuing to use these standards perpetuates racial disparities in the diagnosis and treatment of pregnant women, leading to unnecessary medical interventions that can harm both the mother and the baby. By removing race-based growth standards and adopting evidence-based practices for fetal assessment, healthcare systems can improve the accuracy of diagnoses and ensure that all women receive appropriate care tailored to their individual needs.

Furthermore, addressing these disparities requires a broader understanding of the social determinants of health that affect maternal and infant outcomes. Other actors identified through the interview with Dr. Ennen relate to structural inequalities such as poverty, access to education, and discrimination in healthcare settings, all contributing to the inequitable distribution of health outcomes. For example, women who experience chronic stress due to financial instability, discrimination, or inadequate access to healthcare services are at higher risk for pregnancy complications. These factors are compounded for Black and AIAN women, who often face compounded disadvantages due to the intersectionality of race, class, and gender. Policies aimed at addressing these broader social determinants of health are necessary to reduce the overall

burden of health inequities. These policies might include expanding access to affordable housing, improving access to quality education and employment opportunities, and ensuring that all individuals have access to high-quality healthcare services, regardless of their background.

Ultimately, addressing the disparities in pregnancy outcomes for Black and AIAN women requires a holistic approach that considers the complex interplay of historical, social, and systemic factors that shape health disparities. By focusing on eliminating racial biases in healthcare practices and addressing the broader social determinants of health, we can begin to reduce the racial disparities that persist in maternal and infant health. In doing so, we can ensure that all women, regardless of their race or socioeconomic status, have access to the same quality of care and the same opportunities for healthy pregnancies. This is not only a moral imperative but a necessary step toward achieving health equity for all women.

Conclusion

The findings from this study suggest that differences in the utilization and interpretation of Doppler Ultrasound contribute significantly to racial disparities in pregnancy outcomes. Black and AIAN women, as well as women from lower socioeconomic backgrounds, are more likely to experience poor pregnancy outcomes due to the over-diagnosis of complications based on racial assumptions and systematic inequality that prevents them from frequent clinical visits.

The historical context of medical exploitation and mistrust in healthcare institutions is a key factor in explaining why these disparities persist. The legacy of medical experimentation on marginalized communities continues to shape how these communities interact with healthcare systems and their willingness to engage with medical technologies like DUS. Overcoming this historical trauma is essential to building trust and improving healthcare access for these

populations. Moreover, the literature review and clinician interviews highlight the role of systemic biases in healthcare systems, including mistrust in the medical system due to previous implicit biases towards minority groups among healthcare providers, race-based growth standards, and disparities in healthcare infrastructure. These systemic factors contribute to the unequal use and interpretation of DUS and ultimately to the racial disparities observed in pregnancy outcomes.

This study has important implications for policy and clinical practice. Policymakers must work to ensure that all women, regardless of race or socioeconomic status, have equal access to high-quality prenatal care, including Doppler Ultrasound. This will require increased funding for healthcare infrastructure in underserved communities, including access to ultrasound equipment and qualified technicians. Additionally, healthcare providers must receive training on implicit bias and race-neutral approaches to interpreting DUS results. Standardizing fetal growth standards and removing race-based assumptions from ultrasound interpretation will help ensure that all women receive accurate diagnoses and appropriate care.

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