Duke Clinical & Translational Science Institute

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Maternal Morbidity at Duke and UNC

A Multicenter Examination of Risk Factors and Trends of Pregnancy-Related Morbidity

A TRANSLATIONAL SCIENCE BENEFITS MODEL **CASE STUDY**

In a Nutshell

Over the past 30 years, maternal morbidity and mortality rates for pregnant patients in the United States have more than doubled. Rates now exceed other high-income nations, and there are severe disparities in maternal mortality. This research determines the severe maternal morbidity rate (SMM) at Duke and UNC and examines racial and ethnic disparities within those morbidity events.

Significance

Maternal morbidity is disappointingly high in North Carolina with unjust race and ethnic disparities. Severe maternal morbidity (SMM) encompasses events that occur during and after pregnancy that are harmful or dangerous to a patient's health and may even lead to death. These morbidity events include organ damage, such as heart attacks, strokes, lung failure, blood clots and kidney failure. Severe maternal morbidity occurs in 1.75% of deliveries in North Carolina, compared to roughly 1.2% of deliveries nationwide. Also in North Carolina, Black patients experience SMM at a rate 1.8 times higher than White patients. While predicting which patients may experience maternal morbidity has the potential to improve health care delivery and save lives, there are currently no effective mechanisms for prediction.

Overarching Goals and Approach

Ultimately, this project aimed to reduce maternal morbidity and mortality at Duke and UNC. Towards that goal, the project specifically intended to create a multicenter dataset of maternal comorbidities (medical diseases before pregnancy) and outcomes. With this dataset, the team 1) used the OB Comorbidity Index (OB-CMI; a weighted risk score that uses 20 diseases present at the time of delivery; Leonard 2020) to determine the risk profile of pregnant patients at Duke and UNC and determine the morbidity events that are most common; 2) determined the SMM rate at Duke and UNC; and 3) explored what racial and ethnic disparities exist in SMM. Duke and UNC both have large health systems and significant referral volume for high levels of care.

The dataset included information on patient outcomes, the OB-CMI, and demographic factors including race. To create the multicenter dataset, electronic medical records of both hospital systems were used to collect data about birth-related hospitalizations from 2016 to 2020 regarding comorbidities (such as chronic hypertension and autoimmune diseases) preceding delivery admission and diagnoses acquired during hospital admission, as well as readmission.

Because the OB-CMI was developed in a different region of the U.S., one of our goals was to examine how the OB-CMI performs in this dataset, and how rates of SMM and non-transfusion SMM compared between patients who delivered in our health systems and to national rates generated from delivery hospitalizations in the 2018 National Inpatient Sample (NIS). The distributions of OB-CMI were similarly compared using weighting designed to predict SMM and non-transfusion SMM across the health systems and births in the 2018 NIS sample. Researchers found that, at both Duke and UNC, there was large variation in burden of comorbid conditions and non-transfusion SMM among birthing patients. For the OB-CMI scores, both health systems had a higher median

score when compared to the national sample.

To evaluate the association between race and ethnicity and the incidence of SMM, electronic medical records were used to extract demographic and pregnancy-related data. To ensure an adequate sample size and occurrence of the outcome, the analysis was limited to non-Hispanic Black, Hispanic, and non-Hispanic White pregnant people. The primary outcome of interest was non-transfusion SMM at the time of birth hospitalization, as defined by the Centers for Disease Control and Prevention. The secondary outcome of interest was all SMM. There were significant differences in outcomes among groups by age, payer, gestational age at delivery and route of delivery, and OB-CMI score. Odds ratios (OR) were adjusted for primary payer, delivery rout, and OB-CMI. In addition, non-Hispanic Black (OR 1.32, 95% CI 1.11, 1.56) and Hispanic (OR 1.43, 95% CI 1.14, 1.80) birthing people had significantly higher adjusted odds of non-transfusion SMM than birthing non-Hispanic White people, with the adjusted odds of non-transfusion SMM highest among Hispanic people.

Future Directions

Future directions include validation of SMM events by comparing coding to events included in the electronic health records and developing computable phenotypes (a set of criteria that do not require clinician interpretation, such as laboratory data or vitals for each SMM event) to verify SMM events without opening individual charts. Much retrospective clinical research is performed by individual chart abstraction; however, that is tedious and time consuming. In contrast, coding data is less accurate and does not completely capture the patient's experience. A computable phenotype would allow for improved accuracy in SMM research and a clearer picture of these rare but serious outcomes. Future directions include ensuring that SMM events are 1) coded correctly by billers, and 2) do not represent a previous diagnosis carried forward from an earlier hospital encounter. Creating universal computable phenotypes (definitions that consist of data elements and logical expressions such as AND, OR, and NOT) that can be interpreted and executed by data algorithms would also be helpful to identify SMM events. This would offer a more valid process than using the ICD 10 codes alone.

Facilitators of Success

Pilot Award to Junior Researchers

The Pilot award between two institutions, as well as the funder's willingness to grant funding to two early career investigators, contributed significantly to the success of the project.

Historical Collaboration

The primary investigators of this study were introduced by a mentor collaborating between the two institutions. This introduction was facilitated by an historic institutional collaboration between the Duke and UNC Obstetric and Obstetric Anesthesiology departments. Furthermore, the partnership established a strong team of co-investigators and trainees, allowing a variety of knowledge to influence the project independent of specific institutions.

Interinstitutional Collaboration

This Duke/UNC collaboration brings together a team with diverse expertise and allows for more complete data capture than possible with a single institution. Marie-Louise Meng, MD (Duke principal investigator) is an obstetric and cardiothoracic anesthesiologist with expertise in high-risk maternal care research. Johanna Quist-Nelson,

MD (UNC principal investigator) is a maternal-fetal medicine physician with expertise in maternal safety and quality improvement. This collaboration recognized the need for partnership between obstetrics and anesthesiology to provide appropriate care to pregnant patients at risk of severe maternal morbidity. Both PIs had mentors who are national leaders in maternal-fetal medicine with expertise in areas such as risk assessment and data-informed strategies for risk-appropriate care, as well as in racial and ethnic disparities in maternal care. This collaboration improved the data capture as the two sites shared patients. The data query involved steps to identify patients who experience SMM on readmission regardless of site of delivery. Without this collaboration, data would have only captured SMM events at a patient's delivery institution, resulting in less complete data for individual patients. Looking forward, this interinstitutional collaboration will also facilitate implementing strategies to decrease severe maternal morbidity and advance health equity.

Workforce Development

Funding this project directly supported the careers of the co-principal investigators, since both Dr. Meng and Dr. Quist-Nelson are early career investigators. The project also brought together investigators from varying backgrounds, as Dr. Meng is both an obstetric and a cardiac anesthesiologist and Dr. Quist-Nelson is a maternal-fetal medicine specialist.

Challenges and Learnings

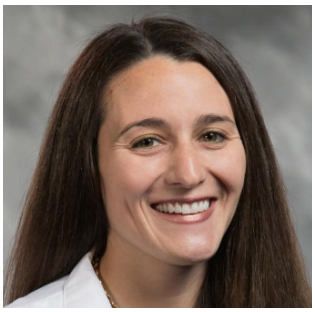
Challenge: Data Use Agreement

One of the biggest challenges for this project was the creation of the data use agreement between the two institutions, which involved time and administrative hurdles. Both PIs are clinicians and junior investigators new to interinstitutional navigation, leading to administrative burden between balancing clinical obligations with researchers and an extended learning process on navigating multiple institutional systems. While the project received IRB approval, the process of the data use agreement was time-consuming and led to delays in the project. The team was able to request and receive a six-month extension to their one-year funding period to accommodate these delays. During the delay, the research team published an article focused on the need for comprehensive, high-quality datasets to improve SMM and racial disparities in obstetrical care and formed a research collaboration with epidemiologists at Harvard, leading to a funded RO1.

Challenge: Data Captured

Because the purpose of this project was to define maternal morbidity in the UNC and Duke populations, the team planned to capture high-level data (i.e. ICD codes). Retrospectively, team members wished that they captured more data points (i.e. disease lab values) to further define problems caused during the childbirth process. The research team plans to dive deeper into the data for their next project. They learned, for future projects, to expand their data set and the details within it.

Key Personnel and Collaborators



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Program Milestones to Date

Date	Milestone Type	Description
April 2021	Funding	Received funding from Duke CTSI to conduct pilot study of Maternal Morbidity at Duke and UNC: a multicenter examination of risk factors and trends of pregnancy related to morbidity.
July 2021	Project Start Date	The beginning date of the project.
August 2021	Foundation for Anesthesia Education and Research MRTG submission	Meng PI Foundation for Anesthesia Education and Research MRTG submission Project Title: Cardiovascular Risk Prediction for Improved Maternal Health This project proposed to use the Duke/UNC dataset created by the CTSI project.
October 2021	FAER MRTG awarded	PI Meng: Start Date: January 1, 2022, End Date: December 31, 2023
Jan 2022	Follow-on Funding	Foundation for Anesthesia Education and Research: Meng PI
Jan 2022	Partnership with Harvard formed	Partnership created with Harvard epidemiologists.
Feb 2022	Poster Presentation	Society for Maternal Fetal Medicine
Dec 2022	Project End Date	The ending date of the project.
Jan 2023	Publication	"For better care we need better data: towards a national obstetrics registry"
Jan 2023	Publication	First paper published in *American Journal of Obstetrics & Gynecology MFM*
Feb, 2023	Abstract Publication	"Differences in severe maternal morbidity and comorbidity indices in two North Carolina Health Systems"
Feb, 2023	Abstract Publication	"Racial and Ethnic Disparities in Severe Maternal Morbidity in Two Health Systems in North Carolina"
July 2023	R01 Submitted	Leveraging machine learning for cardiovascular disease risk prediction and prevention in women with a history of adverse pregnancy outcomes
Dec 2023	Exploratory Research Letter Submitted	Exploratory research letter submitted about morbidity codes.
Dec 2023	R01 funded	"Leveraging machine learning for cardiovascular disease risk prediction and prevention in women with a history of adverse pregnancy outcomes"
Feb 2024	Paper Publication	Hospital Discharge Codes and Overestimating Severe Maternal Morbidity During Delivery Hospitalization

Translational Science Benefits Summary

COMMUNITY

Public Health Practices

SMM is a public health crisis in the United States. Defining the local impact of SMM at two large centers allows for regional public health and policy development. (Potential)

Health Education Resources

Identification of leading regional causes of SMM may inform health education prevention resources for prenatal patients. (Potential)

Health Care Delivery

Evaluation of SMM by nationally recognized maternal levels of care will allow for evaluation for pairing patient risk factors with appropriate institution level. (Potential)

Health Care Quality

SMM is a potential measure of health care quality for pregnancy and delivery. (Potential)

Disease Prevention & Reduction

The creation of a multi-center dataset examining diseases present at the time of delivery and severe maternal morbidity events will help to reduce SMM events and even save lives at our institutions.

This model of localized examination of disease states and multi-center collaboration can be applied to other centers to reduce disease burden. (Potential)

CLINICAL

Guidelines

Standardized approaches for measuring SMM using both administrative (billing) data and clinical including electronic medical record (EMR) data, and reliable comorbidity indices for obstetric care that assist in risk stratification and risk adjustment at the patient and facility level. (Potential)

Software Technologies

Creation of computable phenotypes for SMM will allow for improved data capture to assess maternal morbidity rates and measure improvement. (Demonstrated)

POLICY

Policies

SMM is a public health crisis in the United States. Defining the local impact of SMM at two large centers allows for regional public health and policy development. (Potential)

Other Benefit Indicators

Health Equity & Disparities

There is a need for examination of racial and ethnic disparities that exist within SMM and the OB-CMI. Determining the underlying comorbidities of pregnant patients at Duke and UNC, and the cumulative risk these comorbidities pose by race and ethnicity, is essential to highlighting modifiable disparities in care. This is the first step towards prospective application of this index in our inpatient units. By creating a multicenter dataset, researchers were able to determine where race and ethnicity disparities exist within the Duke/UNC cohort and create a Duke/UNC specific risk score for further review.

CTSA Resources Used

Core	Type of Service
Informatics	Created data set.
Clinical Data Research Networks (CDRN)	Helped to leverage the standardized data platform, provided by the PCORnet Common Data Model, to obtain data which have been made consistent between the two Epic implementations.

Other Institutional Resources Used

Group	Type of Service
Melissa A. Daubert, MD	Received a previous grant looking at blood pressure after delivery between Duke and UNC and set the groundwork for how they hash the patients back and forth between the two institutions.

Resources Needed

Group	Type of Service
Mentorship in Administrative Processes	Two early career investigators navigating two different institutional systems led to the delay in the project. While team members were able to seek help within the institutions, it would have been useful to have a direct support person to help navigate administrative processes between the two institutions, such as the data use agreement.

Images

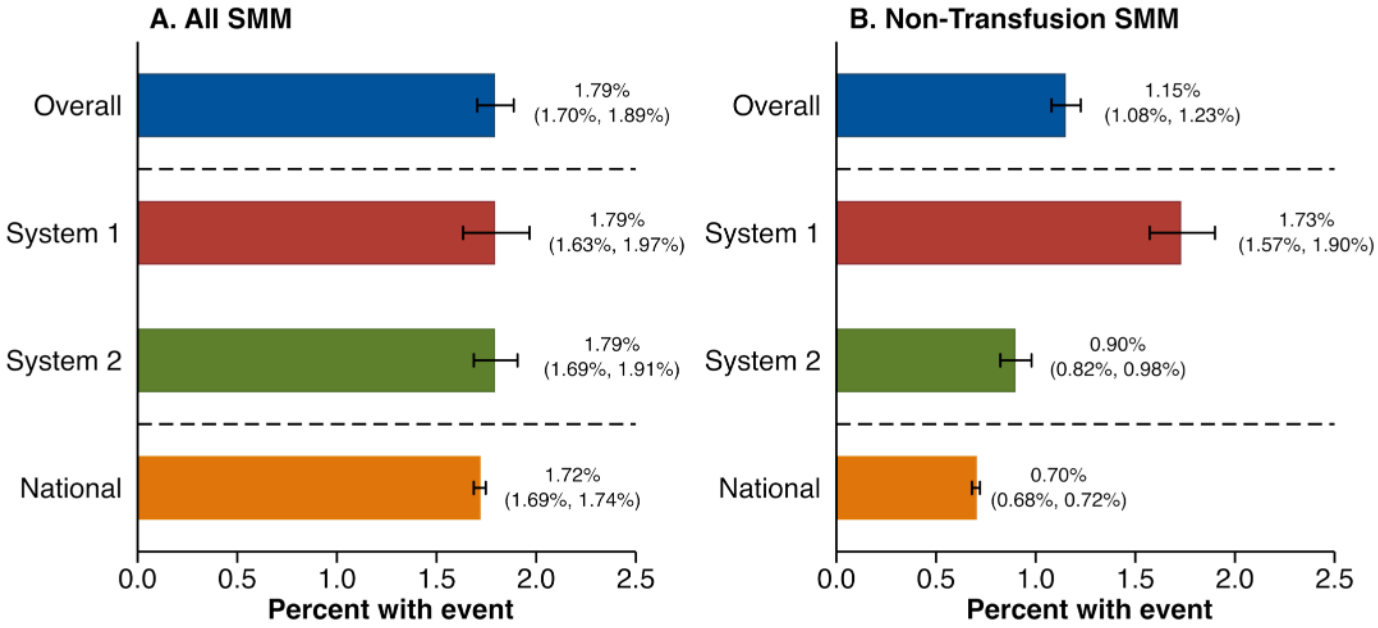


Figure 1: Frequency of severe maternal morbidity (Panel A) and non-transfusion severe maternal morbidity (panel B)

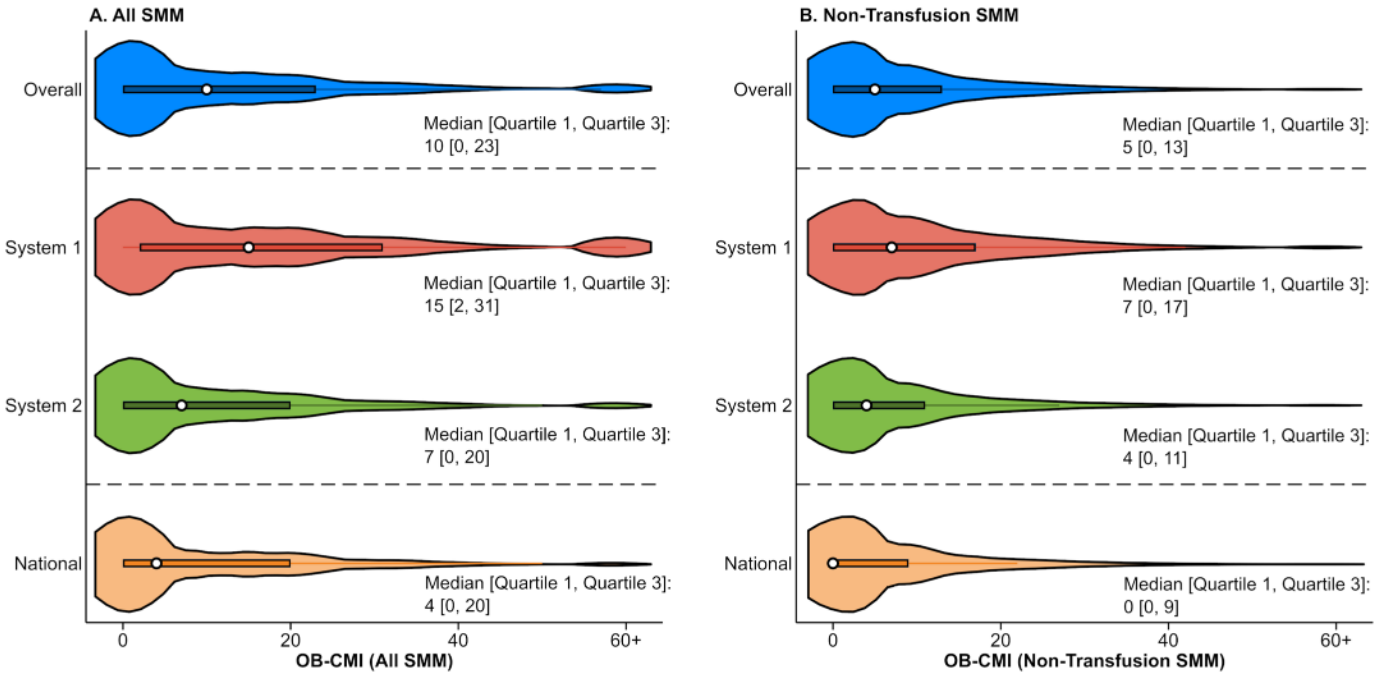
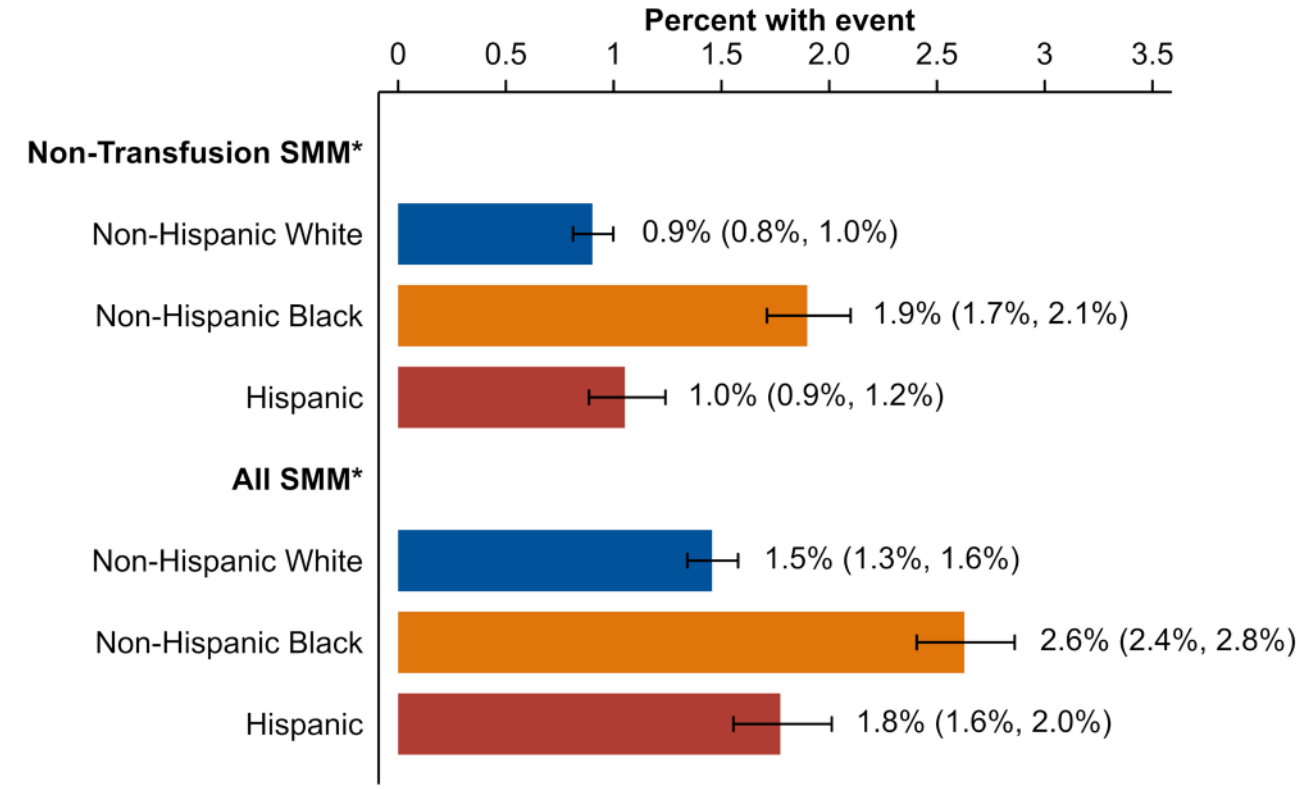


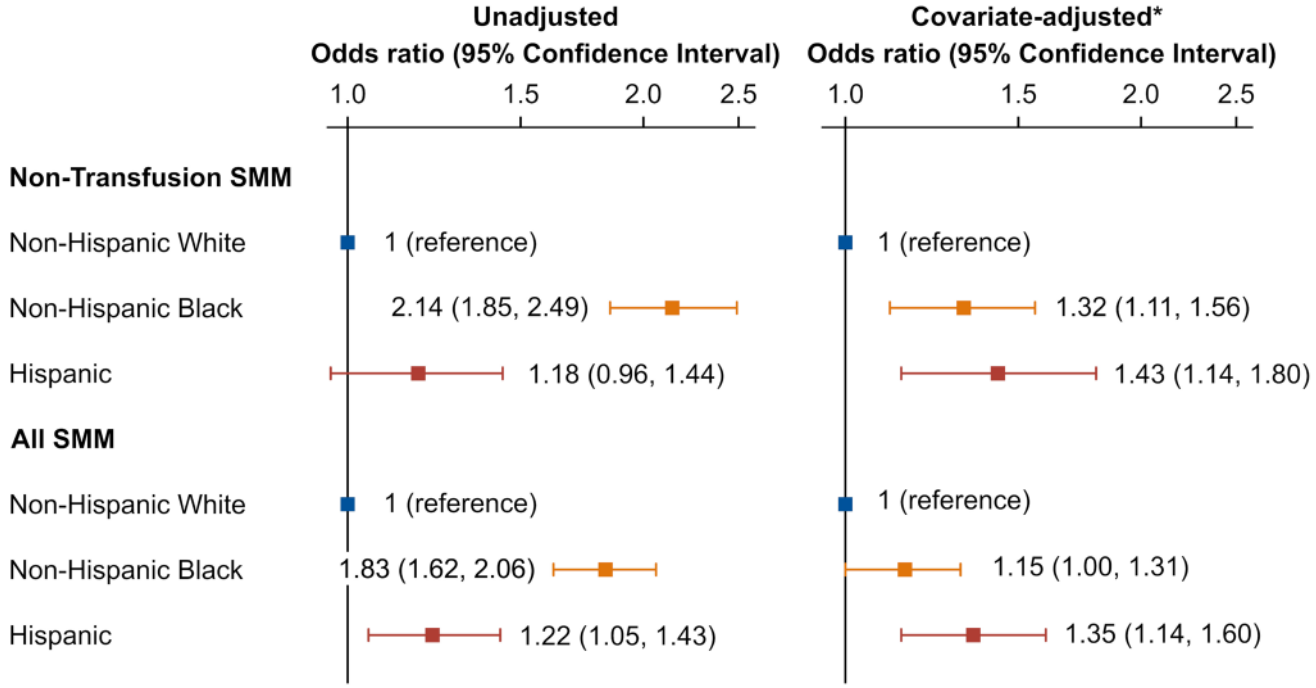
Figure 2: Distribution of Obstetric Comorbidity Index (OB-CMI), weighted for all Severe Maternal Morbidity (SMM) in Panel A and non-transfusion SMM in Panel B. The violin plots show the distribution of risk scores in the overall sample, each health system individually, and compared to the 2018 National Inpatient Sample. The small box plot in the center illustrates the median (circle) and lower quartile and upper quartile range (range of box).

A. Rates of Non-Transfusion and All SMM



* p < 0.0001 for differences among racial/ethnic groups

B. Unadjusted and adjusted comparisons versus Non-Hispanic white



* Adjusting for primary payer, delivery route, and OB-CMI

For More Information

References:

1. Federspiel JJ, Kucirka LM, Mallampati DP, et al. For better care we need better data: towards a national obstetrics registry. *Am J Obstet Gynecol MFM*. 2023;5(1):100787. doi:10.1016/j.ajogmf.2022.100787.

2. Federspiel JJ, Mallampati DP, Hughes BL, et al. Differences in severe maternal morbidity and comorbidity indices in two North Carolina health systems. *Am J Obstet Gynecol*. 2023; 228(1): S492–S493. https://doi.org/10.1016/j.ajog.2022.11.847

3. Mallampati DP, Federspiel JJ, Hughes BL, et al. Racial and ethnic disparities in severe maternal morbidity in two health systems in North Carolina. *Am J Obstet Gynecol*. 2023; 228 (1): S293-S294. https://doi.org/10.1016/j.ajog.2022.11.520

4. Quist-Nelson J, Meng ML, Mallampati D, Federspiel J, Kucirka LM, Fuller MS, Menard MK. Hospital Discharge Codes and Overestimating Severe Maternal Morbidity During Delivery Hospitalization. *Obstet Gynecology*. 2024 Feb 22. Epub ahead of print. PMID: pending

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