Increased Risk of NICU Admission and Neonatal Mortality Associated with Maternal Comorbidities, Race, and Age

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Key Findings:

- Babies born to mothers who had hypertension or gestational diabetes, or who were over age 40 had the greatest risk of being admitted to the NICU.
- Babies born to mothers who are Black, who have a higher social vulnerability index (SVI), or who were over age 40 had the greatest risk of neonatal mortality.

The Centers for Disease Control and Prevention (CDC) considers infant mortality one of the overall indicators of a society's health.[1] To better understand what risk factors are most correlated with neonatal mortality and conditions requiring neonatal intensive care, we studied 3,207,461 infants born between January 1, 2016, and June 30, 2023. In our model we adjusted for maternal hypertension, gestational diabetes, maternal age, SVI, drug use, maternal or infant infections, maternal autoimmune conditions, and marital status.

We found that babies born to mothers diagnosed with hypertension or gestational diabetes during pregnancy had 111% and 55% greater odds of being admitted to the NICU than those born to mothers without those diagnoses, respectively. Babies born to mothers over age 40 had 40% greater odds of being admitted to the NICU than those born to mothers ages 20-29. Lastly, babies born to mothers in the highest SVI percentile had 26% greater odds of being admitted than those born to mothers in the lowest SVI percentile.

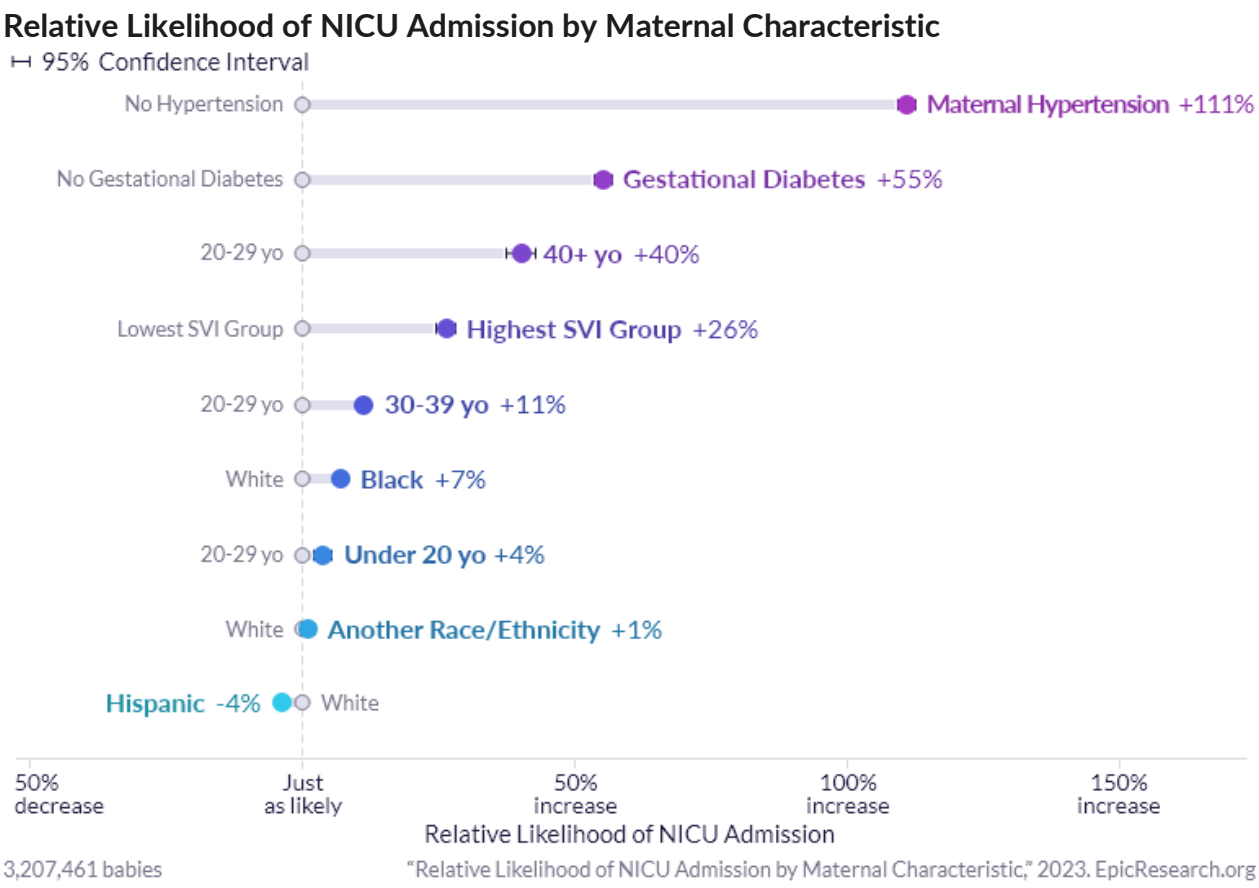

Figure 1. The relative likelihood of a baby being admitted to the NICU by maternal characteristic.

When evaluating increased risk for neonatal mortality, we found that babies born to Black women had 94% greater odds of mortality than babies born to White mothers. Babies born to mothers in the highest SVI percentile had 80% greater odds of neonatal mortality than those born to mothers in the lowest SVI percentile. Babies born to mothers over age 40 had 72% greater odds of mortality than those born to mothers aged 20-29.

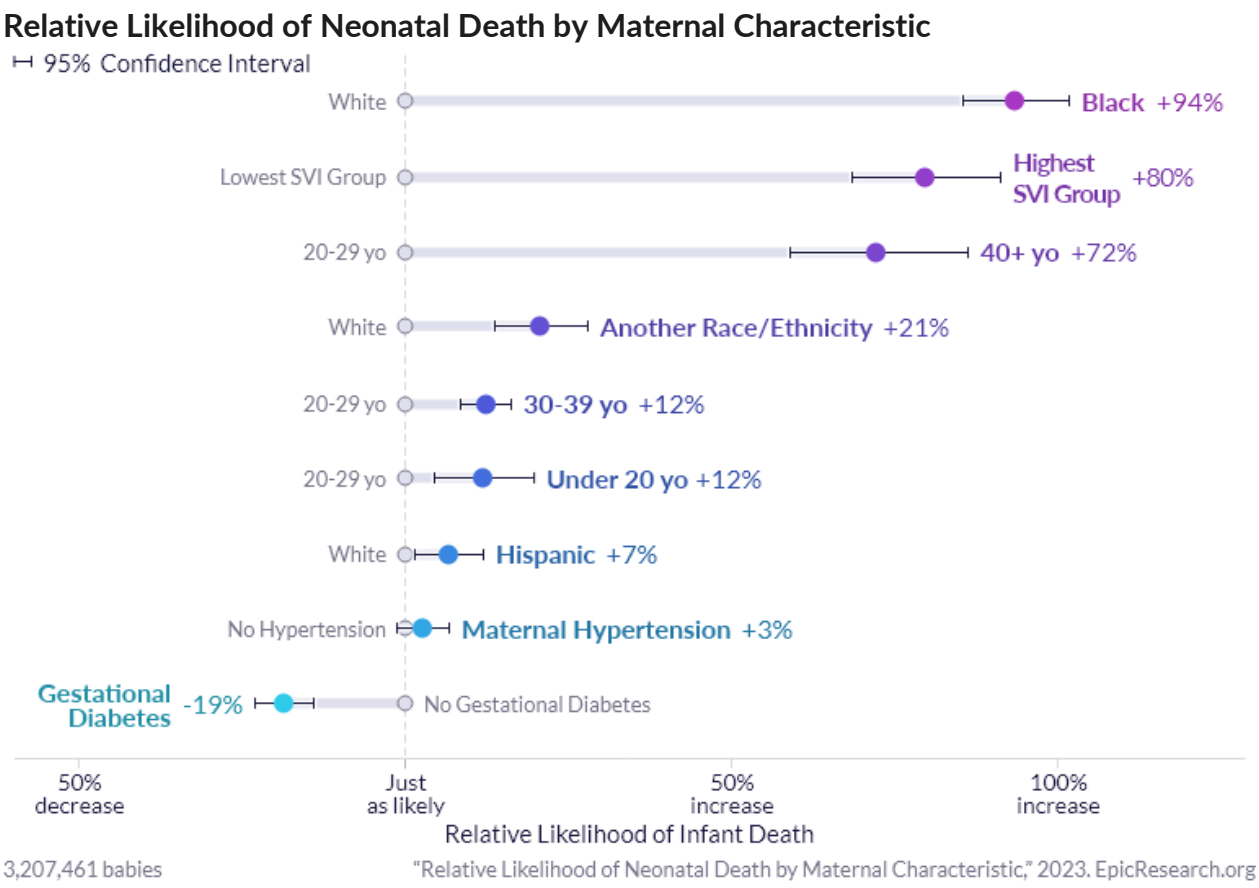

Figure 2. The relative likelihood of neonatal death by maternal characteristic.

A sensitivity analysis using Area Deprivation Index (ADI) instead of SVI found similar trends. For NICU admissions, the greatest factors in this model were hypertension, ADI decile, and gestational diabetes. For neonatal mortality, the greatest factors in this model were ADI decile, maternal race of Black, and maternal age over 40.

These data come from Cosmos, a collaboration of 222 Epic health systems representing over 220 million patient records from 1,272 hospitals and more than 27,200 clinics from all 50 states and Lebanon. This study was completed by two teams that worked independently, each composed of a clinician and research scientists. The two teams came to similar conclusions. Graphics by Brian Olson.

References

1. *Infant mortality*. (2023, September 19). Cdc.gov. https://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm

Data Definitions

Term	Definition
Study period	Births between 1/1/2016 and 6/30/2023 with gestational ages between 14 and 45 weeks.
Study population	Babies with: • Birth record • Mother linkage

	• Gestational age at birth • SVI based on their or the mother's residence • Death in the first 28 days or a face-to-face encounter after 28 days
Outcomes	Newborn death within 28 days after birth. **NICU admission** within 28 days after birth. Both outcomes were assessed with an unconditional logistic regression model.
NICU admission	Procedure linked to CPT code 99468 or 99469 or inclusion in an ICU registry.
Confounders	Comorbidities: **gestational diabetes**, **hypertension**, **drug use**, **autoimmune conditions**, **infection**, if the mother was documented as married, and maternal age
Gestational Diabetes	A diagnosis with ICD-10-CM code O24.1*-O24.9* or E11* on mother's chart.
Hypertension	A diagnosis with ICD-10-CM code O10*-O16* on the mother's chart.
Autoimmune conditions	A diagnosis with ICD-10-CM code M32.9, O99.891, R76.0, D68.61, O99.891, M06.9, O99.11*, O99.12*, or L40.5* on the mother's chart.
Infection	A diagnosis with one of the following ICD-10-CM codes on the mother's chart between gestation date and birth date: Infections affecting pregnancy or birth: O98*, O99.82* Bacterial vaginosis - N76.0 Chlamydia - A56.0* or A56.8 Fifth disease - B08.3 Gonorrhea - A54.0* Group B strep - Z22.330 Hepatitis B - B16*, B18.0, B18.1, or B19.1* Hepatitis C - B17.1*, B18.2, or B19.2*. HIV/AIDs - B20 HPV - B97.7 Lyme's disease - A69.2* Rubella - B06.* Syphilis - A51.* or A52.* Trichomoniasis - A59.* Zika - A92.5 Or a diagnosis with one of the following ICD-10-CM codes on the infant's chart between gestation date and 30 days after delivery: Chlamydia - P23.1 or P39.1 Group B strep - P00.82 Listeria/listeriosis - A32* or P37.2 Rubella - P35.0 Syphilis - A50.* Toxoplasmosis - B58.* or P37.1 Zika - P35.4 Or mother's lab result with an abnormal flag, numeric result above the reference range, or a text result identified as "positive" or a variant of that. Including **chlamydia lab**, **gonorrhea lab**, **group B strep lab**, **listeria lab**,

	Lyme's disease lab, **syphilis lab**, or **toxoplasmosis lab** between the gestation date and birth date.
Chlamydia lab	A lab with one of the following LOINC codes: 16600-9, 21189-6, 21190-4, 32774-2, 35713-7, 35715-2, 35716-0, 45084-1, 50387-0, 53926-2, 6356-0, 14463-4, 44807-6, 45068-4, 45095-7, 70163-1, 80361-9, or 92684-0.
Gonorrhea lab	A lab with one of the following LOINC codes: 21414-8, 32705-6, 45070-0, 50388-8, 53879-3, 70163-1, 80361-9, 693-2, or 92684-0.
Group B strep lab	A lab with one of the following LOINC codes: 11266-4, 41508-3, 48683-7, 5034-4, 581-9, 583-5, 584-3, 586-8, 72607-5, 76582-6, 91847-4, or 91875-5.
Listeria lab	A lab with one of the following LOINC codes: 23210-8, 26698-1, 26907-6, 49711-5, 5021-1, 5240-7, 61369-5, 6456-8, 74732-9, 74749-3, 82180-1, 82184-3, 85762-3, 85763-1, 88261-3, 88262-1, 88265-4, 92767-3, or 92780-6.
Lyme's disease lab	A lab with one of the following LOINC codes: 83080-2 or 83081-0.
Syphilis lab	Lab with one of the following LOINC codes: 71793-4, 17726-1, 17727-9, 17729-5, 22592-0, 22594-6, 34147-9, 47236-5, 47238-1, 51838-1, 6561-5, 73752-8, 11597-2, 13288-6, 17723-8, 17724-6, 17725-3, 22585-4, 22587-0, 22590-4, 24110-9, 24312-1, 26009-1, 34382-2, 5393-4, 63464-2, 8041-6, 34954-8, or 68502-4.
Toxoplasmosis lab	A lab with one of the following LOINC codes: 56991-3, 10723-5, 12262-2, 21570-7, 22578-9, 22580-5, 25542-2, 30038-4, 30568-0, 30569-8, 31178-7, 33320-3, 35281-5, 35282-3, 40677-7, 40678-5, 5388-4, 5389-2, 5390-0, 5391-8, 8039-0, 8040-8, 9741-0, 15396-5, 16279-2, 20464-4, 22577-1, 24399-8, 27999-2, 29904-0, 42626-2, 49447-6, 49448-4, 62465-0, 53611-0, or 57770-0.
Area Deprivation Index (ADI)	*ADI Funding acknowledgment:* *This project was supported by the National Institute on Aging of the National Institutes of Health under Award NumberRF1AG057784 (PI: Kind), the National Institute On Minority Health And Health Disparities of the National Institutes of Health under Award Number R01MD010243 (PI: Kind); the University of Wisconsin School of Medicine and Public Health (UWSMPH) Center for Health Disparities Research and the Department of Medicine. Content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or of the University of Wisconsin.*

Table 1: Relative Likelihood of NICU Admission by Maternal Characteristic

Characteristic	Odds Ratio	Lower CI (95%)	Upper CI (95%)
Hypertension	2.11	2.09	2.13
Gestational Diabetes	1.55	1.54	1.57
40+ years	1.40	1.38	1.43
SVI Decile	1.26	1.25	1.28
30-39 years	1.11	1.10	1.12
Black	1.07	1.06	1.08

Under 20 years	1.04	1.02	1.06
Other Race	1.01	1.00	1.02
Hispanic	0.96	0.95	0.97

Table 2: Relative Likelihood of Neonatal Death by Maternal Characteristic

Characteristic	Odds Ratio	Lower CI (95%)	Upper CI (95%)
Black	1.94	1.86	2.02
SVI Decile	1.80	1.69	1.91
40+ years	1.72	1.59	1.86
Other	1.21	1.14	1.28
30-39 years	1.12	1.08	1.16
Under 20 years	1.12	1.04	1.20
Hispanic	1.07	1.02	1.12
Hypertension	1.03	0.99	1.07
Gestational Diabetes	0.81	0.77	0.86