

# Obstetrical unit closures and racial and ethnic differences in severe maternal morbidity in the state of New Jersey



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**BACKGROUND:** In the United States, racial disparities in maternal morbidity and mortality are pronounced and persistent. Although the maternal mortality ratio and the severe maternal morbidity rates have increased over the past 30 years, the number of obstetrical units in the country has simultaneously diminished. Black women are 3 times more likely to die during childbirth than White women and twice as likely to suffer severe maternal morbidity (or a near miss). Between 2003 and 2013, 366 (10%) obstetrical units closed, and rural obstetrical unit closures were more likely in the Black communities. The state of New Jersey has the highest Black maternal mortality rate (131.8/100,000 live births) of all states reporting these data. Very few studies have examined the role that urban obstetrical unit closures play in racial and ethnic disparities in maternal health outcomes.

**OBJECTIVE:** To analyze racial differences in severe maternal morbidity in New Jersey hospitals among women experiencing the loss of their nearest obstetrical unit during the years 2006–2015.

**STUDY DESIGN:** This study used data on all births in New Jersey hospitals (2006–2015) by women living in ZIP code tabulation areas that lost their nearest obstetrical unit during that period. Severe maternal morbidity was measured using a composite variable for severe illness during hospitalizations (eg, acute heart failure, acute renal disease, disseminated intravascular coagulation, sepsis) identified using the International Classification of Diseases, Ninth Revision. Logistic regression models were used to analyze the associations between race and ethnicity on the individual likelihood of severe maternal morbidity, adjusting for annual trends, individual socioeconomic characteristics, age, preexisting conditions, and delivery hospital characteristics (ie, percentage of Black patients >25% [Black-serving hospital] and percentage of Medicaid discharges in the delivery obstetrical unit).

**RESULTS:** There were 227,412 delivery hospitalizations among women who lived in the 124 New Jersey ZIP code tabulation areas that lost the nearest obstetrical unit from 2006 to 2015. Black women had the highest severe maternal morbidity rates, increasing from 1.2% in 2006 to 2.3% in 2015. The Black-White gap remained similar in magnitude over the period, as White women's severe maternal morbidity rates increased from 0.7% to 1.4%. However, for Hispanic women, the severe maternal morbidity increased dramatically from 0.7% in 2006 to 2.4% in 2013, followed by a decreasing trend during 2013–2015. When adjusting for individual factors, the odds of severe maternal morbidity among all women was greater if they delivered after the loss of the nearest obstetrical unit (adjusted odds ratio, 1.55; 95% confidence interval, 1.30–1.86). Hispanic women experienced the greatest increase in severe maternal morbidity, regardless of whether they delivered before or after the closure of their nearest obstetrical unit. For all women, delivering in a Black-serving obstetrical unit was associated with a greater likelihood of individual severe maternal morbidity (adjusted odds ratio, 1.36; 95% confidence interval, 1.19–1.56).

**CONCLUSION:** Racial and ethnic disparities in severe maternal morbidity persist and might be exacerbated by nearby obstetrical unit closures. In New Jersey ZIP codes with obstetrical unit loss, the Hispanic-White gap in the severe maternal morbidity widened substantially, and the rates were also higher among women who delivered in Black-serving hospitals. Policymakers should take steps to prevent obstetrical unit closures and to ensure that the resources available at Black-serving obstetrical units are at least on par with those of other institutions.

**Key words:** hospital closures, maternal health disparities, maternity ward closures, racial disparities

## Introduction

Severe maternal morbidity (SMM) in the United States (US) has increased dramatically in recent decades, much like the US maternal mortality ratio (MMR), which is the highest of any developed country.<sup>1,2</sup> Between 1993 and 2014,

the US SMM rate increased by nearly 200%, from 49.5 to 144 per 10,000 deliveries.<sup>2</sup> Racial disparities in SMM rates are profound, with Black women being twice as likely to suffer from SMM than their White counterparts.<sup>3</sup>

Several explanations for the staggering racial disparities in maternal morbidity and mortality focus on individual health characteristics or behavioral factors such as preexisting conditions, maternal age, and receipt of prenatal care. Yet, studies that control for many such variables are not able to explain the large racial disparities in SMM rates that remain.<sup>4,5</sup> Other explanations focus

on factors such as structural racism and the cumulative impact of stress from a lifetime of exposure to racism.<sup>6,7</sup>

Fewer studies have examined how changes in the health system, the availability of hospital-level services, and hospital quality of care have affected disparities in SMM. Recent research on birth hospital characteristics as the predictors of SMM has shown that giving birth at a Black-serving hospital is associated with adverse maternal outcomes.<sup>8–10</sup> Although research shows that Black communities are more likely to lose obstetrical (OB) units than other communities, few studies examine the

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## AJOG MFM at a Glance

**Why was this study conducted?**

Obstetrical unit closures may affect racial and ethnic disparities in maternal morbidity. We analyzed the racial differences in severe maternal morbidity (SMM) in New Jersey hospitals among patients who lost their nearest obstetrical (OB) unit between 2006 and 2015.

**Key findings**

For Black, White, and Hispanic women living in ZIP code tabulation areas that lost their nearest OB unit, Black women had the highest SMM rates. The Black-White gap remained similar in magnitude over time. The Hispanic SMM increased, creating a large Hispanic-White gap. The adjusted odds of SMM were greater among women who delivered when their nearest OB unit was already closed. For all women, delivering in a Black-serving OB unit was associated with a greater likelihood of SMM.

**What does this add to what is known?**

Racial and ethnic disparities in SMM persist and might be exacerbated by nearby obstetrical unit closures.

impact of OB unit loss on racial disparities in maternal morbidity.<sup>11</sup>

**Obstetrical unit closures**

Between 2002 and 2013, 10% of hospital OB units closed nationwide. Research on the impact of these OB unit closures shows evidence of increased travel times for childbirths and adverse birth outcomes.<sup>12–14</sup> Much of this literature focuses on rural communities with significant distances between OB units; the distance between OB units is less of an issue for urban and suburban communities. Urban and suburban communities are more likely to have multiple OB units of different sizes and service levels that serve different segments of the community.<sup>14</sup> The study of urban and suburban areas provides an opportunity to examine the higher maternal morbidity rates of Black and Hispanic women,<sup>1,15,16</sup> the higher likelihood of OB unit closure in Black neighborhoods,<sup>17</sup> and the changes in maternal health outcomes over time.

This study focuses on urban and suburban areas of New Jersey (NJ) that experienced OB unit closures between 2006 and 2015. NJ is an important case, because it has experienced a large number of hospital closures over the last 30 years.<sup>18</sup> In addition, it has high rates of SMM and the highest Black MMR (131.8/100,000 live births) for 2019 of the US states reporting these data. Yet,

the causes of these extreme rates have not yet been determined.<sup>19</sup>

**Materials and Methods****Data source and study period**

This study used the Healthcare Cost and Utilization Project's (HCUP's) State Inpatient Discharge (SID) Database for NJ. HCUP is sponsored by the Agency for Healthcare Research and Quality within the Department of Health and Human Services.<sup>20</sup> The SID includes information on all-payer patient encounters for all the inpatients in hospitals. We used SID data to analyze patient-level outcomes for women with childbirth hospitalizations in NJ between January 2006 and September 2015. The patient data were merged with hospital-level indicators from the American Hospital Association (AHA) annual survey, spatial data on NJ road networks, and ZIP code tabulation area (ZCTA)-level socioeconomic data from the US Census.

**Study sample**

The sample was limited to Black, White, and Hispanic delivery hospitalizations of women residing in the 124 NJ ZIP codes that lost the closest OB in the period from 2006 to 2015 (N=227,412) (Table 1). The ZCTAs that experienced closures were determined by identifying the nearest hospital OB to each patient ZIP code (calculated using the Closest

Facility tool in ArcGIS). All women living in a ZIP code for which the nearest facility closed were included in the analysis.

The Tufts University Social, Behavioral, and Educational Research Institutional Review Board determined that this study was excluded from review owing to the use of deidentified data.

**Severe maternal morbidity**

The primary outcome—SMM—was measured using a composite variable that accounts for the occurrence of acute end-organ damage or mortality during a delivery hospitalization.<sup>21</sup> The types of maternal end-organ injuries included in this index were acute heart failure, acute renal failure, acute myocardial infarction, acute respiratory distress, disseminated intravascular coagulation and coagulopathy, coma, pulmonary edema, pulmonary embolism, and sepsis. A composite variable representing these conditions was derived from the International Classification of Diseases, Ninth Revision (ICD-9) diagnosis codes.

**Obstetrical unit closure**

Obstetrical unit closures were identified by comparing the year-to-year changes by comparing the year-to-year changes documented in the AHA Change Logs with the key variables in AHA survey data. The key survey responses included whether a hospital was classified as an OB hospital, the volume of births occurring at the hospital, and the level of OB services (I, II, III, or IV) available at the institution. If a hospital closed entirely, if only OB services closed, or if the annual births decreased to  $\leq 50$ , it was determined that the OB services were eliminated at that location. In the cases where a consolidation occurred and it was unclear whether the OB services remained at each constituent hospital, we used the SID data on births, and cross-checked service availability in the American Hospital Directory. In addition, if a hospital relocated  $>3$  miles, we considered the OB unit relocation to be a closure. In the baseline year of 2006, all OB units in our sample of ZCTAs were considered open, and by the end of the study period (2015), all the sample ZCTAs' nearest OB units had closed.

**TABLE 1**  
**Individual and hospital-level characteristics by severe maternal morbidity in New Jersey ZIP code tabulation areas that experienced obstetrical unit closure (2006–2015) (N=227,412)**

| Characteristic                                       | No severe maternal morbidity (N=224,535) | Severe maternal morbidity (N=2877) | Total (N=227,412) |
|--|--|------------------------------------|-------------------|
| <b>Race and ethnicity</b>                            |  |                                    |                   |
| White  | 111,408 (49.6)                           | 1096 (38.1)                        | 112,504 (49.5)    |
| Black  | 55,029 (24.5)                            | 979 (34.0)                         | 56,008 (24.6)     |
| Hispanic   | 58,098 (25.9)                            | 802 (27.9)                         | 58,900 (25.9)     |
| <b>Closest obstetrical unit closed</b>               |  |                                    |                   |
| No   | 106,018 (47.2)                           | 1058 (36.8)                        | 107,076 (47.1)    |
| Yes  | 118,517 (52.8)                           | 1819 (63.2)                        | 120,336 (52.9)    |
| <b>Delivery hospital characteristics</b>             |  |                                    |                   |
| <b>Payer mix (percentage of Medicaid discharges)</b> |  |                                    |                   |
| ≤20%   | 91,946 (40.9)                            | 1035 (36.0)                        | 92,981 (40.9)     |
| >20%–45%   | 78,880 (35.1)                            | 1062 (36.9)                        | 79,942 (35.2)     |
| ≥45%   | 53,709 (23.9)                            | 780 (27.1)                         | 54,489 (24.0)     |
| <b>Black-serving obstetrical unit</b>                |  |                                    |                   |
| ≤25%   | 147,585 (65.7)                           | 1541 (53.6)                        | 149,126 (65.6)    |
| >25%   | 76,950 (34.3)                            | 1336 (46.4)                        | 78,286 (34.4)     |
| <b>Birth volume</b>                                  |  |                                    |                   |
| <2400  | 82,996 (37.0)                            | 1013 (35.2)                        | 84,009 (36.9)     |
| 2400–4000  | 61,375 (27.3)                            | 954 (33.2)                         | 62,329 (27.4)     |
| >4000  | 80,164 (35.7)                            | 910 (31.6)                         | 81,074 (35.7)     |
| <b>Patient characteristics</b>                       |  |                                    |                   |
| <b>Primary payer</b>                                 |  |                                    |                   |
| Private insurance                                    | 130,532 (58.1)                           | 1534 (53.3)                        | 132,066 (58.1)    |
| Medicaid   | 72,196 (32.2)                            | 950 (33.0)                         | 73,146 (32.2)     |
| Medicare   | 1149 (0.5%)                              | 53 (1.8)                           | 1202 (0.5)        |
| Self-pay   | 16,876 (7.5)                             | 276 (9.6)                          | 17,152 (7.5)      |
| No charge  | 688 (0.3)                                | 21 (0.7)                           | 709 (0.3)         |
| Other  | 3093 (1.4)                               | 43 (1.5)                           | 3136 (1.4)        |
| <b>Poverty rate (ZIP code tabulation area)</b>       |  |                                    |                   |
| <5%  | 42,221 (18.8)                            | 448 (15.6)                         | 42,669 (18.8)     |
| ≥5%–<15%   | 73,968 (32.9)                            | 952 (33.1)                         | 74,920 (32.9)     |
| ≥15%–<25%  | 96,410 (42.9)                            | 1256 (43.7)                        | 97,666 (42.9)     |
| ≥25%   | 11,936 (5.3)                             | 221 (7.7)                          | 12,157 (5.3)      |
| <b>Age (y)</b>                                       |  |                                    |                   |
| <20  | 14,703 (6.5)                             | 163 (5.7)                          | 14,866 (6.5)      |
| 20–29  | 108,661 (48.4)                           | 1256 (43.7)                        | 109,917 (48.3)    |
| 30–34  | 59,052 (26.3)                            | 756 (26.3)                         | 59,808 (26.3)     |
| 35–39  | 33,549 (14.9)                            | 525 (18.2)                         | 34,074 (15.0)     |
| 40–44  | 7997 (3.6)                               | 150 (5.2)                          | 8147 (3.6)        |
| >45  | 573 (0.3)                                | 27 (0.9)                           | 600 (0.3)         |

(continued)

TABLE 1

Individual and hospital-level characteristics by severe maternal morbidity in New Jersey ZIP code tabulation areas that experienced obstetrical unit closure (2006–2015) (N=227,412) (continued)

| Characteristic                  | No severe maternal morbidity (N=224,535) | Severe maternal morbidity (N=2877) | Total (N=227,412) |
|---------------------------------|--|------------------------------------|-------------------|
| <b>Diabetes</b>                 |  |                                    |                   |
| No                              | 211,224 (94.1)                           | 2662 (92.5)                        | 213,886 (94.1)    |
| Yes                             | 13,311 (5.9)                             | 215 (7.5)                          | 13,526 (5.9)      |
| <b>Obesity</b>                  |  |                                    |                   |
| No                              | 218,849 (97.5)                           | 2746 (95.4)                        | 221,595 (97.4)    |
| Yes                             | 5686 (2.5)                               | 131 (4.6)                          | 5817 (2.6)        |
| <b>Preexisting hypertension</b> |  |                                    |                   |
| No                              | 219,238 (97.6)                           | 2639 (91.7)                        | 221,877 (97.6)    |
| Yes                             | 5297 (2.4)                               | 238 (8.3)                          | 5535 (2.4)        |
| <b>Year</b>                     |  |                                    |                   |
| 2006                            | 25,115 (11.2)                            | 219 (7.6)                          | 25,334 (11.1)     |
| 2007                            | 25,244 (11.2)                            | 248 (8.6)                          | 25,492 (11.2)     |
| 2008                            | 23,698 (10.6)                            | 273 (9.5)                          | 23,971 (10.5)     |
| 2009                            | 23,489 (10.5)                            | 270 (9.4)                          | 23,759 (10.4)     |
| 2010                            | 22,704 (10.1)                            | 284 (9.9)                          | 22,988 (10.1)     |
| 2011                            | 22,101 (9.8)                             | 252 (8.8)                          | 22,353 (9.8)      |
| 2012                            | 21,843 (9.7)                             | 299 (10.4)                         | 22,142 (9.7)      |
| 2013                            | 21,993 (9.8)                             | 374 (13.0)                         | 22,367 (9.8)      |
| 2014                            | 21,966 (9.8)                             | 367 (12.8)                         | 22,333 (9.8)      |
| 2015                            | 16,382 (7.3)                             | 291 (10.1)                         | 16,673 (7.3)      |

Data are expressed as number (percentage).

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## Statistical analysis

Logistic regression was used to estimate the associations between OB unit closures by year and individual SMM. The key predictors included a measure of whether the nearest OB unit to a patient's ZIP code (in 2006) was closed at the time of delivery. A variable that interacted OB closure with the year of delivery was constructed to capture this effect. The variables Post-OB Unit Closure \* Year and Pre-OB Unit Closure \* Year were defined with reference to 2006, which was the baseline year of the study. An average value for each interaction variable was calculated from year-to-year estimates to preserve the anonymity of hospitals in the data set. The estimates reflect the average effect

over the subsequent years of delivering when the (formerly) nearest OB unit was closed (Post-OB Unit Closure \* Year), or remained open (Pre-OB Unit Closure \* Year), relative to 2006 (Tables 2 and 3).

Additional key explanatory variables are maternal race and ethnicity (Black, White, and Hispanic) and the characteristics of a woman's hospital of delivery. The delivery hospital characteristics include the payer mix (the percentage of OB discharges for which Medicaid was the primary payer), racial composition (whether or not >25% of the delivery OB units discharges were Black patients [hereafter called a Black-serving OB]), and birth volume (Table 1). The 25% threshold for Black-serving

OB was determined using a methodology introduced by Jha et al<sup>22</sup> and Howell et al<sup>8</sup> by ranking the proportion of Black patients by hospital in the baseline year and choosing the top quartile, which in 2006 was ≥25%.

Full models controlled for the patients' socioeconomic status (primary payer and ZCTA-level poverty status), age, and preexisting conditions (hypertension, obesity, and diabetes). Analyses were performed on the combined sample of Black, White, and Hispanic women and then subsequently conducted on subsets of each race and ethnicity (Tables 2 and 3).

Data manipulation was performed in R (R Foundation for Statistical Computing, Vienna, Austria) and SAS version

TABLE 2

**Logistic regression models predicting severe maternal morbidity among Black, White, and Hispanic patients living in New Jersey ZIP codes that lost obstetrical services (2006–2015) (N=227,412)**

| Explanatory variables                                     | Model 1 (crude ORs)              | Model 2 (plus race and ethnicity) | Model 3 (adjusted ORs)           |
|---|----------------------------------|-----------------------------------|----------------------------------|
| Post—OB Unit Closure * Year                               | 1.70 <sup>a</sup><br>(1.38–2.09) | 1.62 <sup>a</sup><br>(1.35–1.95)  | 1.55 <sup>a</sup><br>(1.30–1.86) |
| Pre—OB Unit Closure* Year                                 | 1.20 <sup>b</sup><br>(1.03–1.39) | 1.32 <sup>a</sup><br>(1.14–1.52)  | 1.44 <sup>a</sup><br>(1.24–1.68) |
| <b>Race and ethnicity</b>                                 |                                  |                                   |                                  |
| Black   |                                  | 1.75 <sup>a</sup><br>(1.51–2.03)  | 1.44 <sup>a</sup><br>(1.25–1.67) |
| Hispanic  |                                  | 1.35 <sup>a</sup><br>(1.15–1.58)  | 1.27 <sup>a</sup><br>(1.12–1.45) |
| <b>Delivery hospital characteristics</b>                  |                                  |                                   |                                  |
| Payer mix (percentage of Medicaid discharges) (ref: <20%) |                                  |                                   |                                  |
| Medicaid OB (20%–<45%)                                    |                                  |                                   | 0.95<br>(0.81–1.12)              |
| Medicaid OB (≥45%)  |                                  |                                   | 0.97<br>(0.78–1.22)              |
| Racial composition (ref: <25%)                            |                                  |                                   |                                  |
| Black-serving OB (≥25%)                                   |                                  |                                   | 1.36 <sup>a</sup><br>(1.19–1.56) |
| Birth volume (ref: <2400)                                 |                                  |                                   |                                  |
| 2400–4000   |                                  |                                   | 1.15 <sup>b</sup><br>(1.02–1.30) |
| >4000   |                                  |                                   | 1.03<br>(0.89–1.19)              |
| <b>Patient-level characteristics</b>                      |                                  |                                   |                                  |
| Primary payer (ref: private insurance)                    |                                  |                                   |                                  |
| Medicaid  |                                  |                                   | 1.02<br>(0.92–1.12)              |
| Medicare  |                                  |                                   | 2.74 <sup>a</sup><br>(2.04–3.69) |
| Self-pay  |                                  |                                   | 1.28 <sup>b</sup><br>(1.04–1.58) |
| No charge   |                                  |                                   | 1.80 <sup>c</sup><br>(1.22–2.65) |
| Other   |                                  |                                   | 1.17<br>(0.80–1.70)              |
| Poverty rate (ZIP code tabulation area)                   |                                  |                                   |                                  |
| 5%–<15%   |                                  |                                   | 1.06<br>(0.92–1.22)              |

(continued)

TABLE 2

**Logistic regression models predicting severe maternal morbidity among Black, White, and Hispanic patients living in New Jersey ZIP codes that lost obstetrical services (2006–2015) (N=227,412) (continued)**

| Explanatory variables  | Model 1 (crude ORs) | Model 2 (plus race and ethnicity) | Model 3 (adjusted ORs)           |
|------------------------|---------------------|-----------------------------------|----------------------------------|
| 15%–<25%               |                     |                                   | 1.01<br>(0.85–1.19)              |
| ≥25%                   |                     |                                   | 1.05<br>(0.84–1.31)              |
| Age category (y)       |                     |                                   |                                  |
| <20                    |                     |                                   | 0.89 <sup>d</sup><br>(0.77–1.02) |
| 30–34                  |                     |                                   | 1.14 <sup>c</sup><br>(1.04–1.26) |
| 35–39                  |                     |                                   | 1.38 <sup>a</sup><br>(1.22–1.56) |
| 40–44                  |                     |                                   | 1.55 <sup>a</sup><br>(1.28–1.87) |
| >45                    |                     |                                   | 3.80 <sup>a</sup><br>(2.38–6.07) |
| Preexisting conditions |                     |                                   |                                  |
| Diabetes               |                     |                                   | 0.95<br>(0.80–1.14)              |
| Obesity                |                     |                                   | 1.19 <sup>d</sup><br>(0.98–1.44) |
| Hypertension           |                     |                                   | 2.74 <sup>a</sup><br>(2.38–3.14) |

Data are expressed as odds ratios (95% confidence intervals).

OB, obstetrical; OR, odds ratio; ref, reference.

<sup>a</sup> $P < .001$ .

<sup>b</sup> $P < .05$ .

<sup>c</sup> $P < .01$ .

<sup>d</sup> $P < .10$ .

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9.4 (SAS Institute Inc, Cary, NC); ArcGIS Pro 2.6 (ESRI, Inc, Redlands, CA) and Stata 16.1 (StataCorp LLC, College Station, TX) were used for spatial and statistical analyses, respectively.

## Results

More than 20% of NJ's OB units in existence in 2006 closed or relocated over the 10-year period from 2006 to 2015. Of the 227,412 births occurring in 124 NJ ZIP codes that lost OB services in the 10-year period, 1.3% of patients

experienced SMM at time of hospitalization. The SMM rates ranged from 0.9% to 1.75% per year among Black, White, and Hispanic patients residing in ZIP codes that lost the nearest OB unit (Figure 1). During the study period, the SMM rates were higher among patients whose closest OB had already closed than among women who delivered at a time when the closest OB was still open.

Approximately half (49.5%) of the women in the sample were White,

whereas Black and Hispanic patients made up a quarter of the sample each at 24.5% and 25.9%, respectively (Table 1). More than half (52.9%) of all the deliveries took place at a time when a patient's nearest OB unit (in 2006) was already closed (Table 1 and Figure 2). More than one-third (34.4%) of all deliveries occurred in a Black-serving OB unit, and almost one-quarter (24.0%) took place in the OB units for which at least 45% of all discharges were primarily paid for by Medicaid. Approximately 35.7% of the

TABLE 3

**Logit models predicting SMM for Black, White, and Hispanic women in New Jersey ZIP codes that lost obstetrical services (2006–2015)**

| Explanatory variables                         | White women (N=112,503)          | Black women (N=56,008)           | Hispanic women (N=58,900)        |
|---|----------------------------------|----------------------------------|----------------------------------|
| OB unit closure by year                       |                                  |                                  |                                  |
| Post–OB Unit Closure * Year                   | 1.41 <sup>a</sup><br>(1.15–1.73) | 1.37 <sup>b</sup><br>(1.00–1.87) | 1.87 <sup>c</sup><br>(1.36–2.57) |
| Pre–OB Unit Closure * Year                    | 1.37 <sup>a</sup><br>(1.12–1.67) | 1.27<br>(0.87–1.83)              | 1.86 <sup>c</sup><br>(1.39–2.48) |
| Payer mix (ref: Medicaid ≤20%)                |                                  |                                  |                                  |
| Medicaid OB (>20%–<45%)                       | 0.91<br>(0.70–1.18)              | 1.07<br>(0.86–1.32)              | 1.09<br>(0.87–1.38)              |
| Medicaid OB (≥45%)                            | 0.87<br>(0.60–1.25)              | 1.33 <sup>d</sup><br>(1.06–1.67) | 0.96<br>(0.71–1.30)              |
| Racial composition (ref: Black serving, <25%) |                                  |                                  |                                  |
| Black-serving OB (≥25%)                       | 1.46 <sup>c</sup><br>(1.16–1.85) | 1.20 <sup>b</sup><br>(0.99–1.45) | 1.30 <sup>a</sup><br>(1.04–1.63) |
| Birth volume (ref: <2400)                     |                                  |                                  |                                  |
| Birth volume (2400–4000)                      | 1.03<br>(0.86–1.23)              | 1.05<br>(0.90–1.24)              | 1.40 <sup>a</sup><br>(1.15–1.71) |
| Birth volume (>4000)                          | 0.90<br>(0.75–1.07)              | 1.08<br>(0.94–1.25)              | 1.32 <sup>d</sup><br>(1.02–1.70) |

Data are expressed as odds ratios (95% confidence intervals).

OB, obstetrical; SMM, severe maternal morbidity.

<sup>a</sup> $P < .01$ .

<sup>b</sup> $P < .10$ .

<sup>c</sup> $P < .001$ .

<sup>d</sup> $P < .05$ .

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deliveries took place in a hospital with a relatively high annual birth volume (>4000 births). Most hospitalizations in the sample (58.1%) were primarily paid for by private insurance, and another 32.2% were primarily covered by Medicaid.

Black women were overrepresented among SMM cases, making up 34% of all cases while only accounting for 25% of the study population. Hispanic women made up 28% of the SMM cases, whereas White women were underrepresented among patients experiencing SMM, comprising 38% of SMM deliveries.

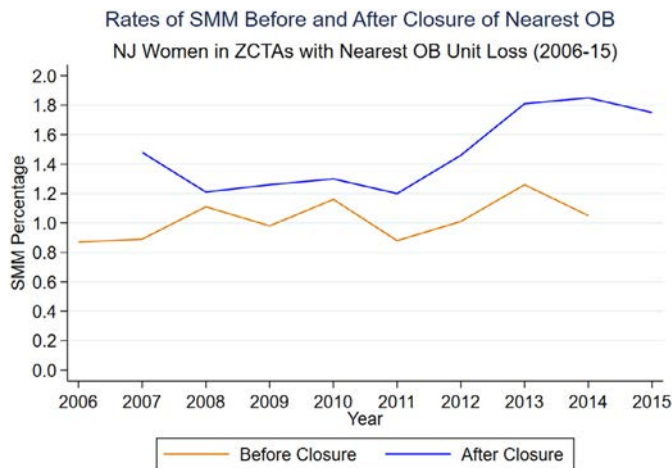
Over time, the Black-White gap in the SMM rates was consistent and large (Figure 3), with a continually increasing

trend of SMM rates for Black women from 1.2% in 2006 to 2.3% in 2015, and from 0.7% in 2006 to 1.4% in 2015 for White women. The Black-White SMM ratio ranged from 1.4 to 2.0 during the period. Although the Hispanic-White gap was very small in the beginning of the study period, this gap began to widen in 2012 when Hispanic women in the sample started to experience rates similar to those of Black women. The average Hispanic SMM rate increased from 0.95% during 2006–2011 to 2.05% during 2012–2015, and the Hispanic-White SMM ratio jumped from 0.88 in 2007 to 2.1 in 2013.

In fully adjusted models, the loss of the nearest obstetrical unit by year is

associated with higher rates of SMM (Table 2). For patients who delivered at a time when their nearest OB unit had already closed, their average odds (adjusted odds ratio [AOR], 1.55) of SMM were greater than if they had delivered in the baseline year when their local OB unit was still open. The average magnitude of this effect is greater than that for patients who delivered at a time when their nearest OB unit was still open (AOR, 1.44). Although there was an overall increase in the SMM over time, the increase was greater for those who delivered in the years where the nearest OB unit was already closed. The odds of SMM were also greater among Black (AOR, 1.44) and Hispanic

**FIGURE 1**  
Rates of SMM before and after closure of nearest OB



NJ women in ZCTAs with nearest OB unit loss (2006–2015).

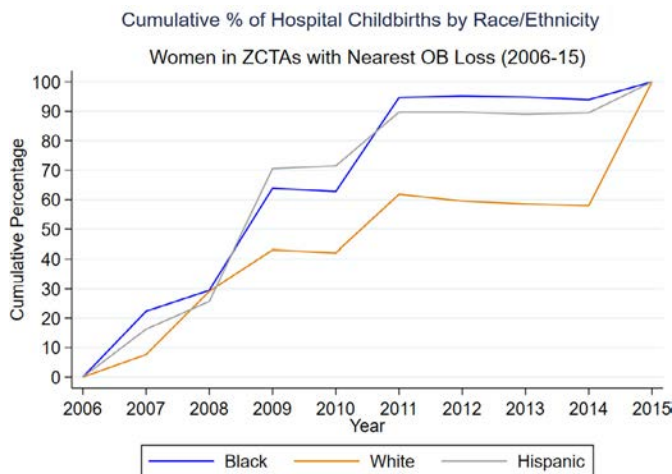
NJ, New Jersey; OB, obstetrical; SMM, severe maternal morbidity; ZCTAs, ZIP code tabulation area.

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women (AOR, 1.27) than they were among White women. Other factors associated with significantly greater odds of SMM are as follows: delivering in a Black-serving OB (AOR, 1.36); being in an age category of >30 years; having preexisting hypertension (AOR,

2.74); and being in the payer categories of Medicare (AOR, 2.74), no charge (AOR, 1.80), and self-pay (AOR, 1.28). Individual socioeconomic factors such as being insured by Medicaid and living in a high-poverty ZCTA were not statistically significant.

**FIGURE 2**  
Cumulative percentage of hospital childbirths by race and ethnicity



Women in ZCTAs with nearest OB loss (2006–2015).

OB, obstetrical; ZCTAs, ZIP code tabulation area.

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In stratified analyses, a similar pattern was observed for the effect of OB unit closure on the SMM in each of the 3 racial and ethnic subsets. Overall, the individuals who delivered at a time when their nearest OB unit had already closed had slightly greater average odds of SMM than individuals of the same race and ethnicity who delivered when the nearest OB unit was still open. However, the estimated effect of delivering after 2006 was much larger for Hispanic women (AOR, 1.87), regardless of whether their nearest OB unit had already closed. For Black women and White women, the effects of delivering at a time when the nearest OB unit was already closed were indicated by AORs of 1.37 and 1.41, respectively.

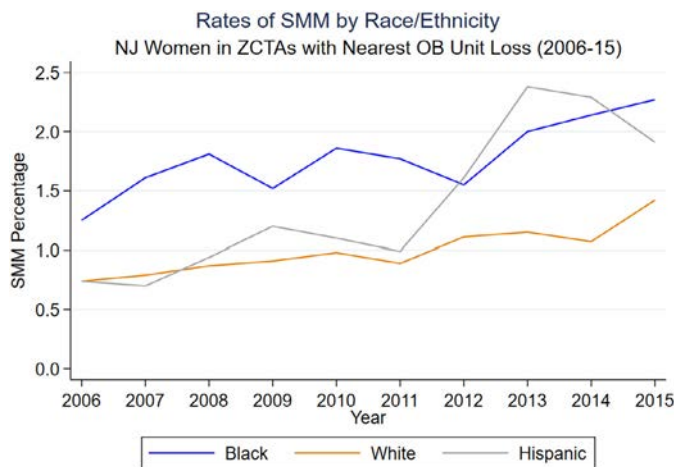
Delivery in a Black-serving OB was significantly associated with the likelihood of SMM across all subsets. Among Hispanic women only, a higher birth volume of the OB unit of delivery was associated with greater odds of SMM (AOR, 1.40 for birth volume between 2400 and 4000; AOR of 1.32 for birth volume of >4000) than for Hispanic women delivering in relatively lower birth volume hospitals. For Black women, delivering in an OB unit with the highest fraction of Medicaid patients was associated with a greater likelihood of SMM (AOR, 1.33).

**Comment**  
**Principal findings**

After analyzing the statewide all-payer hospital discharge data from 227,412 births occurring in NJ ZCTAs that lost the nearest OB unit between 2006 and 2015, we found that the SMM increased over the period across all race and ethnicity groups. A large Black-White gap in SMM persisted throughout the period, and a large Hispanic-White gap emerged in 2012. In addition to these racial and ethnic disparities in SMM rates, women who delivered in Black-serving OB units had 1.36 times the odds of SMM than their counterparts delivering in other OB settings. After controlling for these individual and hospital-level variations in SMM, the OB unit closures were still associated with a higher likelihood of SMM, raising



**FIGURE 3**  
Rates of SMM by race and ethnicity



NJ women in ZCTAs with nearest OB unit loss (2006–2015).

NJ, New Jersey; OB, obstetrical; SMM, severe maternal morbidity; ZCTAs, ZIP code tabulation area.

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concerns about access to the quality of obstetrical care for women in the state with the highest Black MMR nationally.

## Results

Overall, the SMM rates among women in our study sample followed similar increasing trends of SMM in the US population. However, the emerging Hispanic-White gap in the SMM is a surprising finding that remains unexplained.

Existing research shows that having a Hispanic nationality (ie, Puerto Rican vs Dominican vs Mexican) and a foreign-born status is associated with varying rates in maternal and birth outcomes.<sup>16,23</sup> Regardless of the nationality, Hispanic women in New York city were documented to have a greater risk of SMM than their White counterparts.<sup>16</sup> The increase in Hispanic SMM over time that we observed in NJ does not seem to have been identified in other studies. Our results showing that Hispanic women who deliver in high-volume OB unit have greater odds of SMM also run counter to the conventional wisdom that high-volume hospitals report better outcomes for the

procedures that they perform frequently.<sup>24</sup>

Our finding that the racial composition of the delivery OB has a larger impact than the payer mix is also of note. Several recent studies showed that the birth hospital has a significant effect on maternal health outcomes.<sup>8,9</sup> Many explanations have been offered as to why Black-serving hospitals are likely to be less equipped to provide quality care, such as the lower levels of capital investment that are more often observed in Black-serving hospitals.<sup>8,25–27</sup>

## Clinical implications

The American College of Obstetricians and Gynecologists (ACOG) has identified several ways that healthcare teams and providers can prevent maternal morbidity. The findings of this study imply that local increases in SMM are associated with delivery after a nearby OB unit closes, which warrants additional examination by the ACOG and review boards. In 2019, the first lady of NJ launched a statewide initiative to lower maternal mortality rates and to eliminate the racial disparity in MMR.<sup>28</sup> As the maternal mortality review boards examine the reasons for a high MMR in

NJ, which is a relatively wealthy state, this research sheds light on the impact of the large change in obstetrical care that have occurred in NJ over recent decades.

## Research implications

Our results support the need for more research on the local impact of OB unit closures in urban and suburban areas. Further research is needed on the emerging Hispanic-White SMM gap in NJ and whether this gap is explained by shifts in the site of delivery, changes in the composition of the Latinx population, or other structural changes in risk exposure faced by Latinx populations.

## Strengths and limitations

Although this analysis contributes to our understanding of the maternal health impacts of OB unit closures, it is not without limitations. First, the lack of street addresses in the SID data on women forced the use of ZCTA (ZIP code) centroids to approximate the patient residence and to calculate the closest OB for each patient. The ZCTAs were then used as a proxy for individual patient exposure to OB unit loss. The use of ZCTA centroids masks the fact that the patients may reside at any point within a ZCTA boundary and not just at the centroid. If specific address data were available, a more precise identification of exposure to OB unit loss could have been made.

Second, we did not compare women experiencing the loss of OB units with those who did not lose their nearest OB. This retrospective study includes only those areas that experienced the loss of their nearest OB unit in any year of the study period. Therefore, we did not examine the differences between the areas experiencing closures and those not experiencing them and did not study the factors that led to the closures. In addition, this study could not conclude the causality of the OB unit closures.

Third, this study employed a documented approach to identify the SMM from the administrative data, which might be subject to systematic errors in coding.<sup>29</sup> Furthermore, using the claims

data did not allow us to identify all the clinical conditions that might affect racial and ethnic variations in SMM over time. However, we did find associations between OB closures and the SMM in estimates by racial and ethnic groups and also when controlling for diabetes, preexisting hypertension, and a measure of obesity (which is known to be undercoded in hospital administrative data).<sup>30</sup>

Finally, this study focused on comparing the outcomes for 2 historically disadvantaged maternal populations—Black and Hispanic women—with the outcomes of non-Hispanic Whites. This was because of limitations in the SID coding of the racial and ethnic categories and the small sample sizes of some categories. Therefore, our results might not be generalizable to other groups.

## Conclusions

Racial and ethnic disparities in SMM persist and might be exacerbated by nearby obstetrical unit closures and the extent to which patients deliver in Black-serving hospitals. Policymakers should take steps to prevent OB unit closures and to ensure that the resources available at Black-serving OB units are at least on par with those of other institutions. ■

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.ajogmf.2021.100480](https://doi.org/10.1016/j.ajogmf.2021.100480).

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