

# Rural–Urban Disparities in Adverse Maternal Outcomes in the United States, 2016–2019

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**Objectives.** To describe differences in maternal admissions to the intensive care unit (ICU) and mortality in rural versus urban areas in the United States.

**Methods.** We performed a nationwide analysis and calculated age-standardized rates and rate ratios (RRs) of maternal ICU admission and mortality per 100 000 live births between 2016 and 2019 in rural versus urban areas.

**Results.** From 2016 to 2019, there was no significant increase in age-standardized rates of maternal ICU admissions in rural (170.6–192.3) or urban (161.7–172.4) areas, with a significantly higher rate, albeit a relatively small difference, in rural versus urban areas (2019 RR = 1.14; 95% confidence interval [CI] = 1.04, 1.20). Maternal mortality increased in both rural (66.9–81.7 deaths per 100 000 live births) and urban (38.1–42.3) areas and was nearly 2 times higher in rural areas (2019 RR = 1.93; 95% CI = 1.71, 2.17).

**Conclusions.** Pregnant individuals in rural areas are at higher risk for ICU admission and mortality than are their urban counterparts. Significant increases in maternal mortality occurred in rural and urban areas.

**Public Health Implications.** Public health efforts need to focus on resource-limited rural areas to mitigate geographic disparities in maternal morbidity and mortality. (*Am J Public Health.* 2023;113(2): 224–227. <https://doi.org/10.2105/AJPH.2022.307134>)

Although maternal mortality rates have decreased globally, those in the United States have increased significantly and now are the highest among developed countries.<sup>1</sup> In the United States, there are substantial place-based disparities in maternal morbidity and mortality. Data from the National Inpatient Sample from 2007 to 2015 demonstrated that rural residents had a 9% higher probability of severe maternal morbidity and mortality than did urban residents, even after controlling for socioeconomic factors and clinical conditions.<sup>2</sup> These data, however, do not capture individuals with out-of-hospital births, which was 1 of every 62 births in

2017 and disproportionately occurred in rural areas. Thus the differences for the overall birthing population may not be understood.<sup>3</sup> Additionally, those admitted to an intensive care unit (ICU) during delivery have among the most severe delivery complications, and these instances are associated with a 4 times higher increase in health care costs.<sup>4,5</sup> To inform strategies to mitigate this growing public health crisis, we aimed to describe contemporary rates of maternal ICU admissions and maternal mortality among pregnant individuals residing in rural compared with urban areas in the United States.

## METHODS

We performed a serial cross-sectional analysis comparing rural and urban areas in the United States from 2016 to 2019 using the Centers for Disease Control and Prevention (CDC) Wide-Ranging Online Data for Epidemiologic Research (WONDER). Maternal ICU admissions were indicated on the birth certificate after delivery, and we determined maternal deaths by using *International Classification of Diseases, 10th Revision* (Geneva, Switzerland: World Health Organization; 1992) codes for pregnancy, childbirth, and the puerperium (O00–O99) as underlying or contributing cause of death.

Our analysis began with 2016, which was the first year ICU admissions were publicly available and implementation of the pregnancy-associated mortality checkbox became near universal across the United States. For each of the study years, we obtained counts of maternal ICU admissions and deaths for individuals aged 15 to 44 years in 5-year age groups stratified by rural and urban residence. We classified areas as rural or urban using the 2013 National Center for Health Statistics Classification.<sup>6</sup> We calculated age-standardized rates per 100 000 live births and rate ratios (RRs) using the age distribution of pregnant individuals who had a live birth in 2016, the first year of the study, by 5-year age groups.

We analyzed trends between 2016 and 2019 by estimating the average annual percentage change (AAPC) using the Joinpoint Regression Program (National Cancer Institute, Bethesda, MD). We performed all other analyses in SAS Enterprise Guide version 7.1 (SAS Institute, Cary, NC) and Stata version 14 (StataCorp LP, College Station, TX).

## RESULTS

From 2016 to 2019, there were 15 295 384 live births to individuals aged 15 to 44 years. Of these births, 13.5% were to individuals residing in rural areas and 86.5% in urban areas. Self-reported race and ethnicity were as follows: 52.7% non-Hispanic White, 15.2% non-Hispanic Black, 23.4% Hispanic, and 7.0% Asian/Pacific Islander. Compared with urban areas, rural areas had a higher proportion of pregnant individuals who were younger than 25 years (66.5% vs 51.6%), were non-Hispanic White (73.3% vs 49.4%), and had a high school education or less (47.6% vs 38.2%). The timing of prenatal

care initiation was similar in both rural and urban areas, with the majority of pregnant individuals receiving care within the first 5 months.

From 2016 to 2019, there were 25 541 maternal ICU admissions during the delivery hospitalization, of which 13.9% occurred among individuals residing in rural areas (n = 3562) and 86.1% in urban areas (n = 21 979). Rates increased nonsignificantly from 170.6 (158.8–182.7) to 192.3 (179.5–205.0) ICU admissions per 100 000 live births for pregnant individuals in rural areas (AAPC+3.3%/year = –5.3%, 12.7%) and from 161.7 (157.4–165.9) to 172.4 (167.9–176.9) ICU admissions per 100 000 live births in urban areas (AAPC+2.1%/year = –3.9%, 8.5%) from 2016 to 2019 (Table 1). Rural rates in each year of the study period were between 10% and 20% significantly higher than were those in urban rates (Table 1; pooled 2016–2019 RR = 1.14; 95% confidence intervals [CI] = 1.09, 1.18).

Of the 6758 pregnancy-related deaths from 2016 to 2019, 20.4% (n = 1378) were in rural areas and 79.5% (n = 5380) in urban areas. Rates of maternal mortality per 100 000 live births increased from 2016 to 2019 in rural (from 66.9; 95% CI = 59.1, 74.6 to 81.7; CI = 73.2, 90.1; AAPC = 7.0%/year; range = 2.2%–12.1%) and urban (from 38.1; 95% CI = 36.0, 40.2 to 42.3; 95% CI = 40.1, 44.5; AAPC = 3.5%/year; range = 2.2%–12.1%) areas (Table 1). Maternal mortality rates were persistently higher among individuals in rural than in urban areas (Table 1; e.g., 2019 RR = 1.93; 95% CI = 1.71, 2.17).

## DISCUSSION

In this nationwide, population-based study of adverse maternal outcomes, we found significantly higher rates of maternal ICU admissions and maternal mortality in rural than in urban areas.

**TABLE 1— Comparison of Maternal Mortality and Maternal Intensive Care Unit Admissions in Rural Versus Urban Areas: United States, 2016–2019**

Year	Rural, ASR (95% CI) or AAPC (Range)	Urban, ASR (95% CI) or AAPC (Range)	RR (95% CI)
<b>Maternal ICU admission</b>			
2016	170.6 (158.8, 182.7)	161.7 (157.4, 165.9)	1.06 (0.98, 1.14)
2017	192.2 (179.3, 205.1)	158.7 (154.5, 163.0)	1.21 (1.13, 1.30)
2018	187.4 (174.7, 200.1)	160.7 (156.4, 165.0)	1.17 (1.08, 1.25)
2019	192.3 (179.5, 205.0)	172.4 (167.9, 176.9)	1.12 (1.04, 1.20)
Pooled 2016–2019	185.5 (179.3, 191.9)	163.3 (161.2, 165.5)	1.14 (1.09, 1.18)
AAPC 2016–2019	+3.3 (–5.3 to 12.7)	+2.1% (–3.9 to 8.5)	NA
<b>Maternal mortality</b>			
2016	66.9 (59.1, 74.6)	38.1 (36.0, 40.2)	1.75 (1.54, 1.99)
2017	69.1 (61.4, 76.8)	39.7 (37.6, 41.9)	1.74 (1.53, 1.97)
2018	73.9 (65.8, 82.0)	40.9 (38.7, 43.1)	1.81 (1.59, 2.04)
2019	81.7 (73.2, 90.1)	42.3 (40.1, 44.5)	1.93 (1.71, 2.17)
Pooled 2016–2019	72.9 (68.9, 77.0)	40.2 (39.2, 41.3)	1.81 (1.70, 1.93)
AAPC 2016–2019	+7.0 (2.2 to 12.1)	+3.5 (2.2 to 12.1)	NA

Note. AAPC = annual average percentage change; ASR = age-standardized rate (per 100 000 live births); CI = confidence interval; ICU = intensive care unit; NA = not applicable; RR = rate ratio.

Specifically, pregnant individuals residing in rural areas experienced maternal mortality rates of up to almost twice the rate of individuals in urban areas, with persistent differences between 2016 and 2019. Moreover, in both rural and urban areas, maternal mortality rates have steadily increased.

Our findings extend those of previous studies, as we used more contemporary data using all births and pregnancy-associated deaths between 2016 and 2019. Also, previous studies analyzed rural-urban disparities in maternal morbidity and mortality as a composite measure or selected a small, sub-national region for their study focus.<sup>2,7,8</sup> We newly provide data specifically on maternal ICU admissions from all live births as an indicator that individuals needed the highest acuity of care. Of note, the frequency of ICU admission was relatively flat and the rural-urban disparity was relatively narrow. By contrast, we demonstrated significant increases in maternal mortality rates in all geographic locales and persistent differences in the rates for rural versus urban areas.<sup>2,7</sup>

Although the reasons for the higher rates of adverse maternal outcomes in rural areas are likely multifactorial, substantial declines in hospital-based obstetric services between 2014 and 2018 in rural counties highlight the importance of policy efforts to ensure access to high-quality and high-acuity care.<sup>9</sup> Previous work has also demonstrated rural-urban differences in individual cardiovascular health factors that may contribute to adverse maternal outcomes, such as obesity, diabetes, and hypertension, as well as adverse pregnancy outcomes, such as hypertensive disorders of pregnancy.<sup>10,11</sup>

Limitations of this study include potential miscoding of adverse maternal

outcomes on birth and death certificates as well as the potential for variation in the threshold for ICU admission between hospitals. As maternal mortality review committees are not universally available in each jurisdiction to adjudicate deaths, a more advanced understanding of causes of death is not possible with the current data set. However, the CDC WONDER Natality and Mortality Databases provide comprehensive and robust data on total maternal mortality and ICU admissions in the United States.

## PUBLIC HEALTH IMPLICATIONS

Our results demonstrate higher maternal ICU admission and mortality rates in rural than in urban areas, with statistically significant increases in maternal mortality in all areas between 2016 and 2019. The disproportionate burden of maternal risk in rural areas is especially concerning given the decline of health care facilities and obstetric care in these areas. These data reflect the pervasiveness of poor maternal outcomes across the United States, and future research should incorporate the intersection of place with other important social determinants of health.<sup>12</sup>

Lack of access or additional barriers to abortion care are associated with adverse maternal outcomes, which suggests that future trends in maternal ICU admission and mortality rates will likely accelerate following the US Supreme Court's revocation of the constitutional right to abortion. It remains to be determined how this will differentially affect rural and urban areas and should be an area of future research. The persistent outcome gap between rural and urban areas demonstrates the added burden in resource-limited

rural areas that warrant targeted public health interventions. **AJPH**

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## CONTRIBUTORS

K. A. Harrington completed the analyses and the first draft of the article. K. A. Harrington and S. S. Khan designed the study. N. A. Cameron, K. Culler, W. A. Grobman, and S. S. Khan made critical revisions to the article. N. A. Cameron, W. A. Grobman, and S. S. Khan supervised the analyses and contributed to the interpretation of the findings.

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## CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

## HUMAN PARTICIPANT PROTECTION

The Northwestern University Feinberg School of Medicine institutional review board deemed this study exempt from review because of the publicly available de-identified nature of the data used.

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