Letters

RESEARCH LETTER

Rural and Urban Differences in Neonatal Abstinence Syndrome and Maternal Opioid Use, 2004 to 2013

Incidence rates for neonatal abstinence syndrome (NAS) and maternal opioid use increased nearly 5-fold in the United States between 2000 and 2012.[1] Previous studies suggest the incidence of NAS may be increasing rapidly in some rural states,[2] in parallel with rising rural rates of other opioid use–related conditions including hepatitis C and overdose deaths.[3,4] To our knowledge, no study has examined national trends in NAS and maternal opioid use among rural patients compared with their urban counterparts.

Methods | We used 2004 to 2013 data from the National Inpatient Sample, a nationally representative, all-payer sample of hospital discharges in the United States compiled by the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality.

The study population consisted of all neonatal births and obstetric deliveries between 2004 and 2013.[5] Infants with NAS were identified using the *International Classification of Diseases, Ninth Revision, Clinical Modification* code of 779.5 in any diagnosis field. Cases of potentially iatrogenic NAS were excluded using previously described methods.[6] Maternal opioid use was defined using *International Classification of Diseases, Ninth Revision, Clinical Modification* codes 304.0x, 304.7x, or 305.5x. The University of Michigan institutional review board determined the study was exempt because the National Inpatient Sample Data contain deidentified data. Patient consent was therefore neither required or obtainable.

Location of residence was defined as rural or urban using the National Center for Health Statistics Classification Scheme for Counties. We tabulated demographic characteristics for infants with NAS and mothers with opioid use by rural/urban status and calculated the proportion of NAS cases accounted for by rural infants in each 2-year period. Incidence rates of NAS and maternal opioid use by rural/urban status were calculated using predictive margins with 2 separate logistic regression models that interacted variables for each 2-year period with rural/urban status.

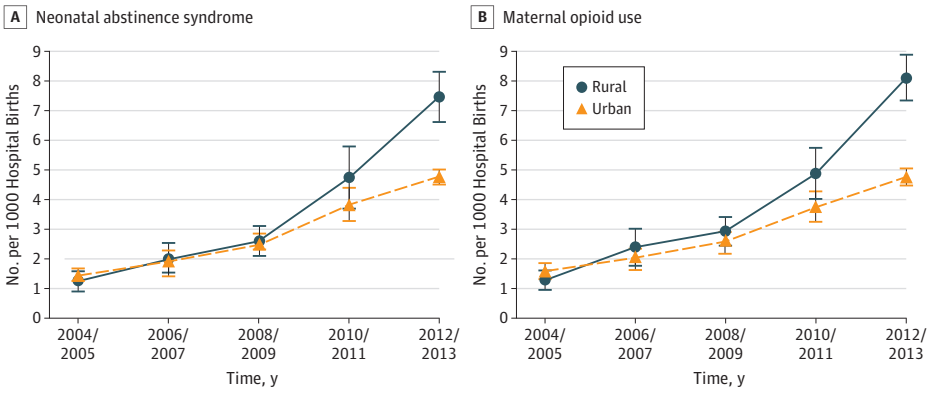
To allow for comparisons over time, we used trend weights provided by the Healthcare Cost and Utilization Project that account for National Inpatient Sample sampling changes in 2012. We conducted analyses using Stata, version

Table. Characteristics of Infants and Mothers With Opioid-Related Diagnoses in the United States, 2004-2013

Characteristic	No. (weighted %)		*P* Value
	Rural	Urban	
Infants with NAS, unweighted No.	4192	19 752	NA
Girls	1889 (45.2)	9106 (46.2)	.30
Income quartile			
1 (lowest income)	2344 (58.3)	5829 (30.1)	<.001
2	1218 (30.2)	4896 (25.2)	
3	402 (9.9)	5185 (26.8)	
4 (highest income)	61 (1.6)	3462 (17.9)	
Insurance			
Public	3404 (81.8)	15 375 (78.0)	<.001
Private	429 (10.3)	3054 (15.5)	
Uninsured	336 (8.0)	1296 (6.5)	
Transfer to another hospital	408 (14.9)	873 (7.7)	<.001
Mothers with opioid use	9730	41 533	NA
Income quartile			
1 (lowest income)	5038 (53.1)	11 436 (28.0)	<.001
2	3327 (35.5)	10 035 (24.4)	
3	920 (9.8)	11 281 (27.5)	
4 (highest income)	148 (1.6)	8140 (20.1)	
Insurance			
Public	6532 (67.2)	24 653 (59.2)	<.001
Private	2668 (27.6)	14 456 (35.1)	
Uninsured	510 (5.2)	2380 (5.7)	
Transfer to another hospital	40 (0.6)	57 (0.2)	<.001

Abbreviations: NA; not applicable; NAS, neonatal abstinence syndrome.

Figure. Changes in Opioid-Related Diagnoses Among Infants and Mothers by Urban/Rural Status



Frequency of neonatal abstinence syndrome (A) and maternal opioid use (B) per 1000 hospital births by rural vs urban status, displayed as 2-year combined estimates.

14.1 (StataCorp) and used survey commands to account for the complex sampling design; *P* less than .05 was considered statistically significant.

Results | Compared with their urban peers, rural infants and mothers with opoid-related diagnoses were more likely to be from lower-income families, have public insurance, and be transferred to another hospital following delivery (**Table**). The proportion of infants diagnosed with NAS who were from rural counties increased from 12.9% in 2003/2004 to 21.2% in 2012/2013 (*P* < .001).

From 2004 to 2013, the incidence of NAS increased from 1.2 (95% CI, 0.9-1.6) to 7.5 (95% CI, 6.6-8.3) per 1000 hospital births among rural infants and from 1.4 (95% CI, 1.2-1.7) to 4.8 (95% CI, 4.5-5.0) per 1000 hospital births among urban infants (**Figure**, A).

Similarly, during the same period, the frequency of hospital deliveries complicated by maternal opioid use increased from 1.3 (95% CI, 1.0-1.6) to 8.1 (95% CI, 7.3-8.9) per 1000 hospital deliveries among rural mothers and from 1.6 (95% CI, 1.3-1.9) to 4.8 (95% CI, 4.5-5.1) per 1000 hospital deliveries among urban mothers (Figure, B).

Discussion | The incidence of NAS and maternal opioid use in the United States increased disproportionately in rural counties from 2004 to 2013 relative to urban counties. This geographic disparity highlights the urgent need for policymakers to appropriate funding for clinicians and programs that could improve access to opioid prevention and treatment services for rural women and children. Potential targets include increasing access to rural primary care buprenorphine distribution and programs supporting rural and critical access hospital treatment of women and infants affected by opioid use.

Our analysis may reflect changes in coding practices over time and increased awareness of opioid-related comorbidities, but this is unlikely to account for the rural/urban disparities we found. Further dedicated research is warranted to identify factors that contribute to geographic disparities in NAS and maternal opioid use and to inform effective opioid use prevention and treatment strategies for vulnerable rural Americans.

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