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Perinatal Depression Associated With Increased Pediatric Emergency Department Use And Charges In The First Year Of Life

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ABSTRACT In New Jersey, universal screening for perinatal depression at the time of delivery has resulted in a 95 percent screening rate. The widespread availability of screening data allowed me to investigate the association between perinatal depression severity and infant emergency department (ED) use and charges in the first year of life. I used birth records linked to hospital discharge records for the period 2016–19. Compared with infants who had mothers with no symptoms, infants with mothers with mild or moderate/severe depressive symptoms had significantly higher overall and nonemergent ED use, but not significantly higher emergent ED use. The positive associations between depressive symptoms and ED charges were particularly striking for infants with Medicaid, which pays for a disproportionate share of pediatric ED care in the United States. This study contributes to the evidence base linking perinatal depression screening and pediatric ED use. Opportunities may exist within Medicaid to optimize screening and referrals for perinatal depression, with potential cost-saving benefits for reducing nonemergent pediatric ED visits.

The use of the emergency department (ED) in the first year of life is common, yet these visits are likely to be low-resource, nonemergent visits that are preventable.[1,2] Use of the ED for nonemergent reasons is costly and puts stress on ED staff and resources.[2] Infant ED use is particularly costly to Medicaid, as Medicaid is billed for disproportionately more pediatric ED visits compared with private insurers, accounting for 61.6 percent of pediatric ED visits.[3] Social determinants of health such as lower income, poor health literacy, and neighborhood disadvantage are associated with greater use of the ED for both postpartum people and their infants in the first year.[4–6]

Perinatal mental health conditions affect 20 percent of birthing people[7] and are associated with a range of adverse child outcomes,[8] including increased ED use.[4,5,9–13] This may be a result of increased illness or injury due to biological effects of depression on infant health[14] or inadequate infant care practices associated with parental depression.[15–17] Alternatively, increased ED use may be due to overuse resulting from a lack of social support at home or low health literacy.[2,6] However, few studies have examined whether parental depression–related infant ED use is attributable to emergent or nonemergent reasons, which is important for assessing policy implications.[18] In addition, most studies that use depression screening tools to detect perinatal depression use an above- or below-cutoff score. However, perinatal people may experience a broad range of depression symptom severity, from mild to severe, which has different implications for care pathways.[19] Yet there is little evidence examining the relationship between symptom severity and health care use and outcomes. Furthermore, much of the evidence is

limited by either low generalizability[4,5,11,13] or reliance on administrative claims to identify people with depression, which fails to capture the large proportion of people who do not get diagnosed.[9,12,18] When these factors are taken together, there is an important gap in understanding the relationship at the population level between perinatal depression symptom severity and emergent and nonemergent infant ED use.

To address this gap, I used data from New Jersey, where universal depression screening has been implemented since 2006, requiring all birthing people to be screened before discharge from the hospital.[20] Most hospitals use the Edinburgh Postnatal Depression Scale (EPDS) as the screening instrument, and results of the screening are recorded in New Jersey birth records. Although New Jersey's policy did not appear to affect treatment patterns for postpartum people,[21] it was highly successful at increasing screening rates to 90 percent (in our data, 95 percent), creating a unique opportunity to use the screening data at a population level.[22] I therefore took advantage of the near-universality of maternal depression screening and linked these data to infants' hospital discharge records to examine the association between mothers' depressive symptom severity at delivery and emergent and nonemergent infant ED use and charges in the first year of life. As Medicaid is the most common primary payer for pediatric ED visits, I also stratified my analyses by primary payer at delivery.[3] I discuss the implications of our results for Medicaid programs and the advantages and limitations of universal screening at delivery as a policy for improving diagnosis and treatment of perinatal depression, reducing nonemergent pediatric ED visits, and lowering costs.

Study Data And Methods

STUDY POPULATION I used data from New Jersey birth records on all live births between January 1, 2016, and December 31, 2018.[23] I limited the analysis to singleton infants (multiple births have significantly higher morbidity and costs)[24] whose mothers resided in New Jersey. I excluded infants who died in the hospital and those born with a congenital anomaly or fetal alcohol syndrome (<1 percent) because of high mortality rates.[9] I also excluded infants with mothers whose EPDS score at delivery was not recorded or was recorded incorrectly (5 percent) and those who were missing data on primary payer at delivery (1 percent).

I linked these data to New Jersey Uniform Billing Hospital Discharge records between January 1, 2016, and December 31, 2019.[25] Linking was conducted using a probabilistic match based on a set of personal identifiers and was achieved for 76 percent of infants (online appendix table A.1).[26] The main analytical sample included all infants who were successfully matched to a birth discharge record. I evaluated differences in characteristics between the full population and the matched sample, using absolute standardized differences.[27] Differences for all covariates met the commonly used threshold of <0.1 (appendix table A.1).[26]

CONCEPTUAL FRAMEWORK I used Ronald Andersen's Behavioral Model of Health Services Use to guide the analysis.[28] In this model, infant ED use is influenced by predisposing, enabling, and need factors. Maternal depression was conceptualized as a predisposing factor, with greater ED use corresponding to greater severity of symptoms.[9] Additional predisposing factors were drawn from previous evidence on pediatric ED use[5,29,30] and included the socioeconomic and demographic characteristics of the mother and father. The enabling factor was health insurance, which affected people's choices about the use of services. Need factors included variables on infants' health status at birth, as adverse birth outcomes are associated with increased infant health care use.[31]

MEASUREMENT OF VARIABLES I used the Healthcare Cost and Utilization Project criteria, using revenue and procedure codes, to identify ED visits in the hospital discharge data that occurred after the newborn's discharge after birth and before age one year (appendix table A.2).[26] I categorized ED visits following the New York University ED algorithm and subsequent updated algorithm "patch," which uses the primary diagnosis code at discharge to assign probabilities of the visit being nonemergent, emergent and primary care treatable, emergent but preventable, and emergent and not preventable, as well as separate categories for injury, mental health, alcohol, drug-related, and unclassified.[32,33] I categorized a visit as nonemergent if the sum of the probabilities of nonemergent and emergent and primary care treatable were greater than 50 percent, and as emergent if the sum of the probabilities of emergent and not preventable and emergent but preventable were greater than 50 percent.[32] The most common diagnoses categorized as emergent and nonemergent are shown in appendix table A.2.[26] As outcomes, I examined the total number of ED visits, as well as, separately, the total number of emergent, nonemergent, outpatient, and inpatient ED visits (details are in appendix table A.2).[26] Finally, I examined total claim charges during the first year of life from all ED visits during 2016–19. All charges were adjusted for

inflation to 2020 dollars, using the Consumer Price Index for All Urban Consumers. I measured perinatal depression symptoms using the EPDS score at delivery. I categorized symptom severity as none (EPDS score, 0–6), mild (score, 7–13), and moderate/severe (score, 14 or greater).[19] Demographic and socioeconomic characteristics were obtained from birth records and were self-reported by the mother. Following my conceptual model, predisposing demographic factors included maternal age, race and ethnicity, nativity, number of previous births, marital status, and birth year. Socioeconomic factors included maternal and paternal education; timely prenatal care; maternal smoking; and participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Race and ethnicity were included in the analyses because of the historical and ongoing impact of structural racism on disparities in maternal and child health in the US.[7] Delivery characteristics were obtained from birth records and reported by the hospital. The enabling factor was the primary payer for the delivery (commercial insurance, Medicaid, or uninsured). Need factors included low birthweight, preterm birth, vaginal delivery, and infant admitted to the neonatal intensive care unit (NICU). See appendix table A.3 for variable definitions and types.[26]

ANALYSIS I used descriptive statistics to analyze characteristics of the study sample. I then used negative binomial models to estimate the associations between severity of perinatal depressive symptoms and ED use outcomes. The unit of analysis was the infant. I report adjusted incidence rate ratios. I then applied a generalized linear model with a gamma distribution and log link function to estimate the association between perinatal depressive symptoms and total charges in the first year of life. To determine how this association differed by payer, I ran a model with an interaction term between depressive symptoms and primary payer at delivery and calculated average adjusted predictions of total charges by group.[34] I used a chi-square test to jointly test equality of predictive margins over levels of symptom severity within the payer group. All models were adjusted for covariates described above. Cluster-robust standard errors at the mother ID level were applied to account for siblings and for overdispersion. For missing information on covariates, I included separate indicators for "unknown."

I conducted a series of robustness checks (appendix tables A.4–A.7).[26] First, I examined binary versions of the outcomes, using logistic regression models, to ensure that findings were not driven by extreme values in the number of ED visits. Second, I used the more common EPDS cutoff score of 11 to define perinatal depression as a dichotomous variable and also compared results with a cutoff score of 7.[35] Third, I tested an alternative probability threshold in the New York University ED algorithm for classifying visits as emergent and nonemergent.[32] Finally, I expanded the analysis to infants who matched to any hospital discharge record in the first year.

I recognize that not all birthing people identify as mothers; for clarity of language, I use the terms "maternal" and "mother" in relationship to the infant. Analysis was conducted using Stata, version 18. Institutional Review Board approval was obtained from the Rutgers School of Public Health (Pro2022002252).

LIMITATIONS I note several limitations of the analysis. First, the data, although at the population level, were limited to New Jersey, and results might not be generalizable to other states. However, New Jersey is a diverse state with a high percentage of foreign-born mothers (38 percent),[36] which is a strength of this analysis. Second, 24 percent of infants could not be matched to a birth episode in discharge records. Standardized differences between the characteristics of the full population and matched sample were small (<0.1). In a sensitivity analysis, I reran the models using a sample of infants who matched to any discharge record (with only 16 percent of infants not matched), and the results were unchanged. Third, in the data, I was limited to calculation of charges, which might not accurately reflect provider or payer cost because of markups and discounts. Fourth, the New York University ED algorithm is an imperfect predictor of ED visit acuity and was also not specifically designed for pediatric populations; however, previous studies have successfully applied it to pediatric populations.[37,38] Fifth, although this unique data set provides a rich set of variables for our analysis, the study was observational and subject to unobservable confounding, which precludes causal interpretation of estimates. Despite these limitations, the results are robust to a range of specifications and variable definitions.

Study Results

Exhibit 1 provides descriptive statistics of infants' characteristics by perinatal depressive symptom severity at delivery. Slightly more than 10 percent of infants were born to mothers with mild depressive symptoms at delivery, and just under 1 percent were born to mothers with moderate/severe depressive symptoms. The results show the significant influence of socioeconomic factors on likelihood and severity of depressive symptoms: Those with mild or moderate/severe

EXHIBIT 1

Descriptive statistics for the study population of New Jersey–born infants, by severity of perinatal depressive symptoms at delivery, 2016–18

Characteristics	Total (%) (*N* = 207,428)	Perinatal depressive symptom severity (%) None (*n* = 184,322)	Mild (*n* = 21,251)	Moderate/severe (*n* = 1,855)
Primary payer at delivery				
Commercial	62.2	62.8	58.3	51.5
Medicaid[a]	30.3	29.9	32.7	40.1
Uninsured[b]	7.5	7.3	9.0	8.4
Maternal age, years				
Under 20	2.9	2.8	3.5	3.6
20–29	38.0	38.2	36.6	38.7
30–39	53.6	53.7	53.4	51.4
40 or older	4.6	4.4	5.5	5.2
Maternal race and ethnicity				
White (non-Hispanic)	45.7	46.4	39.7	40.5
Black or African American (non-Hispanic)	13.5	13.1	16.3	22.7
Hispanic	28.4	28.6	27.2	26.8
Asian	9.8	9.4	13.2	7.6
Native Hawaiian or Pacific Islander	1.2	1.2	1.4	0.9
Other[c]	1.5	1.4	2.2	1.5
Maternal nativity: born in the US	63.6	64.2	57.7	69.1
Maternal number of previous births: 1 or more	60.5	60.9	57.0	63.4
Maternal marital status: ever married	69.1	69.8	65.1	55.1
Maternal education: high school or less	33.8	33.5	35.5	43.1
Paternal education: high school or less				
No	55.4	55.8	53.3	43.8
Yes	37.5	37.5	36.7	38.9
Unknown father	7.1	6.7	10.0	17.3
Maternal smoking before or during pregnancy	6.7	6.3	9.3	17.3
Received prenatal care in first trimester	80.8	81.2	78.0	74.4
Participated in WIC	21.4	21.0	24.4	27.7
Low birthweight	5.7	5.4	7.8	11.3
Preterm birth	7.3	7.0	9.5	13.4
Vaginal delivery	65.7	66.4	61.2	54.0
Infant admitted to the NICU	9.5	8.9	13.3	19.8

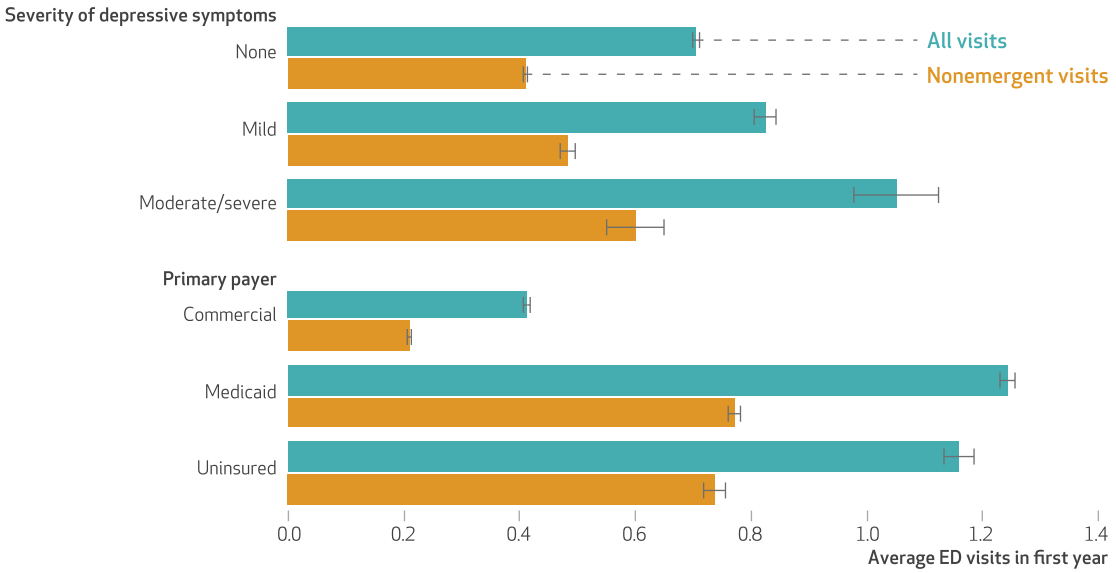
SOURCE Author's analysis of New Jersey birth records data, 2016–18. **NOTES** Depressive symptom severity categorized as none (Edinburgh Postnatal Depression Scale [EPDS] score, 0–6), mild (EPDS score, 7–13), or moderate/severe (EPDS score, 14 or above). All variable definitions are in appendix table A.3 (see note 26 in text). Percent unknown for the following covariates: primary payer ("missing" dropped from analysis); maternal age (0.9%); maternal race and ethnicity ("missing" included in "other"); maternal nativity (0.1%); number of previous births (0.1%); maternal education (0.5%); paternal education ("missing" included in "unknown father"); maternal smoking (0%); prenatal care in first trimester (3.7%); participated in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (1.4%); and marital status, low birthweight, preterm birth, vaginal delivery, and neonatal intensive care unit (NICU) admission (all <0.01%). [a]Medicaid or NJ FamilyCare, which consists of Children's Health Insurance Program, Medicaid, and Medicaid expansion populations. [b]Includes self-pay and no charge or charity. [c]Includes a composite of small cell categories of American Indian/Alaska Native, unknown race, and other race not otherwise categorized to maintain anonymity.

symptoms were disproportionately more likely to have low education, smoke before or during pregnancy, have late prenatal care initiation, and participate in WIC. They were also disproportionately likely to be Black or African American and have Medicaid insurance, and their infants were disproportionately likely to be low birthweight, premature, born by cesarean delivery, and admitted to the NICU.

Across ED visits, 57.2 percent of visits were paid for by Medicaid, and 68.4 percent of visits were classified as nonemergent (appendix table A.8).[26] Among infants, 36.2 percent had an ED visit in the first year of life, 5.4 percent had an emergent visit, and 24.7 percent had a nonemergent visit (appendix table A.9).[26] I observed differences in the average number of ED visits by severity of mother's depressive symptoms and primary payer (exhibit 2). Infants whose delivery was paid for by Medicaid had 1.24 ED visits in the first year compared with 0.41 visits among those with commercial insurance. Those with mothers with no depressive symptoms had 0.70 visits, whereas those with mothers with mild and moderate/severe symptoms had 0.82 and 1.05 visits, respectively. Patterns of use were similar

EXHIBIT 2

Average number of infant emergency department (ED) visits in the first year of life, by severity of perinatal depressive symptoms and primary payer at delivery, New Jersey, 2016–19



SOURCE Authors' analysis of New Jersey Uniform Billing Hospital Discharge and birth records data, 2016–19. **NOTES** $N = 207,428$. Depressive symptom severity is defined in the exhibit 1 notes. Medicaid includes NJ FamilyCare, which consists of Children's Health Insurance Program, Medicaid, and Medicaid expansion populations. Uninsured includes self-pay and no charge or charity. A table of corresponding data is in appendix table A.9 (see note 26 in text). Whiskers depict 95% confidence intervals.

for nonemergent visits.

After covariates were controlled for, there remained a significant association between perinatal depression symptom severity and infant ED use (exhibit 3). Infants with mothers with mild symptoms had 10 percent more ED visits (aIRR: 1.10; 95% confidence interval: 1.07, –1.12), whereas those with mothers with moderate/severe symptoms had 21 percent more ED visits (aIRR: 1.21; 95% CI: 1.13, 1.29) compared with those with mothers who had no symptoms. The associations were significant for nonemergent visits (for mild symptoms, aIRR: 1.09; 95% CI: 1.05, 1.12, and for moderate/severe symptoms, aIRR: 1.18; 95% CI: 1.09, 1.29) but were not significant for emergent visits. Both mild and moderate/severe symptoms were also significantly associated with both inpatient and out-

EXHIBIT 3

Adjusted incidence rate ratios for the associations between perinatal depressive symptom severity at delivery and number of infant visits to the emergency department (ED) in the first year of life, New Jersey, 2016–19

	Perinatal depressive symptom severity				
	None	Mild		Moderate/severe	
ED visit types	Adjusted incident rate ratio	Adjusted incident rate ratio	95% CI	Adjusted incident rate ratio	95% CI
All ED visits	Ref	1.10***	1.07, 1.12	1.21***	1.13, 1.29
Emergent	Ref	1.05	0.99, 1.12	1.17	0.97, 1.40
Nonemergent	Ref	1.09***	1.05, 1.12	1.18***	1.09, 1.29
Inpatient	Ref	1.12***	1.05, 1.20	1.40***	1.17, 1.67
Outpatient	Ref	1.09***	1.07, 1.12	1.20***	1.12, 1.29

SOURCE Authors' analysis of New Jersey Uniform Billing Hospital Discharge and birth records data, 2016–19. **NOTES** $N = 207,428$. Depressive symptom severity is defined in the exhibit 1 notes. Models are negative binomial regression models adjusted for all variables shown in exhibit 1 and include cluster-robust standard errors. Appendix table A.10 shows the full results of regression estimates (see note 26 in text). Definitions of emergent, nonemergent, inpatient, and outpatient ED visits are in appendix table A.2. Infants may have more than one type of ED visit. The reference value is 1.00. ***$p < 0.01$

patient visits. Full regression results are in appendix table A.10.[26]

Exhibit 4 illustrates that total charges associated with infant ED visits in the first year were higher for infants with Medicaid, as compared to those with commercial insurance, across all levels of perinatal depression severity. Among the Medicaid-insured infants, charges were significantly higher as mothers' symptom severity increased ($p = 0.0003$) (appendix table A.11).[26] Medicaid-insured infants whose mothers had moderate/severe symptoms incurred $7,936 in charges in the first year compared with $5,537 for those with mothers without symptoms (adjusted difference: $2,399; 95% CI: 619, 4,179), for an increase of 43 percent. Those with mild symptoms incurred $6,608 in charges (adjusted difference: $1,071; 95% CI: 407, 1,734), for an increase of 19 percent. Conversely, those with commercial insurance did not have significantly different charges across depression severity levels ($p = 0.21$) (exhibit 4).

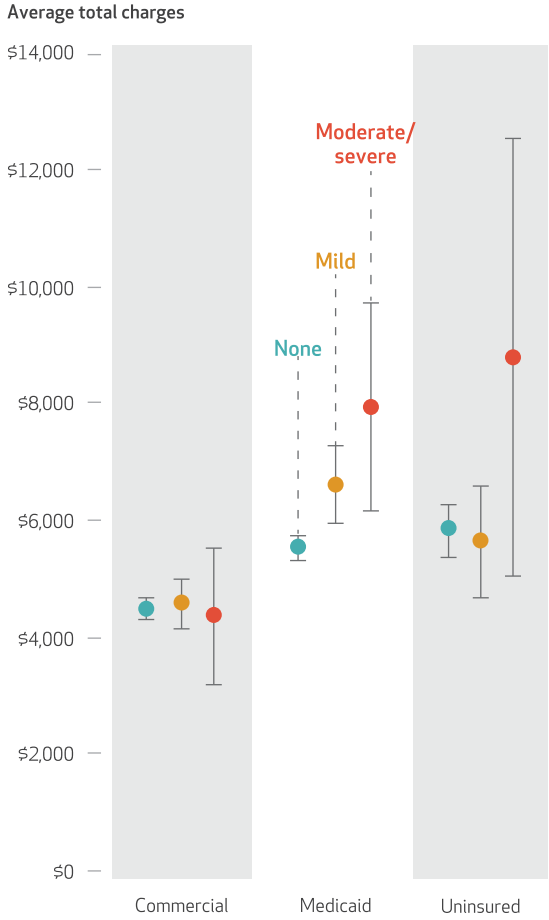
Discussion

In this analysis of linked birth records and hospital discharge data for New Jersey, I found that perinatal depressive symptoms were associated with increased infant ED use and charges in the first year of life. Moreover, even mild depressive symptoms were associated with greater nonemergent infant ED use, whereas depressive symptoms were not significantly associated with emergent use.

I also identified important inequities in the association between perinatal depression and ED use and charges by payer. Infants whose delivery was paid for by Medicaid had considerably more ED visits compared to those with commercial insurance. Furthermore, among those with Medicaid, total ED charges in the first year were 43 percent higher for infants with mothers with moderate/severe symptoms and 19 percent higher for those with mothers with mild symptoms compared with no symptoms. This association was relatively flat and was not significant for those with commercial insurance. These results are consistent with evidence showing that Medicaid insurance is a predictive factor for nonemergent and frequent ED use among perinatal people[5] and their infants.[30,39] Medicaid is the primary payer for more than 60 percent of pediatric ED visits, and this proportion has been steadily rising.[3] Implementing policies that interrupt the relationship between perinatal depression and nonemergent ED use is therefore an important priority with potential for cost savings. For example, extending Medicaid insurance for birthing people to one year postpartum (a change recently enacted in New Jersey) may be effective in increasing access to depression treatment.[40] Redesigning Medicaid reimbursement to incentivize co-located services for postpartum parent and infant may facilitate the assessment and management of perinatal depression in the same visit.[7] Finally, expanding Medicaid coverage to home visitors, doulas, and community health workers could help support mothers' mental well-being while addressing infants' care

EXHIBIT 4

Average adjusted emergency department charges in infants' first year of life, by perinatal depressive symptom severity and primary payer at delivery, New Jersey, 2016–19



SOURCE Authors' analysis of New Jersey Uniform Billing Hospital Discharge and birth records data, 2016–19. **NOTES** Depressive symptom severity is defined in the exhibit 1 notes. Adjusted charges estimated using a generalized linear model with gamma distribution and log link, with interaction between perinatal depressive symptom severity and payer. Model adjusted for all variables shown in exhibit 1 and includes cluster-robust standard errors. Appendix table A.11 provides a source table with significance tests (see note 26 in text). Medicaid includes NJ FamilyCare, which consists of Children's Health Insurance Program, Medicaid, and Medicaid expansion populations. Uninsured includes self-pay and no charge or charity. Whiskers depict 95% confidence intervals.

Routine screening in the ED could play an important role in identifying perinatal people with mental health conditions.

needs.[7,41] Cost-benefit analysis is needed to understand the economic impact of these policies.

This study built on the existing literature on perinatal depression and pediatric ED use by offering new evidence on emergent and nonemergent use and by investigating a wider range of depression symptom severity. The analysis also addressed several methodological limitations in the literature. First, I used population-level data in a diverse state, rather than a select sample. Second, the data included depression screening scores, using a validated instrument from the full population, instead of relying on claims data for identification of people with perinatal depression, which have been shown to underestimate prevalence and skew the sample to those who engage in postpartum care.[18] My estimate of depression prevalence of 11 percent was similar to that of a recent systematic review.[42] Third, I had complete and objective records of ED use, rather than self-reports. Last, the cohort design of the study with linked birth and discharge records provided clear temporality for the variables, as well as a rich set of demographic and socioeconomic covariates.

The American College of Obstetricians and Gynecologists recommends depression screening at least once during the perinatal period.[43] Since New Jersey implemented universal screening for perinatal depression in 2006, at least twenty-five states and Washington, D.C., have implemented policies to address perinatal mental health conditions.[20] Only Arkansas, Florida, and New Jersey require depression screening at the time of delivery.[44] Medicaid programs in eleven states require maternal depression screening as part of a well-child visit.[45] Although screening at multiple points during pregnancy and postpartum is optimal, one benefit of screening at delivery is that it covers nearly all birthing people and offers an opportunity to identify people at risk for postpartum depression before they leave the hospital. This is critical because postpartum people often face multiple barriers to postpartum care; among Medicaid beneficiaries, approximately 40 percent do not attend the routine postpartum visit, and most people with perinatal mental health conditions are not diagnosed.[7] Moreover, history of depression and experiences of antenatal depression are consistently two of the strongest predictors of postpartum depression.[46] However, for screening policies to meaningfully improve outcomes, screening must be followed up with accessible and culturally appropriate care.[7] Supports must also be in place for obstetric and pediatric providers to reinforce hospital discharge recommendations and coordinate follow-up care.[47] Finally, structural barriers to accessing mental health care, such as geographic and transportation-related barriers, language-related barriers, and lack of after-hours availability, must be addressed.[47] Perinatal psychiatry access programs are a promising model for bridging perinatal and mental health care systems via provider capacity training, consultation, and linkages to resources and referrals.[48] In conjunction with New Jersey's ongoing Nurture NJ perinatal health initiatives, these access programs are connected to a statewide coordinated system of referral (Connecting NJ), which links patients with depressive symptoms to mental health services and community programs.[49] My results suggest that these initiatives can have positive influences on health equity and return on investment.

The study's findings also suggest that routine screening in the ED could play an important role in identifying perinatal people with mental health conditions. Studies have found that postpartum depression screening in a pediatric ED setting is feasible.[50,51] Perinatal users of the ED, particularly those who screen positive for depression, are likely to be a high-risk, socially vulnerable population, who may have concerns about disclosure of depressive symptoms, judgment from providers, and loss of parental rights.[5] Therefore, ED policies for depression screening need to follow patient-centered, nonstigmatizing approaches and be linked to a case management system to address underlying social determinants of health.[5,52]

Conclusion

Perinatal depressive symptoms, ranging from mild to severe, were associated with increased total and nonemergent infant ED use. Total charges associated with ED visits in the first year were higher for those with Medicaid compared to those with commercial insurance, across all levels of depression severity. The large disparities I observed by payer suggest that opportunities ex-

ist within Medicaid to optimize screening and referrals for perinatal depression, with potential cost-saving benefits for reducing nonemergent pediatric ED visits. ■

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26 To access the appendix, click on the Details tab of the article online.

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