Maternal Substance Use Disorders and Infant Outcomes in the First Year of Life among Massachusetts Singletons, 2003-2010

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Objective To determine the association of maternal substance use disorders (SUDs) during pregnancy with adverse neonatal outcomes and infant hospital re-admissions, observational stays, and emergency department utilization in the first year of life.

Study design We analyzed 2 linked statewide datasets from 2002 to 2010: the Massachusetts Pregnancy to Early Life Longitudinal data system and the Massachusetts Bureau of Substance Abuse Services Management Information System. Generalized estimating equations were used to assess the association of maternal SUDs and neonatal outcomes and infant hospital-based care in the first year of life, controlling for maternal and infant characteristics.

Results Maternal SUDs increased from 19.4 per 1000 live births in 2003 to 31.1 per 1000 live births in 2009. In the adjusted analysis, exposed neonates were more likely to be born preterm (aOR 1.85; 95% CI 1.75-1.96) and low birthweight (aOR 1.94; 95% CI 1.80-2.09). After controlling for maternal characteristics and preterm birth, SUD-exposed neonates were more likely to have intrauterine growth restriction, cardiac, respiratory, neurologic, infectious, hematologic, and feeding/nutrition problems, prolonged hospital stay, and higher mortality (aOR range 1.26-3.80). Exposed infants were more likely to be rehospitalized (aOR 1.10; 95% CI 1.04-1.17) but less likely to have an observational stay (aOR 0.90; 95% CI 0.82-0.99) or use the emergency department (aOR 0.87; 95% CI 0.83-0.90) in the first year of life.

Conclusions Infants born to mothers with SUD are at higher risk for adverse health outcomes in the perinatal period and are also more likely to be rehospitalized in the first year of life. *(J Pediatr 2017;■■:■■-■■).*

The incidence of substance use disorders (SUDs) in pregnant women, particularly opioid use with subsequent delivery of infants with neonatal abstinence syndrome (NAS), has been increasing in recent years. A cross-sectional study using national hospital discharge data demonstrated that between 2000 and 2009, the number of mothers using or dependent on opiates increased from 1.19 to 5.63 per 1000 hospital births per year.[1] Concurrently, the number of infants diagnosed with NAS increased from 1.20 to 3.39 per 1000 hospital births per year.[1] In 2012 and 2013, the National Survey on Drug Use and Health found that 5.4% of pregnant women aged 15 to 44 years reported illicit drug use, with lower rates in the third trimester compared with the first and second trimesters (2.4% vs 9.0% and 4.8%).[2] Although infants born to women with SUDs are at increased risk for adverse neonatal outcomes such as preterm birth, low birthweight, and other respiratory, neurologic, and gastrointestinal disorders,[3,4] data on subsequent health in the first year of life is very limited; the true extent of neonatal clinical problems may be underestimated due to lack of robust epidemiologic data bases.

Despite the growing problem of maternal addiction and associated adverse neonatal outcomes, our ability to monitor and understand the details of this major public health issue has been limited by the lack of robust data systems. To date, epidemiologic studies about maternal SUDs and infant outcomes have primarily been cross-sectional, lacking longitudinal analysis of outcomes of individual mothers and infants. Moreover, the identification of maternal SUDs has been limited to the use of self-reported surveys or medical record diagnoses, if present. Thus, the current analyses of perinatal risk associated with maternal SUDs may not be accurate.

This study builds off of the work of Kotelchuck et al, which first addressed these gaps through analysis of a longitudinal database that linked maternal and infant medical records, Bureau of Substance Abuse Services (BSAS) SUD treatment records, and birth certificate information, allowing a more robust longitudinal approach to identifying maternal SUDs and determining its association with birth outcomes.[5]

BSAS	Bureau of Substance Abuse Services
EMSANT	Explicit Mention Substance Abuse need for Treatment
MA	Massachusetts
MDPH	MA Department of Public Health
NAS	Neonatal abstinence syndrome
PELL	Pregnancy to Early Life Longitudinal data system
SUDs	Substance use disorders

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Although this prior analysis provided more accurate estimates of maternal SUDs and birth outcomes, infant health outcomes beyond the immediate perinatal period was not assessed. We move beyond this initial analysis with 3 additional years of data and include more detailed infant clinical health outcomes and utilization of hospital-based care up to the first year of life.

The objectives of this study were to determine the association of maternal SUDs during pregnancy with adverse neonatal outcomes (including NAS, prolonged newborn hospital stay, and medical complications such as respiratory problems, feeding difficulties, and neurologic problems) and to determine the association of maternal SUDs during pregnancy and infant hospital re-admissions, observational stays, and urgent care utilization in the first year of life.

Methods

The data sources for this study derive from a unique linkage of 2 Massachusetts (MA) population based data systems: The MA Pregnancy to Early Life Longitudinal (PELL) and The MA BSAS Management Information System. The PELL data system is a very comprehensive maternal and child health relational data systems, that longitudinally links all MA birth certificates and fetal death records to their corresponding maternal and infant hospital discharge records for delivery utilization, and then in turn is longitudinally linked with multiple associated reproductive and pediatric programmatic and surveillance datasets, including child and maternal death data; inpatient hospital discharge, emergency department, and outpatient observation stay data; birth defect and cancer registries; early intervention and Special Supplemental Nutrition Program for Women, Infants, and Children program data. PELL contains information on all MA births since 1998, including over 1 000 000 births and 700 000 unique mothers. It has been used in over 30+ peer-reviewed articles to date. The MA Department of Public Health (MDPH) maintains and develops the PELL data system. The public health datasets in the PELL data system are linked together, on a secure restricted computer at MDPH using randomly generated unique identifiers for mothers and children to form a relational data system organized at the individual level. The PELL core linkage consists of live birth certificates and fetal death reports, provided by the MDPH Registry of Vital Records and Statistics, which are annually linked by MDPH to their corresponding birth and delivery in-patient hospital discharge records, provided by the Center for Health Information and Analysis. Over 98% of birth certificates have been linked to corresponding maternal or infant hospital discharge records. The result is the dyadic linkage of the birth and delivery records of the child and mother. Further details about the PELL data system have been described elsewhere.[6,7] For this study, PELL provides information on birth and clinical conditions at delivery, hospital-based health service utilization, and is the source of several indicators to determine maternal SUD history.

The MA BSAS is the state agency responsible for all SUD prevention, treatment and policy programs in MA. Its Management Information System datasets contain longitudinal treatment records for all women of reproductive age to all who use publicly funded substance abuse treatment facilities in MA, over 25 000 annually. BSAS supports about 90% of all SUD treatment facilities in MA, including detoxification programs, inpatient and residential programs, and methadone clinics. This database provides information about women who have SUDs needs, especially for those women who do not SUD treatment information noted in their hospital based clinical encounters. The BSAS data system provides information on drugs of choice and formal SUD treatments over time; but it has limited information on women's pregnancy and motherhood status. Furthermore, it does not support Alcoholics Anonymous or Driving While Intoxicated programs, and their participants are not included in the BSAS database.

In 2010, through a collaboration of MDPH and Boston University, a multisource multistep linkage algorithm was used to develop a new database linking PELL and BSAS datasets. Details have been previously published.[5,8]

For maternal SUD identification, we used a sex-specific tool/algorithm tested in our prior studies (REF).[9,10] This new algorithm, the Explicit Mention Substance Abuse need for Treatment (EMSANT) in Women, uses a variety of means to establish maternal SUDs, conceived as a (longitudinal) chronic condition. First and foremost, EMSANT developed a new (*International Classification of Diseases, Ninth Revision, Clinical Modification*) SUD diagnostic code-based groupers that can be applied to hospital-based administrative discharge data. The EMSANT algorithm is described in detail elsewhere.[9,10] Mothers were also considered to have SUDs based on birth certificate record mention of a positive toxicology screen, or a record of BSAS treatment within 1 year before delivery. All other women were considered as not having SUDs. Compared with other methods of identifying maternal substance abuse on a population-basis, this algorithm allows for a more robust approach given that it draws upon multiple sources of maternal and infant records.[9,10]

All MA resident mothers who delivered a live-born singleton infant in a MA hospital during 2003-2009 were included in this study (N = 509 548). Mothers were classified as having SUDs or not per the EMSANT algorithm, described above. Infants born to mothers with SUDs were considered "exposed" whereas those born to mothers without SUDs were considered "unexposed." Infants born in 2009 were followed until the end of 2010 to assess their use of hospital-based care in the first year of life. Thus, although the birth cohort was from 2003 to 2009, study outcomes were assessed from 2003 to 2010.

Based upon prior studies, relevant neonatal outcomes of interest included in this study were NAS, preterm birth, low birthweight, neonatal mortality, and intrauterine growth restriction, prolonged hospital stay (>2 days for vaginal births and >4 days for cesarean deliveries) for infants born ≥35 weeks gestational age, neonatal respiratory problems, cardiac problems, feeding/growth difficulties, neurologic abnormalities, infectious conditions, and hematologic problems. Hospital-based infant care in the first year of life included an episode