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Prenatal Methamphetamine Exposure and Short-Term Maternal and Infant Medical Outcomes

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Abstract

Objective—Examine maternal and infant medical outcomes of prenatal exposure to methamphetamine (MA).

Study Design—Four hundred and twelve mother-infant pairs (204 MA-exposed and 208 unexposed matched comparisons) were enrolled in the Infant Development, Environment and Lifestyle (IDEAL) study. Exposure was determined by maternal self-report during this pregnancy and/or positive meconium toxicology. Maternal interviews assessed prenatal drug use, pregnancy course, and sociodemographic information. Medical chart reviews provided medical history, obstetric complications, infant outcomes, and discharge placement.

Results—MA-using mothers were more likely to be poor, to have a psychiatric disorder/emotional illness and less prenatal care, and to be less likely to breast-feed their infant than comparison mothers. After adjusting for covariates, MA-exposed infants were more likely to exhibit poor suck, to have smaller head circumferences and length, to require neonatal intensive care unit (NICU) admission, and to be referred to child protective services (CPS). Several outcomes previously reported from studies that lacked adequate control groups or adjustment for covariates were not significantly different in this study.

Conclusion—Prenatal MA exposure is associated with maternal psychiatric disorder/emotional illness, poor suck, NICU admission, and CPS involvement, and MA-exposed infants were less likely to be breast-fed; however, the absence of many serious complications, such as fetal distress, chronic hypertension, preeclampsia, placenta previa, abruptio placentae, and cardiac defects, suggests confounding variables influenced prior studies.

Keywords

amphetamine; methamphetamine; drug; antenatal; neonate

Methamphetamine (MA) use, especially among women of reproductive age, is of continuing concern worldwide. In the United States, over 1.3 million people over the age of 12 have used MA in the past year.¹ MA use results in increased wakefulness and physical activity, hypertension, tachycardia, confusion, decreased appetite, and extreme weight loss.² Prenatal MA use can also lead to vasoconstriction and a restriction of nutrients and oxygen to the fetus.³ Because MA can cross the placenta,^{4,5} fetal tachycardia and hypertension can result and lead to fetal organ damage and strokes. The possibility of these potentially adverse consequences of prenatal MA use has raised concern among public health professionals and health care providers.

A limited number of prior studies have investigated the possible prenatal effects of MA use; however, the data from these studies have not provided conclusive evidence regarding maternal and infant medical outcomes associated with prenatal MA exposure. Some studies have reported that placental abruption and premature delivery are associated with MA use during pregnancy.⁶⁻⁹ Cases of seizures¹⁰ and cardiovascular collapse¹¹ have also been reported in women using MA during pregnancy. However, in larger studies, no differences were found with respect to several pregnancy complications, such as pregnancy-induced hypertension, peripartum abruption, premature rupture of membranes and meconium staining, amnionitis, syphilis, chorioamnionitis, and hepatitis.^{12,13} A large study of Australian women found prenatal amphetamine exposure was associated with being single, homelessness, domestic violence, not breast-feeding, maternal psychiatric disorder, prematurity, and involvement with child protective services (CPS).¹⁴

Findings regarding the infant medical outcomes of prenatal MA exposure are also conflicting. Some studies have observed an increased risk of musculoskeletal and cardiac defects, as well as gastroschisis.^{15,16} Exposed infants have been associated with an increased likelihood of clefting, fetal growth restriction, cerebral hemorrhage, bradycardia, tachycardia, and cardiac anomalies,³ as well as an increase in infant mortality.⁶ In contrast, Little et al¹³ did not observe differences in major congenital anomalies between newborns prenatally exposed to MA and those not exposed. Additionally Oei and colleagues also found no association with congenital anomalies, neonatal death, respiratory distress, antepartum hemorrhage, and neonatal intensive care unit (NICU) admission.¹⁴

Overall, most prior maternal and infant studies have utilized retrospective designs that assess drug use via self-report only or do not conduct toxicology screening on all participants, consist of case series reports or small samples, and, moreover, lack matched control groups to investigate the extent to which any observed medical outcomes are the result of other variables associated with MA use during pregnancy (e.g., concomitant tobacco, alcohol, and other illicit drug use or sociodemographic characteristics). To overcome these limitations, the Infant Development, Environment and Life-style (IDEAL) study matched exposed and comparison participants on four demographic variables and prospectively studied a large group of infants prenatally exposed to MA. The IDEAL study has already found MA exposure is associated with multiple maternal psychosocial risks,¹⁷ neurobehavioral patterns of decreased arousal, increased stress, and poor quality of movement,¹⁸ and increased prematurity and incidence of small for gestational age (SGA).¹⁹ The current study reports both maternal and infant medical outcomes from women and infants enrolled in the study.

Methods

Detailed methods for the IDEAL study have been previously reported.²⁰ Briefly, recruitment occurred over a 2-year period at four clinical sites (Los Angeles, CA; Des Moines, IA; Tulsa, OK; Honolulu, HI) that had an elevated prevalence of MA use compared with other areas in the United States. The study was approved by the Institutional Review Boards at all participating sites, and informed consent was obtained from all participants. A federal Certificate of Confidentiality was obtained to ensure the confidentiality of maternal drug use and results of meconium drug testing, but any evidence of child abuse or neglect remained reportable.

The study involved screening of 34,833 mother-infant pairs at the time of the infant's birth, of which 26,999 were available and screened for eligibility (Fig. 1). After screening for eligibility, 17,961 (66.5%) were eligible for the study. Mothers were excluded if they were under 18 years of age (3.5%, $n = 957$); used opiates, lysergic acid diethylamide, phencyclidine, or cocaine only during pregnancy (2.2%, $n = 583$); displayed low cognitive functioning (0.2%, $n = 48$); were overtly psychotic or had a documented history of psychosis (0.1%, $n = 34$); or were non-English speaking (17.7%, $n = 4773$). An additional 222 mothers (0.8%) were excluded for various other reasons including mother incarcerated or institutionalized, having a child previously enrolled in the study, or distance from study site prohibitive for follow-up. Exclusion criteria for infants included critical illness and unlikely to survive (0.5%, $n = 133$), multiple birth (4.5%, $n = 1219$), major life-threatening congenital anomaly or documented chromosomal abnormality associated with mental or neurological deficiency (0.5%, $n = 128$), overt clinical evidence of an intrauterine infection (0.07%, $n = 2$). Of these eligible subjects, 3705 (21%) mother-infant pairs consented to participate in the study.

Meconium was collected on all infants. Meconium samples were collected in the nursery and began immediately after obtaining consent to attempt to collect the first and/or earliest discharge of meconium. In some cases, more than one collection of meconium from an infant was used to ensure an adequate amount that could be tested. The samples were shipped to a central laboratory (United States Drug Testing Laboratory in Des Plaines, IL) for analysis of the amphetamine class, cocaine metabolites, cannabinoids, opiates, and cotinine. The specimen was initially screened with a sensitive enzyme-multiplied immunoassay test (EMIT II; Dade-Behring, Cupertino, CA). If positive results were obtained, the specific drug analyte or metabolite was confirmed by gas chromatography-mass spectrometry. Information on the collection procedures and analysis have been previously reported.²⁰

Among the consented, only mothers with prenatal MA use and their matched unexposed comparisons were enrolled for longitudinal follow-up ($n = 412$). Two hundred four infants had prenatal MA exposure and were identified by maternal self-report of MA use during this pregnancy and/or positive meconium toxicology. The 208 comparisons participants denied MA use during this pregnancy and had a negative meconium screen. Four additional comparison participants were enrolled with difficult-to-find matched characteristics in the event a family was lost during follow-up. Of the 204 exposed, 146 were identified by self-report only, 50 identified by self-report and positive toxicology, and eight denied use but had positive toxicology screens. All participants were matched on race, birth weight category (<1500 g, 1500 to 2500 g, >2500 g), maternal education, and type of insurance as a proxy for socioeconomic status (SES).

After informed consent was obtained, a maternal interview (the Recruitment Lifestyle Interview) was conducted in the hospital to determine the presence or absence of licit and

illicit prenatal drug use, information regarding the course of pregnancy, number of prenatal care visits, and sociodemographic information.^{21,22} Interviewers were trained and certified in the administration of maternal interviews and utilized scripted introductions to ensure consistency between sites.

For each drug used during pregnancy, a second interview, the Substance Use Inventory, assessed retrospectively the frequency and quantity of drug and alcohol use during four time periods: 3 months prior to pregnancy and during the first, second, and third trimesters of pregnancy.^{23–25} To assist in recall for each drug used at all four sites, a calendar was introduced that outlined the pregnancy trimesters, as well as important dates such as birthdays, anniversaries, holidays, and any other significant life events the mother was willing to share. In the current study we utilized maternal report (yes versus no) of MA, tobacco, alcohol, and marijuana. Interviews were completed within the first 5 days after delivery. Hollingshead V Index was used that ranks SES on the basis of education and occupation.²⁶

Maternal Outcomes

Past medical history of chronic conditions, hospitalizations, infections, medications administered during pregnancy, pregnancy complications, psychiatric disorder/emotional illness, and sexually transmitted infections were obtained from medical chart reviews by trained interviewers utilizing a yes-or-no checklist. The medical chart review captured paired dichotomous data for all of the items with the exception of pregnancy history and the number of hospitalizations. Chronic conditions included any class of diabetes mellitus that required the injection of insulin, as well as persistently high arterial blood pressure that was not pregnancy induced. Hospitalizations were limited to the current pregnancy and did not include emergency room visits or the hospitalization that resulted in delivery. Infections included documented diagnosis or treatment of a urinary tract infection, as well as a hepatitis diagnosis during this pregnancy. Medications administered during this pregnancy included all medications prescribed by a physician up until the time of delivery. Pregnancy complications included delivery by cesarean section, documented fetal distress as any change in baseline vital signs via fetal monitoring, preeclampsia, rupture of the placental membranes for 24 hours or more, treatment for chorioamnionitis (excluding routine treatment of mothers of immature fetus for bulging membranes), abruptio placentae, and placenta previa. Psychiatric disorder/emotional illness was defined as any diagnosed mental disorder, including clinical diagnoses such as anxiety and treatment for mental disorders during this pregnancy. Sexually transmitted infections required diagnosis of the infection during this pregnancy.

Infant Outcomes

Infant autonomic stress symptoms, birth complications, birth defects, child abuse report, central nervous system (CNS) symptoms at discharge, feeding preference, infections, and respiratory symptoms were also obtained from the medical chart review utilizing a yes-or-no checklist. The medical chart review captured paired dichotomous data for the majority of the items, with the exception of infant growth parameters, Apgar scores, and the number of days receiving services in the NICU. Autonomic stress symptoms were only counted if documented. Birth complications included receiving supplemental oxygen after admission to a nursery from Labor and Delivery, and documented NICU admission and administration of resuscitation medications not including narkan. Birth defects included diagnoses documented on the medical chart at discharge. Child abuse report was documented by either the physician or Social Services. Central nervous system symptoms, feeding preference, infections, and respiratory symptoms were also only counted if documented.

Alexander's algorithm was used to calculate SGA, defined as growth parameters <10% for standard growth curves.²⁷ Gestational age was determined by the estimated date of confinement for women with good prenatal care. The postnatal examination by the subject's physician was used in the event of a discrepancy between the postnatal gestation assessment and obstetric dating. For women with no or inadequate prenatal care, the postnatal examination by the patient's physician was used for gestational dating.

Statistical Analyses

Maternal and infant characteristics were examined by prenatal MA exposure status. Means and standard deviations are used for continuous measures. Categorical variables are expressed as observed counts and percentages. Significance levels for differences in MA exposure were derived from unpaired *t* tests and χ^2 tests, as determined by variable type.

Maternal characteristics, as shown in Table 1, were considered as potential covariates in the multivariate models. Potential covariates included site, mother's age, mother's prepregnancy weight, socioeconomic status (low versus other), marital status (partnered versus not), medical insurance status (public/no insurance versus other), mother's first born (yes versus no), and use of the following drugs during pregnancy (yes versus no): tobacco, alcohol, marijuana, and cocaine. A covariate was included in a multivariate model if the covariate was associated with MA exposure status and/or the outcome being analyzed (*p* value ≤ 0.10).

Maternal and infant medical outcomes and infant characteristics that showed significant associations by MA exposure group (*p* ≤ 0.05) were adjusted for covariates. In addition, multivariate adjustments for categorical medical outcomes were only evaluated if there was sufficient cell size (≥ 5 per group).

Multivariate models (logistic and linear regression, as appropriate) were constructed initially using a set of 10 potential covariates in addition to a dichotomous MA exposure variable. Through a backward selection process using a *p* value ≤ 0.10 , extraneous variables were eliminated from the model. Presented are both the unadjusted and adjusted *p* values for MA exposure status that were obtained through this process.

All analyses were performed using SPSS v17 (Chicago, IL) and SAS v9.1.3 (Cary, NC). Two-sided *p* values ≤ 0.05 were used in the analysis, unless otherwise noted.

Results

Maternal Demographics and Outcomes

Table 1 compares the maternal sociodemographic characteristics, pregnancy history, and prenatal drug use of the two groups studied. MA-using mothers were of lower SES, poorer, less likely to have a partner (*p* < 0.001), and older than the comparisons (*p* = 0.021). Overall, MA users had less prenatal care and began prenatal care at a later gestational age than mothers in the comparison group (*p* < 0.001). MA-using women gained more weight than comparison mothers, were more likely to have greater parity and gravida, and were less likely to be currently giving birth to their firstborn (*p* < 0.001). Although both groups included individuals who had used alcohol, tobacco, and marijuana during pregnancy, MA-using women were more likely to consume tobacco, alcohol, and marijuana during pregnancy and use all three drugs at a greater frequency (*p* < 0.001).

Table 2 shows the prevalence of medical complications/conditions in this sample that occurred in more than five cases. The mothers in the MA-exposed group were more likely to be diagnosed with gonorrhea (*p* < 0.001) or a psychiatric disorder/emotional illness (*p* = 0.012) than mothers in the comparison group. No differences were found regarding other

maternal medical complications/conditions previously associated with MA use in the literature including hepatitis, active genital herpes, syphilis, diabetes, receiving treatment for urinary tract infection, chronic hypertension, preeclampsia, abruptio placentae, placenta previa, delivery via cesarean section, or the incidence of hospitalization during pregnancy. Although more of the mothers in the comparison group used pain/sedation medication during pregnancy, there was no difference in the administration of any other medications (anesthetics, psychoactives, steroids, phenobarbital, tocolytics, antihypertensives) during this pregnancy. After adjusting for covariates, MA exposure remained significantly associated with being diagnosed with a psychiatric disorder/emotional illness ($p = 0.015$).

Infant Demographics and Outcomes

Table 3 compares the infant characteristics between the MA-exposed and comparison groups. Despite matching by birth weight categories, infants in the MA-exposed group weighed less ($p = 0.031$), had smaller head circumferences at birth ($p = 0.010$), and were shorter ($p < 0.001$) than the comparison group. MA-exposed infants were also born earlier ($p = 0.004$) and were more likely to be SGA ($p = 0.050$) and preterm (< 37 weeks' gestational age, $p = 0.027$). After adjustment for covariates, head circumference and length remained statistically different between the groups ($p = 0.014$ and $p < 0.001$).

Infant medical complications and conditions that were abstracted from the medical chart review and occurred in more than five cases are shown in Table 4. The MA-exposed group was less likely to be breast-fed ($p < 0.001$) and more likely to have a CNS diagnosis ($p = 0.001$), autonomic stress ($p < 0.001$), and CNS hypertonia ($p = 0.002$) at discharge. There was no difference in the incidence of CNS abnormal head sonograms. MA-exposed infants showed poor suck ($p = 0.001$), jitteriness/tremors ($p < 0.001$), and excessive suck ($p = 0.003$), but no increase in other conditions previously associated with prenatal MA exposure: CNS drug withdrawal requiring pharmacological intervention, sweating, tachycardia, facial dysmorphism, skeletal or cardiac defects, or respiratory problems at discharge. The incidence of admission to the NICU was higher in the exposed group, and they were more likely to have CPS involvement. After adjusting for covariates, MA exposure remained significantly associated with poor suck ($p = 0.003$), admission to the NICU ($p = 0.003$), CPS involvement ($p < 0.001$), and exposed infants were less likely to be breast-fed ($p < 0.001$).

Discussion

This study found MA use during pregnancy is associated with the mother being diagnosed with a psychiatric disorder or emotional illness and less likely to breast-feed, and the newborn more likely to have poor suck, to need admission to the NICU, and to need CPS involvement. MA-using mothers were more likely to be of lower SES, poorer, and older than the comparisons and less likely to have a partner. MA users also had less prenatal care, began prenatal care at a later gestational age, gained more weight than comparison mothers, and were more likely to consume tobacco, alcohol and marijuana during pregnancy. Infants in the MA-exposed group had smaller head circumferences at birth and were shorter than the comparison group. Our maternal and infant demographic findings are consistent with previous studies.⁶⁻¹⁴

Maternal Outcomes

We found mothers who used MA during pregnancy were more likely to have a history of a psychiatric disorder/emotional illness. This is consistent with a recent retrospective Australian study that also found maternal amphetamine usage is associated with psychiatric disorders.¹⁴ Psychiatric comorbidity is often observed among pregnant individuals with

serious drug problems,²⁸ and MA use in particular has been associated with paranoia,²⁹ depression, suicidal ideation, and psychosis.^{30–32} This is consistent with data from the Treatment Episode Data Set, a national database obtained from admissions to substance abuse treatment centers, which consistently recorded an increase in psychiatric problems from 1994 to 2006 in admissions due to MA.³³

Use of pain/sedation medication during this pregnancy was more common in the comparison mothers than the MA-exposed mothers. Due to the knowledge that anesthesia may cause complications during delivery in MA users, such as cardiovascular collapse, it is possible many of the mothers using MA were not prescribed them during the pregnancy.³⁴ Decreased use of pain/sedation medication may also indicate an increased pain tolerance by the MA-using mothers due to the increased release of dopamine neurotransmitters, which increases feelings of euphoria.

Similar to recent previous studies,^{12,13} no differences were found in evidence of fetal distress, chronic hypertension, preeclampsia, placenta previa, abruptio placentae, prolonged rupture of membranes, or chorioamnionitis treatment. Older studies that found maternal medical outcomes associated with prenatal MA use have lacked a control group⁸ and have not adjusted for confounders.^{8,9}

Infant Outcomes

The MA-exposed infants were shorter and had smaller head circumferences after adjusting for covariates. With 80% of mothers in the MA-exposed group using tobacco and over 30% using alcohol or marijuana during pregnancy, it is possible this additional drug use may be a contributing factor to decreased growth parameters.³⁵

We found an association between MA exposure and only some of the infant medical complications and conditions reviewed. Our findings of increased poor suck is consistent with previous studies of prenatal MA and cocaine exposure.⁹ Although autonomic stress symptoms were statistically more prevalent in the exposed newborns, these symptoms were not reported in the majority of the MA-exposed newborns, contrary to the expectations of many social workers and nursery clinicians when encountering prenatal substance abuse. Due to the increased CNS diagnosis and autonomic distress at discharge, it is not surprising that more of the MA-exposed infants were admitted to the NICU. Counseled mothers who used MA during pregnancy may have opted not to breast-feed their child due to the knowledge that breast milk can also transfer the drug to the infant.⁴ The disparity in breast-feeding may also be connected to the increase of CPS involvement in the exposed group. A recent study also found prenatal amphetamine exposure was associated with not breast-feeding, prematurity, and CPS involvement distress; however, NICU admission was significantly higher for exposed infants in our study, although the other study found no differences.¹⁴

In a major literature review, Plessinger found prenatal MA use was associated with cardiac defects, cleft lip, low birth weight, tachycardia, bradycardia, and cerebral hemorrhage, among many other adverse outcomes.³ However, we did not find MA use was associated with any of those complications, including cesarean delivery,⁶ placental abruption⁹ or congenital anomalies,³ as many studies have previously reported. These previous studies utilized small samples sizes or did not conduct toxicology screening on all participants, and their control group included use of opioids, which were excluded from our control group. Our study utilized a case-control design in an attempt to overcome some of the potential confounding that might have existed in prior studies.

Limitations

Although we controlled for site as a potential confounder and utilized trained interviewers to review medical charts, there is still the potential for site variability in the documentation of medical complications and conditions that may have impacted our results. In addition, it is possible that MA purity differed among the sites and influenced the severity of medical outcomes observed. Voluntary participation in the study may have contributed to the exclusion of heavy and active MA-using mothers. Additionally, fear of losing child custody may have impacted participation of heavy users, thereby influencing the final results. Moreover, this study did not examine the relationship between the total amount of MA used or timing of MA exposure and the likelihood or severity of problems. Future studies should investigate these possible dose-dependent effects.

Despite improving upon the study design and sample size of previous researchers, the sample size of the current study may not be sufficient to examine the prevalence of rare medical complications such as congenital anomalies. Low overall prevalence of complications and conditions in the total sample may be the result of a lack of association with MA exposure or impacted by an insufficient sample size.

Unfortunately, this study did not gather a lifetime prevalence of psychiatric disorders/emotional illnesses, so we are unable to determine whether the symptoms that led to inclusion in the medical chart were due to a psychiatric disorder, heavy MA use,³⁶ or MA withdrawal.³⁷

Recommendations for Clinicians and Future Studies

Lack of prenatal care remains an issue for substance-using pregnant women. Clinicians should continue to encourage women with substance use history to utilize prenatal care for better outcome of infants. These findings reiterate the importance of continued follow-up of infants prenatally exposed to MA to determine the predictive validity of these early medical complications. Our study indicates a need to identify infants who are prenatally exposed to MA so that ongoing developmental surveillance can be provided. Although we found no major defects or neurological findings in such infants, these infants remain at risk for environmental neglect and attachment issues. The increased CPS involvement and maternal psychiatric problems further strengthen the need for continued follow-up due to the additional environmental, parenting, and child-rearing challenges these families will encounter.

Additional studies on how prenatal MA exposure impacts maternal and infant outcomes are still necessary. This study did not address whether there is a dose- or time-dependent relationship between MA exposure and the medical outcomes. It is also uncertain whether the differences found can be accounted for by more severe concomitant drug use, including tobacco, alcohol, and marijuana, among MA users.

Prevention and Treatment for Pregnant Women Using MA

Identifying substance-using pregnant women and availability of comprehensive treatment programs remain a challenge for health care providers. Ongoing education and awareness by professionals is necessary to assist in overcoming the challenge. A nonjudgmental public health-centered approach toward treatment and follow-up is essential for successful treatment. Medical professionals providing prenatal services need to make use of community resources available to them for early referral and treatment of pregnant women. Additionally, comorbidities such as concurrent psychiatric conditions need to be treated in an appropriate and timely manner to maximize the benefits of drug treatment programs.

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Figure 1.

The recruitment flowchart details how many participants were screened, available, eligible, consented, and included in the longitudinal follow-up. It further details participants by exposure and how the exposed participants were identified.

Table 1**Maternal Sociodemographic Characteristics by MA Exposure**

	Number (%) / Mean (SD)		<i>p</i> Value ^a
	MA-Exposed (<i>n</i> = 204)	Comparison (<i>n</i> = 208)	
Demographic characteristics			
Race/ethnicity			0.971
White	77 (37.7%)	83 (39.9%)	
Hispanic	47 (23.0%)	45 (21.6%)	
Pacific Islander	37 (18.1%)	34 (16.3%)	
Asian	28 (13.7%)	29 (13.9%)	
Black	9 (4.4%)	12 (5.8%)	
Other	6 (2.9%)	5 (2.4%)	
Low SES, Hollingshead-V	68 (33.3%)	25 (12.1%)	<0.001
Annual household income (<\$10K)	68 (33.3%)	38 (19.2%)	<0.001
Public insurance (Medicaid recipient)	183 (89.7%)	180 (86.5%)	0.321
Education (<12 y)	93 (45.8%)	79 (38.2%)	0.117
No partner	115 (56.4%)	70 (33.7%)	<0.001
Mean age (y)	25.8 (5.6)	24.5 (5.5)	0.021
Pregnancy history			
Number of prenatal care visits	11.1 (7.3)	14.1 (5.5)	<0.001
Gestational age at first prenatal care visit (wk)	14.6 (8.1)	9.5 (5.6)	<0.001
No prenatal care	16 (7.8)	5 (2.4)	0.012
Maternal weight gain (lbs)	42.1 (20.2)	34.1 (15.8)	<0.001
Maternal weight (lbs)	141.9 (36.7)	144.5 (35.2)	0.470
Parity	1.8 (1.6)	1.2 (1.4)	<0.001
Gravida	3.7 (2.2)	2.8 (1.8)	<0.001
Firstborn	47 (23%)	81 (38.9%)	<0.001
Prenatal drug use			
Tobacco	163 (79.9%)	55 (26.4%)	<0.001
>10 cigarettes/d	62 (30.4%)	15 (7.2%)	<0.001
Alcohol	78 (38.2%)	28 (13.5%)	<0.001
>0.5 oz absolute alcohol/d	13 (6.4%)	0 (0%)	<0.001
Marijuana	68 (33.3%)	8 (3.8%)	<0.001
>0.5 joints/d	22 (10.8%)	5 (2.4%)	<0.001

MA, methamphetamine; SD, standard deviation; SES, socioeconomic status.

^aSignificance levels for differences in MA exposure were derived from unpaired *t*-tests and χ^2 tests, as determined by variable type.

Table 2

Prevalence of Selected Maternal Medical Outcomes by MA Exposure

Complication/Condition ^a	Prevalence n (%)	MA-Exposed (n = 204), n(%)	Comparison (n = 208), n(%)	Unadjusted p Value	Adjusted p Value ^b
Chronic conditions					
Diabetes–insulin dependent	2.4	3 (1.5)	7 (3.4)	0.338	NA
Chronic hypertension	2.2	6 (3.0)	3 (1.4)	0.333	NA
Hospitalizations	15.3	31 (15.3)	32 (15.5)	0.958	NA
For preterm labor	3.4	9 (4.4)	5 (2.4)	0.261	NA
For infectious illness	2.2	6 (2.9)	3 (1.4)	0.334	NA
Other	8.0	13 (6.4)	20 (9.6)	0.225	NA
Infections					
Treated for UTI	15.5	35 (17.8)	29 (13.9)	0.292	NA
Hepatitis B or C	2.9	9 (4.4)	3 (1.4)	0.073	NA
Medications administered during pregnancy					
Anesthetics	75.2	146 (71.6)	164 (78.8)	0.087	NA
Pain/sedation	57.8	108 (52.9)	130 (62.5)	0.050	0.323
Tocolytics	4.9	8 (3.9)	12 (5.8)	0.383	NA
Steroids	3.6	8 (3.9)	7 (3.4)	0.763	NA
Psychoactive medication	2.9	7 (3.4)	5 (2.4)	0.535	NA
Antihypertensives	1.7	6 (2.9)	1 (0.5)	0.066	NA
Pregnancy complications					
Cesarean section	22.8	50 (24.5)	44 (21.2)	0.417	NA
Evidence of fetal distress	7.8	19 (9.4)	13 (6.3)	0.245	NA
Preeclampsia	3.9	10 (4.9)	6 (2.9)	0.289	NA
Prolonged rupture of membranes	2.7	6 (2.9)	5 (2.4)	0.735	NA
Treated for chorioamnionitis	2.2	3 (1.5)	6 (2.9)	0.503	NA
Psychiatric disorder/emotional illness	10.4	29 (14.4)	14 (6.8)	0.012	0.015
Sexually transmitted infection					
Gonorrhea	3.4	13 (6.5)	1 (0.5)	<0.001	NA

MA, methamphetamine; NA, not available; UTI, urinary tract infection.

^aMedical conditions with fewer than five cases include: hospitalization for injury/accident, for chronic illness, for violence, for detoxification, and for psychiatric illness; use of phenobarbital; abruption placentae; placenta previa; active genital herpes; syphilis. Medical conditions with zero prevalence include: hospitalization for surgery, HIV-positive, and AIDS.

^bMaternal medical conditions that show significant association by MA exposure group ($p < 0.05$) and have sufficient cell size (≥ 5 per group) are adjusted for covariates.

Table 3

Infant Characteristics by MA Exposure

	Number (%) / Mean (SD)			
	MA-Exposed (<i>n</i> = 204)	Comparison (<i>n</i> = 208)	Unadjusted <i>p</i> Value ^a	Adjusted <i>p</i> Value ^b
Birth weight (g)	3183.3 (601.2)	3310.5 (591.5)	0.031	0.176
Head circumference (cm)	33.6 (1.7)	34.1 (1.9)	0.010	0.014
Length (cm)	49.8 (3.5)	51.0 (3.1)	<0.001	<0.001
Gestational age (wk)	38.4 (2.2)	38.9 (1.8)	0.004	0.096
< 37 weeks	36 (17.7%)	21 (10.1%)	0.027	0.078
Small for gestational age	34 (16.7%)	21 (10.1%)	0.050	0.052
Male gender	110 (53.9%)	110 (52.9%)	0.833	NA
Low birth weight (<2500 g)	23 (11.3%)	24 (11.5%)	0.933	NA

MA, methamphetamine; NA, not available; SD, standard deviation.

^aSignificance levels for differences in MA exposure were derived from unpaired *t*-tests and χ^2 tests, as determined by variable type.

^bInfant characteristics that show significant association by MA exposure group (*p* < 0.05) are adjusted for covariates.

Table 4

Prevalence of Selected Infant Medical Outcomes by MA Exposure

Complication/Condition ^a	Prevalence (%)	MA-Exposed (n = 204), n(%)	Comparison (n = 208), n(%)	Unadjusted p Value	Adjusted p Value ^b
Autonomic stress symptoms	10.4	34 (16.7)	9 (4.3)	<0.001	NA
Poor suck	6.6	22 (10.8)	5 (2.4)	0.001	0.003
Jitteriness/tremors	5.1	20 (9.8)	1 (0.5)	<0.001	NA
Excessive suck	1.9	8 (3.9)	0 (0.0)	0.003	NA
Birth complications					
Admitted to NICU	12.1	35 (17.2)	15 (7.4)	0.003	0.003
Required oxygen	7.5	20 (9.8)	11 (5.3)	0.082	NA
Birth defects					
Cardiac defects	3.4	6 (5.0)	8 (6.6)	0.593	NA
Child abuse report					
Referred to CPS	27.8	109 (54.0)	5 (2.4)	<0.001	<0.001
CPS involved—maternal drug use	27.1	106 (52.5)	5 (2.4)	<0.001	<0.001
CNS symptoms at discharge	3.2	12 (5.9)	1 (0.5)	0.001	NA
Hypertonia	2.2	9 (4.4)	0 (0.0)	0.002	NA
Feeding preference					
Breast-fed	57.0	77 (37.7)	158 (76.0)	<0.001	<0.001
Respiratory symptoms	5.1	14 (6.9)	7 (3.4)	0.107	NA
Respiratory distress	3.9	11 (5.4)	5 (2.4)	0.116	NA

CNS, central nervous system; CPS, Child Protective Services; MA, methamphetamine; NA, not available; NICU, neonatal intensive care unit.

^aMedical conditions with fewer than five cases include: mottling, sneezing, sweating, nasal stuffiness, tachycardia, bradycardia, resuscitation medication at birth, skeletal defects, facial dysmorphism, gastrointestinal defects, abnormal head sonogram, drug withdrawal, intraventricular hemorrhage, retinopathy of prematurity, sexually transmitted diseases, sepsis, apnea. Medical conditions with zero prevalence include: hyperthermia, hypothermia, hyperalertness, hiccoughing, cleft lip, hypotonia, hydrocephalus, seizures, hepatitis, HIV, bronchopulmonary dysplasia, and meconium aspiration syndrome.

^bInfant medical conditions that show significant association by MA exposure group ($p < 0.05$) and have sufficient cell size (> 5 per group) are adjusted for covariates.