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Prenatal Methamphetamine Exposure, Postnatal Maternal Depression, Perceived Child Behaviors and Academic Achievement

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Abstract

Background: Prenatal methamphetamine exposure and postnatal depression have significant impacts on child health outcomes and parenting skills. Postnatal depression increases health risks of the mother, that impacts herself and her child. Prenatal exposure to methamphetamine and postnatal depression may influence problematic behaviors in the child.

Methods: The data analyzed was from a longitudinal research study that consisted of four sites within the United States. Four hundred twelve mother-children pairs were enrolled in the study. At the 7.5-year follow-up, 290 children with complete data were available for analysis. Measures included the Child Behavior Checklist, the Woodcock Johnson, and the Wechsler Intelligence Scale for Children.

Results: Mothers of methamphetamine exposed children, with diagnosed postnatal depression, had children with increased problematic behaviors and lower academic achievement. They were more likely to exhibit externalizing and internalizing behaviors and had decreased scores for reading fluency and passage comprehension.

Conclusion: Thorough and increased qualitative interventional and support services are critical in the development of the child and the mother-child relationship. Such services may reduce maternal depression and lead to improved child behavior and academic achievement.

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Chapter One - Introduction:

Prenatal exposure to methamphetamine places the mother and child at risk for poor health outcomes which may lead to the urgent need of accessing fundamental resources for them to reduce these risks. Methamphetamine is a highly addictive stimulant that can become addictive in one single use (Methamphetamine Drug Facts 2019). Methamphetamine increases the amount of the natural chemical dopamine in the brain. Dopamine is involved in body movement, motivation, and reinforcement of rewarding behaviors (Methamphetamine Drug Facts 2019). Methamphetamine dominates global trafficking in amphetamine type stimulants. Women of childbearing age represent an increased proportion of methamphetamine users. (World Drug Report, 2022). This vulnerable population has worse psychosocial and child outcomes than other drug using mothers (Perez et al, 2021.) Therefore, prenatal methamphetamine exposure can profoundly increase the health risks of the mother and baby.

Some of the effects of prenatal methamphetamine use associated with the mother and baby include maternal postnatal depression, poor mother-child relationship, poor child cognitive function and an increased frequency of externalizing and internalizing behaviors at home and in school for the child. In one research study of mothers who used methamphetamine during pregnancy, mothers reported more depressive symptoms, more parenting stress, and more

externalizing and externalizing behaviors than mothers who did not use methamphetamine during pregnancy (Liles et al.,2012). Maternal mental illness is a significant public health problem during the perinatal period with 11.9% of mothers experiencing depression and their risk increasing as the children age (Linares et al, 2020). Maternal postnatal depression may influence the child's behaviors since it can impact on the mother-child relationship. Child behaviors can impact school performance and may increase maternal depression (Liles et al.,2012).

Prenatal exposure to methamphetamine can also impact short and long term neurobehavior in the child. A prospective cohort study in the United States and in New Zealand found that methamphetamine prenatal exposure is associated with greater stress/abstinence, physiological stress, and central nervous system stress in newborns (Lagasse et al., 2011). For children exposed prenatally to MA, there may be early and ongoing deficits in neurodevelopment, such as learning disabilities, intellectual disabilities, and attention-deficit hyperactivity disorder (Wouldes et al., 2014). Prenatal maternal depression symptoms were prospectively associated with reduced cognitive function in the child (Barker et al. 2018). Poorer inhibitory control was observed in heavy methamphetamine exposure exposed children placing them at a high risk for impaired executive function (Smith et al., 2015). Impaired executive function strongly influences the child's academic performance, and usually requires additional resources for the child. The child needs services to improve cognitive function over time. One of the neurodevelopment effects may be the development of attention deficit hyperactivity disorder in the child, which impacts their academic performance. Inattention and hyperactivity may all contribute to the deficits in achievements test scores and school success observed in students with ADHD (Arnold et al., 2015). Therefore, the awareness of prenatal methamphetamine exposure would significantly address ongoing, unexpected outcomes of the child and mother and educate societies of its occurrence and effects.

The purpose of the study is to discover if prenatal methamphetamine exposure and postnatal maternal depression lead to an increase in perceived child behaviors and lower academic achievement. Depression is a consistent finding in methamphetamine using women. In a research study that observed substance use among pregnant women, 68% of women seeking outpatient drug treatment reported a history of feeling depressed and 28% reported attempting suicide at some point in their lifetime (Smith et al., 2012). Pregnancy and the postpartum period are times of significant vulnerability to depression. Bennett et al, found a 12% prevalence of depression during the second and third trimesters (Bennett et al.,2004 as cited in Biaggi` et al.,2016).

Maternal depression is one of the most consistently documented risk factors for childhood maladjustment (Goodman et al., 2011 as cited in Maruyama et al., 2019). The parents may experience a great number of difficulties in trying to complete daily activities, accessing adequately supportive resources, and providing for their child. Caregiver burden might be high in ethnic and racial minority mother-child dyads in low-income settings where there are more stressors in the environment and rates of maternal depression are elevated (Wagner and Valdez, 2020). Low-income families may often experience insufficiency in their education and finances and may be less accepting of community resources. These factors can cause an increased likelihood in maternal depression and make it difficult for the mother to provide for her child. Maternal depression may be harmful in early life because children are dependent on their primary caregivers, and because support and social interactions are important in the child's development (Brentani 2016).

The environment in which the child is in and is exposed to affects their emotional and cognitive skills. Children of abusive parents are at increased risk for child abuse and neglect, disrupted continuity of primary caregiving, high parental stress, caregiver depression, and other

co-occurring mental health disorders (Liles et al. 2012). Children of drug using parents often lack basic needs and resources, and experience negative life events (Wright et al. 2015).

Specific Aim # 1: To examine if infants with prenatal methamphetamine exposure that have mothers with postnatal depression have more reported problematic behaviors.

Hypothesis #1: In this aim, we will test the hypothesis that mothers of infants exposed to methamphetamine during pregnancy with postnatal depression report increased problematic behaviors of their children as measured by the Child Behavior Checklist compared to non-exposed infants whose mothers who did not have postnatal depression.

Specific Aim #2: To assess academic achievement at age 7.5 in methamphetamine exposed infants with postnatally depressed mothers.

Hypothesis #2: In this aim, we will test the hypothesis that academic achievement as measured by the Woodcock-Johnson III and Wechsler Intelligence Scale for Children is decreased in children who were exposed to methamphetamines and maternal postnatal depression.

Chapter Two - Literature Review:

Methamphetamine and its impact:

Methamphetamine is a psychostimulant that causes increased energy and concentration but also increases the risk of aggression, psychosis, and depression (Sankaran et al, 2021). Maternal depression is an important health condition to address because it affects the mother and the child. The goal of health care professionals is to reduce and eventually rid the mother of depression so that she can improve her health and sufficiently support her child. Often, the mother's behaviors can influence the child's behavior. Previous research has suggested that depressed mood in mothers can inflate their report of child behavior problems (Liles et al., 2012). The child's

behaviors can represent a reflection of their mother's parenting. Women with MA use self-report more symptoms associated with paranoid ideation, depression and interpersonal sensitivity and are twice as likely to have a psychiatric disorder as a matched comparison group (Perez, et al. 2021). With poor mental health, the prenatal methamphetamine mothers may indirectly influence poor neurodevelopment in the child. (Perez et al. 2021).

Maternal depression and its connection to child behaviors:

The depressed mood of the mother may increase the likelihood problem behavior of the child. In a study conducted on families of very preterm children 2 years after birth, it was found that mothers who reported symptoms of mental health problems compared to those without these symptoms expressed higher levels of stress related to parental functioning (Treyvaud et al, 2011 as cited in Slomian et al., 2019). Mothers who experience higher stress levels may be less likely to provide parenting skills to their children because they're already experiencing a significant amount of stress. Adding an additional responsibility to the mother may be "stressful" because the mother is feeling helpless, overwhelming, and can easily miscomprehend the needs of their child. MA interferes with parents' ability to provide appropriate day-to-day care for children (Perez et al, 2021).

Some mothers who had depressive symptoms were more likely to report perceived child behaviors. At 3 years of age, children of mothers who had increasing depressive symptoms over time showed more behavior problems overall and more evidence of both internalizing and externalizing behaviors than children of mother in the low group (Park et al, 2017). Maternal depression was significantly and positively correlated with externalizing and internalizing problems in preschoolers, as well as externalizing and internalizing problems in school-aged

children (Khoshroo et al, 2021). As certainty in mental states increases, the relationship between maternal depression and child externalizing problems becomes stronger (Khoshroo et al, 2021).

Maternal depression research:

A systematic review and meta-analysis study in India which incorporated 38 studies and 20,043 women analyzed and obtained a pooled estimate of the prevalence of postpartum depression to be 22%. In earlier studies, researchers found depression among women in the postpartum period was 61% in Korea, 34.8% in Iraq, and 27,3% in China (Necho et al. 2020). In another research study in Canada, scientists found that maternal depression and anxiety disorders were associated with lower Early Development Instrument scores (Comasley et al, 2017). Maternal depression and anxiety disorder recurrence had a stronger association with child outcomes than any time, suggesting that prolonged or recurrent exposure to MDAD has a stronger influence on school readiness at kindergarten than timing of exposure (Comasley et al, 2017).

Methamphetamine and children:

Children who are exposed to methamphetamine are more likely to have increased problem behaviors and difficulty in their academic achievement. The National Institute on Drug Abuse compared neuro-behavioral outcomes during infancy and childhood between methamphetamine-exposed and unexposed cohorts and found that the MA group were emotionally reactive, anxious/depressed, and were at risk for ADHD (Sankaran et al, 2021). Often, these children spend much of their time in an environment of adversity. At age 5, PME children were significantly more emotionally reactive, anxious and/or depressed, and aggressive than comparison children (Abar et al. 2013). These behaviors are likely to have an impact on the child's school performance. In addition, PME children were exposed to significantly more early adversity overall than comparison children, with the largest differences seen with chronic poverty and changes in primary caregiver

of the child (Abar et al, 2013). Other studies suggest possible issues regarding younger school-aged children related to social integration, getting along with peers, as well as having lower results in cognitive testing. Their behavior is often associated with depression, anxiety states, and emotional instability, which manifest as increased externalization and personality disorders (Tomaskova et al, 2020).

Child's cognitive function:

One method in which the child's cognitive function was recorded is the utilization of the Woodcock-Johnson III tests (Smith et al, 2015). The main aims of most intelligence and achievement tests are to determine the intellectual and academic levels of students, particularly exceptional students who are far behind or far ahead of classmates (Abu-Hamour et al 2012). Some students within this research study were academically behind due to lack of support from their parent(s) and community resources. Children of mothers in the increasing trajectory group had poorer executive functions at age 6 than those of mothers in the low group. Children with ADHD may demonstrate cognitive profiles that are like children with learning disabilities, traumatic brain injuries, and social emotional problems (Abu-Hamour et al. 2012). In children with MA exposure, more ADHD problems were found to increase at age 5 when the children reached school age (Smith et al., 2012). This decreases the child's likelihood in achieving academically due to their drug exposure. Children with ADHD would also experience a delayed dopamine signal. These conditions would lead to slower learning or even failure to learn (Ochozkova et al., 2019).

A small cross-sectional study of 23 unexposed children exposed to MA compared to 22 unexposed children at 6 or 7 years found an association between MA and lower IQ, sequential and simultaneous processing, planning, and learning ability (Perez et al, 2021). At 6-15 years, MA-exposed children were more likely to have lower scores on the Full-Scale IQ of the Wechsler

Intelligence Scale of Childhood, and the individual indices of Verbal Comprehension, Perpetual Reasoning, Working Memory, and the Processing Speed Index (Perez et al, 2021).

A research study in Germany examined similarities and differences between cognitive profiles of children with attention deficit hyperactivity disorder and specific learning disorder. The study found that children in the ADHD + SLD performed lower on the following indices: Working Memory Index, Processing Speed Index, Full Scale IQ, Auditory Working Memory Index, Nonverbal Index, General Ability Index, and Cognitive Proficiency Index compared to their control group (Becker at al, 2021). In another research study, 179 children with ADHD were recruited from the Department of Pediatrics of the hospital center in Portugal in which the results indicated that there were significant differences in their results. The WISC-III was completed, and researchers found that 83.7% of children with ADHD having a Freedom of Distractibility Index score below the mean of the control group (Moura et al, 2019).

Summary:

Interestingly, MA withdrawal in adults is associated with excessive depression and anxiety, and it is not inconceivable that the same pathology affects infants' exposure to prenatal MA (Perez, et al. 2021). Methamphetamine may affect the child's neurodevelopment as it affects the mother's mental health. Methamphetamine exposure can negatively impact the health of the mother and child. Parenting a child increases the mother's stress levels and decreases the chances of the mother sufficiently supporting her child. While the child is not receiving adequate support in the home environment, the child is more likely to exhibit problematic behaviors that may hinder their academic achievement.

Chapter Three - Methods

Study design:

This study used data previously collected from a longitudinal research study of women who were prenatally exposed to methamphetamine. Women were recruited from 4 clinical sites: Los Angeles, CA; Des Moines, IA; Tulsa, OK; and Honolulu, HI over a two-year period. At the time of the infant's birth, 34,833 mother-infants were paired. However, 26,999 were available and screened for eligibility. Mothers were excluded from the study if they were under 18 years of age, used opioids, lysergic acid diethylamide, phencyclidine, or cocaine only during pregnancy, displayed low cognitive functioning, or were non-English speaking. Also, mothers were excluded if they were incarcerated, had a child previously enrolled in the study, or distance from study site was prohibitive for follow-up. Exclusion criteria for infants included critical illness, unlikely to survive, multiple birth, major life-threatening congenital anomaly or documented chromosomal abnormality associated with mental or neurological deficiency. Of these eligible participants, 3,705 mother-infants pairs consented to participate in the study. Those who were included in the longitudinal study follow-up were 412 mothers with prenatal MA use and their matched unexposed comparisons.

The longitudinal phase of this study included visits when the child was between 1 month to 7.5 years old, with each visit maintaining a retention rate of over 70%. At specific visits, children's executive function abilities, academic skills, and IQ are assessed by age-appropriate tests and tasks. The current study utilized data collected from 290 children at the 6.5 to 7.5-year visits (Chu et al., 2020).

Maternal postnatal depression was measured by the Computerized Diagnostic Interview Schedule, Version IV. The C-DIS-IV is a computerized program that mimics a clinical interview and

ascertains presence or absence of major psychiatric disorders. It distinguishes significant symptoms from ordinary worries and concerns of daily life, sets requirements for clinical significance, and distinguishes psychiatric symptoms from symptoms caused by physical illness or side effects of drugs or alcohol.

Institutional Review Board Approval:

The parent study was approved by the Institutional Review Boards at all participating sites, and informed consent was obtained from all participants. Confidentiality of information regarding the mothers' drug use was assured by obtaining a National Institute on Drug Abuse Certificate of Confidentiality, which took the place of mandatory reporting of illegal substance use.

Data source:

This study used data collected from the Infant Development, Environment, and Lifestyle (IDEAL) study, a longitudinal research study of women who were prenatally exposed to methamphetamine.

Primary outcome measures:

CBCL: The Child Behavior Checklist was used at the 7-year visit. It is a 118-item parental report questionnaire yielding scores for internalizing and externalizing problems for 6–18-year-olds. Higher scores indicate more problems.

WJ-III: The Woodcock-Johnson III assessed academic achievement. Basic academic skills were measured by the subtest Calculation and the 3 subtests that comprise the Broad Reading Cluster: Letter-Word Identification, Passage Comprehension and Reading Fluency.

WISC-IV: The Wechsler Intelligence Scale for Children IV measured intellectual ability in children. The measures of intellectual functioning include Verbal Comprehension, Perceptual

Reasoning, Working Memory, and Processing Speed. Together they provide the overall level of intelligence, or Full-Scale IQ.

Independent variables:

Prenatal methamphetamine exposure and postanal maternal depression are the independent variables in this study.

Statistical/Analytical approach:

Caregiver and infant characteristics at birth and at the follow-up visit were reported for the maternal postnatal depression and prenatal methamphetamine groups as observed counts and percentages for the dichotomous variables and as means and SDs for the continuous variables. CBCL internalizing, externalizing, total problems and CBCL subscales, WISC subtests, and Woodcock-Johnson III subtests were compared individually by group using one way ANOVA. Multivariable regression models were used to see the effects of the presence of maternal postnatal depression and PMA on the long-term behavior and academic outcomes of the children. These models were adjusted for covariates and included low socioeconomic status, prenatal alcohol tobacco, and marijuana use, infant birthweight, infant sex, maternal race, partner status, and maternal education. All data analysis were performed using SPSS V28.

Chapter Four- Results

Low socioeconomic status, not having a partner, using tobacco, drinking alcohol, and using marijuana prenatally significantly differed by MA exposure and postnatal depression groups (Table 1). Maternal prenatal tobacco use was 41.7% in the MA exposure and postnatal depression group. For infant characteristics, gestational age was significantly different by the MA exposure and postnatal depression groups ($p=0.008$).

Overall means and standard deviations of the WISC, Woodcock-Johnson III and CBCL scores by the postnatal depression/exposure groups are included in Table 2. There were no significant group differences on any of the WISC subtests. The Woodcock Johnson Reading Fluency equivalent scores and passage comprehension equivalent scores were significantly different between the MA exposure and postnatal depression groups. The CBCL internalizing and total problem t-scores were also significantly different between the MA exposures and postnatal depression groups.

In unadjusted analyses for WISC Working Memory Index, children in the MA exposure/depression group had scores that were 5.61 points lower as compared to children in the no MA exposure/no postnatal depression comparison group (Table 3). For the same index, children in the no MA exposure/ depression group had a composite score that was 3.85 points lower compared to the no MA exposure/no postnatal depression comparison group. In adjusted analyses, the Processing Speed Index in the no MA exposure/depression group consisted of scores that were 5.93 points lower as compared to children in the no MA exposure/no postnatal depression comparison group.

In the Woodcock Johnson unadjusted analyses, the Reading Fluency composite scores in the MA exposure/ depression group (-0.47) and MA exposure/no depression group (-0.38) were significantly lower as compared to children in the no MA exposure/no postnatal depression comparison group. However, after adjusting for covariates, the difference between these groups were no longer significant. In adjusted analyses, the Reading Fluency composite score was significantly lower (-0.39) in the no MA exposure/depression group as compared to the no MA exposure/no depression comparison group. In both unadjusted and adjusted analyses, Passage Comprehension composite scores were significantly lower in the MA exposure/no depression (-

0.37 and -0.41) and MA exposure/depression groups (-0.47 and -0.56) as compared to the no MA exposure/no depression comparison group. In unadjusted and adjusted analyses, Letter Word composite scores were also significantly lower in the MA exposure/no depression group (-0.28 and -0.34) as compared to the no MA exposure/no depression group.

CBCL Internalizing, Externalizing, and Total Problems T scores were significantly higher in the MA exposure/depression group in unadjusted analyses as compared to the no MA exposure/no depression comparison group (4.04, 5.63, 4.92 respectively). However, after adjusting for covariates the scores were no longer significant. Externalizing and Total Problems scores after completion of the unadjusted (3.77 and 3.95) and adjusted analyses (3.77 and 3.82) differed significantly in the no MA exposure/depression group as compared to the no exposure/no depression comparison group. The MA exposure/no depression group were significantly higher on externalizing (3.97) and total problem scores (2.76) in unadjusted analyses as compared to the no MA exposure/no depression group. These differences in scores were no longer significant after adjusting for covariates.

Chapter Five- Discussion

The present study provides expanded information about the impact of maternal factors on infant birth outcomes, child behavior and academic achievement as well as how other social determinants of health (SDOH) impact outcomes. Specifically, a health history that included prenatal exposure to methamphetamine was associated with infants being born with lower birth weights and younger viable gestational age. Furthermore, children with the combined health factors of prenatal methamphetamine exposure and postnatal maternal depression had elevated behavior problems and lower academic achievement. Those children with the history of prenatal

methamphetamine exposure and postnatal maternal depression were more likely to have higher reported difficulties for inattention, impulsivity, and aggression. Regarding their academic skills, children with prenatal methamphetamine exposure and exposure to postnatal maternal depression were more likely to present with challenges with being able to fluidly read words and in their ability to comprehend reading passages. Developmental skills of attention and behavioral control along with the ability to read are critically important for providing ongoing foundation for future learning (Rabiner, 2016). Other research notes the relation between maternal depression, parenting skills and their impact on problematic child behaviors. Depressed parents display more negative parenting behaviors, which are associated with more emotional and behavioral problems in the child (Sutherland et al, 2021). Researchers found that women who use MA had significantly higher Beck Depression Index scores than men who used MA (Wright et al. 2012).

The current study also highlights that there are multiple determinants of health, such as education, low SES, and partner status. Another finding was that caregiving burden, as measured through socioeconomic level and partner support, partially explained the relationship between maternal depression and externalizing and internalizing problems in children. Limited economic resources and poor social support may increase caregiving burden and therefore impact child outcomes. Similar to experiencing depression, experiencing high levels of caregiving burden might limit the amount of quality time that caregivers spend with their children and therefore limit the opportunities caregivers have to model important emotional regulatory strategies to their children (Wagner and Valdez 2020).

Prenatal methamphetamine exposure and postnatal depression influenced perceived child behaviors and standard scores of academic achievement. As indicated in the results, these children had lower academic scores than their comparison group and higher parent ratings for having

attention difficulties and aggressive behaviors. Childhood attention problems predict poorer executive functioning in late adolescence (Rabiner et al, 2016). Similar to the mother lacking resources to provide effective parenting skills, the child lacked skills from the parent so that they could achieve academically. When the child is provided with an efficient foundation, they are more likely to succeed. Children who enter school with better developed literacy and numeracy skills are likely to receive more positive teacher feedback that motivates subsequent learning (Rabiner et al, 2016).

The children who are exposed to postnatal depression and prenatal methamphetamine did not seem to have adequate skills to achieve academically. Early acquired skills may also impact long-term educational outcomes indirectly through their effect on more proximal academic outcomes (Rabiner et al, 2016).

Understandably, as the child's externalizing and internalizing behaviors increase, it becomes difficult for the mother to interact positively with the child. The behaviors in the home environment were indirectly imitated in the home environment. Successful adaption to school may contribute to healthy cognitive and socio-behavioral development with good control of emotions and impulsive behaviors, and improved ability to cope with new situations and problems with peers or others (Pedersen et al, 2019).

The current findings illustrate the importance of assessing the social determinants of health and then engaging families who experience these challenges and providing appropriate resources. In a study by Linares and colleagues, they emphasize the importance of integrated models that combine perinatal and behavioral health to support families early in development to help reduce long term problems (Linares et al, 2020). It is important to consider the barriers that exist which may impact women accessing mental health treatment for both depression and substance use. In a

2010 study following up 51 perinatal women who were offered mental health referrals and their treatment engagement process, women cited provider unavailability (56%), cost/insurance mismatch (56%), poor match to need in patient/provider interactions (31%), and lack of time (25%) as the most common barriers to mental health engagement (Mangla et al, 2019).

In low-and middle-income countries, about 80% of patients with psychological, neurological, and substance use conditions do not access services. The World Health Organization launched the Mental Health Gap Program that aimed at integrating mental health interventions with the existing mental health services (Dadi et al, 2020). Mothers who could always afford enough to eat, but accessed unhealthy food had 2.74 times higher odds of poor mental health than mothers from households that could always afford enough good and nutritious meals (Linares et al, 2020).

In addition to barriers to mental health, substance addiction presents specific challenges to supporting pregnant women and their families (Wright et al., 2012). Complexities include the challenges related to relapse, co-occurring behavioral health disorders, and multiple social determinants of health specific to poverty.

An addiction can be extremely difficult to part from during pregnancy, especially if the addiction existed before the pregnancy began or if the pregnancy was not planned. It may distract the pregnant woman from focusing on their health and well-being. For example, pregnant women with MA use had their first prenatal visit five weeks later than pregnant women without MA use (Harst, et al 2021). Delaying medical attention may increase the delay in efficient treatment for the mother and baby. Infants with PME were less mature at birth; in five of six studies, the gestational age of newborns with PME was significantly lower compared to newborns without PME (Harst, et al 2021).

Addiction is defined as a chronic, relapsing disorder characterized by compulsive drug seeking, continued use despite harmful consequences, and long-lasting changes in the brain ("The Science of Drug Use and Addiction: The Basics"). Using substances as a coping tool is consistently linked to other social determinants of health. For example, in the case of working with patients with opioid addiction, the Substance Abuse and Mental Health Services Administration reports that opiate use is more common in those living below the poverty level (Mangla et al., 2019). Therapy and treatment for the mother may be help during the pregnancy as these plans may increase the mother's chances of improving her health and the health of the unborn child. By providing a safe environment to obtain prenatal care, we ameliorated many the effects of the drug use (Wright et al, 20212). Access to essential resources can potentially increase for the mother and child, and reduction of substance use. In modern society, there exists drug programs, such as the Recovery Clinic or the Recovery House in which patients being treated for substance use are monitored and received smaller doses of the drug that they use. In this harm-reduction model of care, prevention is an important factor. In prevention of addiction and the use of alcohol and non-alcoholic drugs, the World Health Organization distinguishes three targets: primary prevention, secondary prevention, and tertiary prevention (Tomaskova et al, 2020). Preventing the serious and lasting health and social problems created by using drugs is crucial in the treatment plan, as the goal is to progress with time (Tomaskova et al, 2021). Influencing mothers during their pregnancy to enroll in these programs may reduce harm for both them and their infants.

One specific study by Wright and colleagues looks at supporting women with methamphetamine use during pregnancy through a harm-reduction model of care (Wright et. Al, 2012). This treatment model supported families around multiple areas of adverse health circumstances (e.g., poverty, interpersonal violence, mental health needs and polysubstance use)

during the perinatal care period. The study findings indicated that this intervention resulted in reducing the occurrence of low birthweight and preterm birth for this group of families and supporting women in maintaining custody of their children. The study illustrates the importance of a comprehensive approach to providing treatment to pregnant women struggling with addiction.

In addition to treatment models that focus on harm-reduction and consider multiple social determinants of health, training and education of health care providers and professionals around how to reduce stigma of substance addiction and increase cultural competence is critical. Cultural competency is key is carrying out a successful healthcare system, and it educates the provider/professionals as it educates the patients/clients. In Rhode Island, the CDC's Hear Her Campaign was launched in 2020 and was designed to help pregnant women or postpartum women, their families, and clinicians recognize when to seek medical care that can help reduce preventable deaths (Kuehn, Bridget M. 2022). The campaign involves asking questions about the women's lives and managing chronic conditions, and it advises clinicians to recognize their own unconscious bias and that of their staff. Depending on the reasoning of the initiation of the drug use will determine which kind of Case Manager the mother will need to see, can influence the mother to be more equipped in her parenting. Future resources that may be helpful to individuals who experience ME would be to create a campaign for those with methamphetamine exposure. This campaign could be designed to help ME mothers, their families, and clinicians recognize when to seek medical care/treatment to prevent potential health conditions and even death. The campaign could involve asking questions about how to manage depression and stop methamphetamine use.

Another critical area of focus for future work to support women and their children with substance use struggles is community engagement and the use of evidence-based programs. The

Substance Abuse and Mental Health Service Administration (2022) emphasizes the importance of both community engagement and evidence-based treatments as key areas to reduce and prevent substance use. Papa Ola Lokahi in Honoloulu, Hawai'i illustrates a designated organization with a community engagement focus, describes how they have used community engagement to conduct a substance use needs to assessment across populations with different needs and practices (Substance Abuse and Mental Health Services Administration).

Supportive services for the mother and children may influence them both to thrive with time. There is a need for universal protocols when working with parents, children, and families impacted by substance use and a critical need to address beliefs about maternal substance use and exposed children (Rhode Island Kids Count, 2023). As families engage in these supportive services, their health risks may decrease and may allow the mother to understand what she needs in order to support her child. Infants and toddlers who face significant family circumstances need extra help and should receive high quality Early Intervention services to develop essential language, social-emotional, and additional skills to reduce the need for services when they are older (Rhode Island Kids Count, 2023).

The present study highlights the need to consider multiple determinants of health to best inform how to develop future treatment programs. By identifying areas in need of support prenatally, this may help reduce ongoing difficulties for both the mother and the child. As healthcare efforts move forward, intervention programs are needed that focus on harm-reduction, supporting multiple areas of SDOH and those that include the active voice of the woman with substance use addiction in identifying areas where support is needed.

Study limitation and strengths:

Although a significant amount of information was found in the data collected from this study, there are some limitations that could potentially strengthen future studies. These limitations include the number of participants within the study that were available at follow-up, including other instruments to measure child behaviors and maternal depression, and following the participants until adolescence. The greater the number of eligible participants in the study may likely inform the findings of the data. The implementation of other child behaviors measures and a measure of ADHD may strengthen the hypothesis of the study., A strength of this study is the inclusion of postnatal maternal depression. There is published literature regarding prenatal depression and methamphetamine use, but a limited amount of literature regarding the effects of postnatal maternal depression on methamphetamine exposed infants. These areas can provide researchers with extensive data that can improve health care and patient outcomes.

Table 1. Methamphetamine Exposure Postnatal Depression

Maternal Characteristics	No MA exposure + No postnatal depression (n=102)	No MA exposure + Postnatal depression (n=43)	MA exposure + No Postnatal depression (n=109)	MA exposure + Postnatal depression (n=36)	P-Value
Minority Race or ethnicity	60 (58.8%)	25 (58.1%)	70 (64.2%)	21 (58.3%)	.342
Low socioeconomic status (SES)	10 (9.8%)	4 (9.3%)	39 (35.8%)	9 (25.0%)	<.001
No partner	34(33.3%)	14 (32.6%)	66 (60.6%)	19 (52.8%)	<.001
Education	34 (33.7%)	18 (41.9%)	52 (47.7%)	15 (41.7%)	.232
Tobacco	2 (2.0%)	5 (11.6%)	28 (25.7%)	15 (41.7%)	<.001
Alcohol	18 (17.6%)	7(7.0%)	36(33.0%)	15(41.7%)	<.001
Marijuana	2 (2.0%)	5 (11.6%)	28 (25.7%)	15 (41.7%)	<.001
Infant Characteristics					
Sex, Male	52 (51.0%))	22 (51.2%)	54 (49.5%)	24 (66.7%)	.333
Birth Weight, grams	3268 (562)	3375 (570)	3169 (629)	3219 (652)	.236
Gestational Age	39.0 (1.7)	39.0 (1.9)	38.1 (2.4)	38.4 (2.5)	.008
Small Gestational Age	13 (12.7%)	4 (9.3%)	16 (14.7%)	7 (19.4%)	.601
Head Circumference, cm	34.1 (1.8)	33.8 (1.8)	33.6 (1.8)	33.8 (2.0)	.315

Table 2. Effects of Prenatal Methamphetamine Exposure

WISC					
Mean (SD)	*No exposure, no depression*	*No exposure, depression*	*Exposure, no depression*	Exposure, depression	***p-value***
Verbal Comprehension, composite score	94.6 (13.3)	94.2(14.1)	92.2 (12.4)	91.3(10.3)	0.426
Perceptual Reasoning, composite score	100.9 (15.8)	98.4 (13.7)	98.3 (14.2)	99.0(10.4)	0.593
Working Memory, composite score	97.7 (13.4)	94.5 (14.2)	93.9 (10.5)	92.1(11.1)	0.064
Processing Speed, composite score	99.6 (13.7)	94.4 (12.8)	97.7 (15.0)	99.0 (17.0)	0.270
Full Scale IQ, composite score	97.3 (13.9)	94.2 (12.9)	93.8 (11.5)	95.2(12.6)	0.263

WOODCOCK JOHNSON					
Mean (SD)	*No exposure, no depression*	*No exposure, depression*	*Exposure, no depression*	Exposure, depression	***p-value***
Letter Word, age equivalent score	0.63 (0.89)	0.36 (1.17)	0.35 (0.81)	0.40 (1.06)	0.163
Reading Fluency age equivalent score	0.37 (1.05)	0.00 (1.09)	-0.01 (1.02)	-0.10 (0.97)	0.030
Passage Comprehension age equivalent score	0.13 (0.96)	-0.16 (1.05)	-0.24 (0.76)	-0.35 (0.87)	0.011
Calculation, age equivalent score	0.24 (0.76)	0.08 (0.90)	0.22 (0.78)	0.09 (0.85)	0.611

CBCL					
Mean (SD)	*No exposure, no depression*	*No exposure, depression*	*Exposure, no depression*	Exposure, depression	***p-value***
T-score Internalizing	49.2 (9.5)	52.0 (10.1)	51.5 (9.9)	53.3 (7.4)	0.116
T-score Externalizing	52.9 (9.2)	56.7 (9.3)	56.9 (10.8)	58.5 (9.5)	0.007
T-score Total Problems	52.1 (9.4)	56.0 (9.1)	54.8 (10.4)	57.0 (9.1)	0.027

Table 3. Learning and Behavioral Outcomes Multivariable Models

Outcome	**No MA exposure + Depression**		**MA Exposure + No depression**		**MA Exposure + Depression**	
WISC						
	B (SE)	**Adj B (SE)**	**B (SE)**	**Adj B (SE)**	**B (SE)**	**Adj B (SE)**
Verbal Comprehension	-0.39(2.35)	-0.29(2.33)	-2.40(1.81)	-3.15(2.22)	-3.35(2.61)	-4.66 (3.00)
Perpetual Reasoning	-2.55(2.64)	-2.35(2.64)	-2.61(2.03)	-1.23(2.52)	-1.90(2.93)	-1.43 (3.40)
Working Memory	-3.22(2.26)	-3.46(2.23)	-3.85*(1.74)	-2.44(2.13)	-5.61*(2.51)	-4.13 (2.87)
Processing Speed	-5.18(2.66)	-5.93*(2.69)	1.95 (2.07)	-2.28(2.56)	-0.66(2.97)	-0.09 (3.45)
Full Scale IQ	-3.10(2.32)	-3.24(2.31)	-3.14 (1.79)	-2.77(2.20)	-3.49(2.58)	-3.35 (2.97)
Woodcock Johnson						
	B (SE)	**Adj B (SE)**	**B (SE)**	**Adj B (SE)**	**B (SE)**	**Adj B (SE)**
Letter Word	-0.26(0.17)	-0.32 (0.17)	-0.28* (0.13)	-0.34*(0.16)	-0.22 (0.19)	-0.35 (.22)
Reading fluency	-0.36(0.19)	-0.39* (0.19)	-0.38* (0.15)	-0.35 (0.18)	-0.47* (0.21)	-0.45 (0.25)
Passage comprehension	0.29(0.16)	-0.31(0.17)	-0.37*(0.13)	-0.41*(0.16)	-0.47**(0.18)	-0.56** (0.21)
Calculation	-0.16 (0.15)	-0.21 (0.15)	-0.03 (0.11)	-0.06 (0.14)	-0.15 (0.16)	-0.22 (0.19)

CBCL						
	B (SE)	**Adj B (SE)**	**B (SE)**	**Adj B (SE)**	**B (SE)**	**Adj B (SE)**
T-score Internalizing	2.73 (1.76)	2.49(1.77)	2.22(1.33)	0.06 (1.67)	4.04* (1.90)	0.83 (2.24)
T-score Externalizing	3.77*(1.83)	3.77*(1.86)	3.97** (1.39)	2.11 (1.75)	5.63** (1.97)	3.05 (2.35)
T-score Total Problems	3.95*(1.80)	3.82(1.82) *	2.76* (1.36)	0.16 (1.72)	4.92* (1.94)	1.48 (2.30)

*p<.05, **p<.01

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