Maternal Mental Health and Substance Use:
An Examination of their Role in
Pregnancy Health Behaviors and Birth Outcomes

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Dedication

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Abstract

Objective: To characterize maternal mental health from a surveillance perspective and to specifically focus on maternal mental health and its potential relationship with prenatal substance use by: describing the co-occurrence of maternal mood and prenatal substance use; exploring the independent and interactive associations of maternal mood and prenatal substance use with infant health outcomes; and examining the relationship between maternal mood, stressful life events and prenatal tobacco cessation and maternal mood, stressful life events, postpartum depression and postpartum tobacco relapse. A qualitative study of methamphetamine use during pregnancy was designed to describe the experiences of pregnant women who had used methamphetamine immediately prior to or during pregnancy, with a specific focus on their mental health history.

Methods: Surveillance data from the Minnesota Pregnancy Risk Assessment Monitoring System (PRAMS), an on-going written/telephone survey of women who recently delivered live births in Minnesota linked to birth certificate data, comprised the dataset used to examine substance use, maternal mental health and infant health outcomes, as well as the tobacco cessation/relapse analyses. It is considered representative of Minnesota's recent mothers and infants.

The Maternal Methamphetamine Study evolved from a community-based, participatory research model. Primary data collection and analysis focused on a small sample of women located in urban and rural settings in Minnesota. Qualitative methods were used to describe a population of women in out-patient therapy for methamphetamine use through county-based treatment programs. Data collection tools were designed in collaboration with researchers from the Minnesota Department of

Health (MDH), Children's Hospitals and Clinics and Hennepin County Medical Center (HCMC). Qualitative data were obtained through in-person or telephone interviews and quantitative data through self-administered, written questionnaires.

The University of Minnesota Institutional Review Board (IRB) reviewed both studies. The PRAMS questionnaire has been previously reviewed and approved by the Centers for Disease Control and Prevention (CDC) and MDH IRBs. The secondary analyses of PRAMS data qualified for IRB exemption, as it uses existing data and does not contain personal identifiers. The methamphetamine project was approved by the University of Minnesota IRB.

Conclusions: Low maternal mood co-occurred with substance use during pregnancy, which has profound implications for the health of women and their infants. Low maternal mood during pregnancy and tobacco use were interactively associated with a two-fold higher risk of low birthweight births. Women who reported low mood during pregnancy and who abstained from alcohol use during the third trimester of pregnancy were twice as likely to have a preterm delivery compared to women who reported higher mood levels. Low mood levels and stress were associated with decreased likelihood of tobacco cessation during pregnancy. Women with a history of methamphetamine addiction reported personal and familial histories of psychological problems. In addition, methamphetamine was described as a remedy for low energy, low self-esteem, depression and anxiety. Women stated they could accomplish more while on methamphetamine and it helped them cope with the demands of daily life. Thus, mental health problems and substance use co-occurred, which may have potential adverse consequences for pregnant women. More study of this complex relationship, and the

resulting effects on women and their children, is important for long-term maternal and child health.

Limitations: The two data sources define depressive symptoms differently, with different data collection methods. Thus, comparability between the study populations is difficult. This further reflects the lack of a gold standard measure for prenatal depression and depressive symptoms and the difficulty of measuring such symptoms during pregnancy. The question related to maternal mood during pregnancy from PRAMS is not considered a standard screening question and requires caution when interpreting results. Additionally, the women participating in the methamphetamine study are a select group of women who were identified through drug treatment programs.

Public Health Implications: This proposal suggests that mental health may be important over the course of a pregnancy and during the postpartum. The innovative nature of this project relates to its exploration of maternal mental health and substance use concurrently, and their potential joint contributions to adverse maternal and infant health outcomes. In addition, it is one of the first studies to describe pregnant women in recovery from methamphetamine addiction. The results from these manuscripts provide information for local, state and federal public health agencies for program development and research allocation, and could influence their confidence in surveillance data designed to track maternal mental health.

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List of Abbreviations

ACOG-American College of Obstetricians and Gynecologists
BDI-Beck Depression Inventory
CDC-Centers for Disease Control and Prevention
CES-D-Center for Epidemiologic Studies Depression Scale
DSM-IV- Diagnostic and Statistical Manual of Mental Disorders
EPDS-Edinburgh Postnatal Depression Screen
ETS-Environmental Tobacco Smoke
FAS-Fetal Alcohol Syndrome
FASD- Fetal Alcohol Spectrum Disorders
HCMC-Hennepin County Medical Center
IRB-Institutional Review Board
LBW-Low birthweight
MDH-Minnesota Department of Health
MN-Minnesota
NICU- Neonatal Intensive Care Unit
NIHCM-National Institute for Healthcare Management
NSDUH-National Survey on Drug Use and Health
PRAMS-Pregnancy Risk Assessment Monitoring System
PRIME-MD-Primary Care Evaluation of Mental Disorders
PSQ-Perceived Stress Questionnaire
PSS-Perceived Stress Scale
QDIS-Quick Diagnostic Interview Schedule
TEDS- Treatment Episode Dataset
TTI- Theory of Triadic Influences

Introduction

Prenatal substance use and maternal mental health have both been associated with maternal health behavior and birth outcomes. Studies have largely focused on the independent effects of mental health conditions or substance use. In addition, many studies of these variables have been conducted in clinic-based settings, which comprise a specific population subgroup. The co-occurrence of mental health problems and substance use has been observed both in studies conducted in the general population, as well as among pregnant women. Yet questions as to the nature of the relationship between substance use and mental health remain unanswered. These questions are both content-specific as well as methodological. What are the best methods for researching these constructs in pregnant or postpartum women? In an era of limited resources, how useful are existing data sets, such as those designed for surveillance, to furthering the study of maternal mental health and substance use? In addition, for areas in which little is known about maternal experiences with a particular substance, such as methamphetamine, would qualitative methods establish a baseline level of knowledge and help generate future research hypotheses? Surveillance data and qualitative methods both have strengths and limitations. The question is whether the strengths of these methods surpass the limitations so they can be used effectively in this field of research.

This dissertation aims to further the literature in two ways. First, it examines topic-specific questions that address the co-occurrence of substance use and mental health problems during pregnancy. The literature is lacking with respect to the joint, or interactive, effects of substance use and prenatal mental health problems on birth outcomes. Further, the literature on the role of mental health in influencing substance use

behaviors, both during the prenatal and postpartum time frames, has been limited by small sample sizes or by larger studies that lack important covariates. Finally, a major data gap exists with respect to the mental health status, motivations for and patterns of drug use, and pregnancy-related experiences of women who use methamphetamine during pregnancy. Limited study data suggest that prenatal methamphetamine use could have serious health consequences for the infant. Yet, very little is known about the experiences and mental health histories of the women who use methamphetamine during pregnancy.

Second, this dissertation critiques the use of surveillance data and qualitative methods for research about maternal mental health and prenatal substance use. It uses two distinct data sets to provide a comprehensive examination of these topics with two analytical methods. The first data set, the Minnesota Pregnancy Risk Assessment Monitoring System (PRAMS), is an ongoing, population-based surveillance system of pregnancy-related risk factors and experiences. It contains state-specific, optional questions about mental health status during pregnancy and the postpartum. Although the Centers for Disease Control and Prevention (CDC) and other states have used these measures, questions remain as to whether the PRAMS mental health measures are valid for research purposes. All datasets have limitations, thus the question is whether the limits of PRAMS data outweigh the potential strengths of using this data for research purposes.

The second data set, the Maternal Methamphetamine Study, contains qualitative information from structured interviews of pregnant women who used methamphetamine either during pregnancy or in the three months pre-conception. The study evolved from

concerns raised by community-based neonatologists who observed rising numbers of methamphetamine-exposed infants. An advisory committee guided the effort to characterize maternal methamphetamine use. Thus, this qualitative study developed with elements of a community-based, participatory research design. This dissertation examines the strengths and limitations of using qualitative data to characterize a specific population of women with a history of methamphetamine use.

The dissertation is structured in the following way: The first chapter provides background information and the theoretical model used to guide study development. The second chapter outlines the study design and research methods used to collect and analyze the data that were obtained from two data sets. The three research manuscripts are presented in Chapters 3-5. The first two manuscripts used PRAMS data and the third manuscript presents results from the Methamphetamine Study.

Manuscript One (Chapter 3) examined the independent and interactive effects of prenatal mood and substance use on birth outcomes. The following aims were the basis for the first manuscript:

Aim 1: Characterize the co-occurrence of maternal mental health, specifically maternal mood and stressful life events, and prenatal substance use (alcohol and tobacco).

Aim 2: Examine how maternal mood and prenatal substance use are independently and interactively associated with infant health outcomes.

Manuscript Two (Chapter 4) examined the relationship between maternal mental health, smoking cessation during pregnancy and postpartum smoking relapse. The following aims were the basis for the second manuscript:

Aim 1: Describe the association of maternal mood and stressful life events with tobacco cessation in pregnant women, comparing the reporting periods of three months prior to pregnancy and the third trimester of pregnancy.

Aim 2: Describe the association between maternal mood, stressful life events and postpartum depressive symptoms with tobacco relapse in postpartum women who reported tobacco cessation during pregnancy.

Manuscript Three (Chapter 5) characterized maternal methamphetamine use among women receiving drug treatment services during pregnancy. The following aims were the basis for the third manuscript:

Aim 1: Describe the maternal mental health status of women who reported methamphetamine use during the three months prior to pregnancy or during pregnancy.

Aim 2: Develop common themes related to women's motivations for using methamphetamine.

Aim 3: Describe patterns of methamphetamine use among pregnant women.

Finally, Chapter 6 provides a discussion of the findings across the three studies, with an emphasis on themes that emerged from the studies. In addition, an in-depth critique of the methods used in these populations is presented. This discussion focuses on the strengths and limitations of qualitative methods and PRAMS surveillance data for research around maternal mental health and prenatal substance use. Chapter 6 closes with recommendations for future research and interventions, specifically in the context of the guiding theoretical model, The Theory of Triadic Influences (TTI).

Chapter 1: Background and Theoretical Framework

A. Maternal Mental Health

Maternal mental health is as an important area of study. The potential co-occurrence of maternal mental health problems and prenatal substance use, and how those factors may work independently and possibly interactively to affect maternal and infant health outcomes, has rarely been examined. Why should we care about the co-occurrence of these maternal factors? There is a strong body of evidence about the risks to infants from maternal exposure to substances such as tobacco and alcohol. The literature supports associations between maternal mood, depressive symptoms, stress and anxiety with adverse birth outcomes. It is possible that the combined effect of substance use and maternal mental health may in fact be greater than the independent effects of either risk alone.

For the purposes of these studies, maternal mental health is defined as the mental health of childbearing women from three months pre-conception through four to six months postpartum, with a focus on depression, depressive symptoms, mood, stressful life events and anxiety [1]. This definition of maternal mental health does not include psychotic or severe mental illness. Anxiety and depression are the most commonly studied mental health conditions during pregnancy [1]. However, symptoms of depression that do not meet the criteria for a diagnosis of clinical depression might also be important to maternal and infant health.

Overall, depression and depressive symptoms are more common in women than in men. The 2007 National Survey on Drug Use and Health (NSDUH) estimated that 7.5% of adults in the U.S. experienced at least one episode of major depression in the last

year [2]. Females were almost twice as likely as men to report an episode of major depression, with rates of 9.5% compared to 5.3% [2]. Women were also more likely to report they received mental health treatment or counseling in the past year (Figure 1.1). This observed sex difference in treatment has remained fairly steady for the years 2002-2008. The prevalence difference between the sexes has been shown in many countries and ethnic groups [3]. The sex difference has been documented as early as age 10, yet typically differences in depression rates between men and women disappear by mid-life [3]. These documented sex differences have led to hypotheses that hormonal fluctuations may increase the risk for depression among women throughout their reproductive cycle [3].

Figure 1.1 Percentage of Males and Females who Received Mental Health Treatment or Counseling in Past Year, NSDUH, 2002-2007
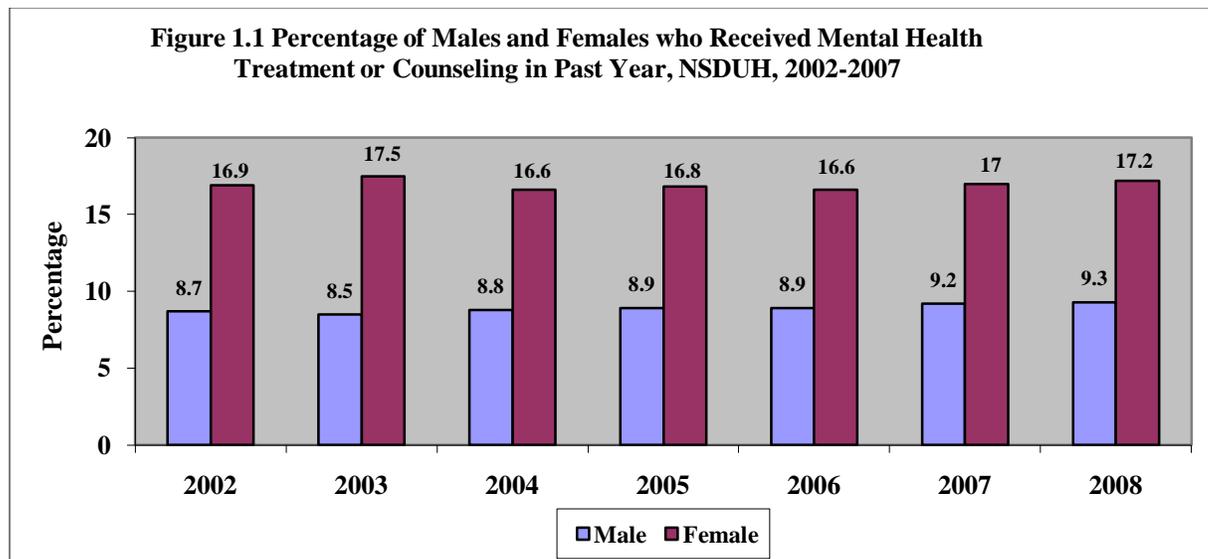
Rates of depression during pregnancy appear to be higher than those found in general populations of women [4]. Research suggests that women with prenatal depression may have an underlying vulnerability to the hormonal changes of pregnancy, which triggers the onset of symptoms [4]. Depression during pregnancy has potentially serious ramifications for both the mother and child, particularly if left undiagnosed and

untreated [5]. Women with depression during pregnancy may be more likely to have

preterm births, obstetrical complications and neonates admitted to neonatal intensive care

units compared to women without depression [6]. While maternal depression is accepted

as a fairly widespread phenomenon, data are often limited by small sample sizes, a focus

on clinic-based populations or a lack of potentially important covariates in larger studies.

Existing data suggest prenatal depression rates range from 13-51 % [5-9]. It is

difficult to directly compare prevalence rates between studies since they often use

different measures, definitions of depression or depressive symptoms, and study

populations that may truly differ in prevalence rates. Table 1.1 provides a summary of

some studies that estimated depression or depressive symptoms during the prenatal or

postpartum time frames.

Table 1.1 Summary of Studies of Prenatal & Postpartum Depressive Symptoms				
Author, Year	**Sample Description**	**Study Instrument**	**When Interviewed**	**Estimated Prevalence**
Sleath et al. , 2005 [5]	73 women; Hispanic, African American & white	BDI-II [17]	At prenatal visit, between 12-32 weeks	19% moderate to severe depressive symptoms
Chaudron et al., 2005 [7]	218 posptartum Hispanic women	EPDS (score of 10 or more) [18]	Telephone interviews of women sampled from birth data	23% reported high levels of depressive symptoms
Dole et al., 2004 [8]	1898 women in prenatal care clinics	CES-D [19]	24-29 weeks	52% -African American 35%-white
Chee et al., 2005 [10]	559 women in Singapore	EPDS [18]	Prenatal appointment and 6 weeks postpartum	12.2% prenatal; 6.8% postpartum
Evans et al., 2001 [11]	12,059 women in prospective cohort	EPDS (score of 13 or more) [18]	18 and 32 weeks; 8 weeks and 8 mos.	18 weeks:13.9% 32

Table 1.1 Summary of Studies of Prenatal & Postpartum Depressive Symptoms				
Author, Year	**Sample Description**	**Study Instrument**	**When Interviewed**	**Estimated Prevalence**
			Postpartum	weeks:15.2% 8 wks post:10.2% 8 mos. post: 8.8%
Bloch et al., 2006 [12]	1,800 women in hospital maternity ward	EPDS (score of 10 or more) [18]	Within 3 days of birth	6.8%
Gordon et al., 2006 [13]	4,322 women in perinatal health clinics	EPDS (score of 12 or more) [18]	Between 28-32 weeks and again at 6 weeks postpartum	11.1% during prenatal time 7.3% in postpartum
Andersson et al., 2004 [14]	1,465 women in prenatal care clinics	PRIME-MD [20]	2nd trimester	11.6%
Nicholson et al.,2006 [15]	174 women in prenatal care settings	CES-D [19]	Less than 20 weeks gestation	15% with depressive symptoms
Pajulo et al., 2001 [16]	391 women at maternity care centers	EPDS (score of 12 or more) [18]	14-37 weeks	7.7%

One article estimated nearly 70% of pregnant women have depressive symptoms at some time during their pregnancies, but don't necessarily meet the full diagnostic criteria for major clinical depression [6]. A study of 1,898 women receiving prenatal care showed there may be racial and ethnic differences in depressive symptoms during pregnancy [8]. Among African American participants, 52% were identified as having moderate to severe depressive symptoms using the Center for Epidemiologic Studies (CES-D) scale, compared to 35% of white participants [8]. These are fairly high rates of prenatal depression, however the participants in this study may represent higher risk pregnancies. Most participants were recruited from a University prenatal clinic setting

that frequently handles complicated pregnancies and thus these women may be at higher risk for prenatal depression [8].

Gavin et al. reviewed 28 studies, all of which measured depressive symptoms either prenatally or in the postpartum. They found point prevalence rates of 6.5% to 12.9%, depending on the time frame of interest [9]. Their best estimate was that the period prevalence for major and minor depressive symptoms during pregnancy was 18.4% [9]. The authors do not present a 95% confidence interval for the period prevalence, but the 95% confidence intervals from individual studies that contributed to their period prevalence estimate were fairly wide. Not surprisingly, period prevalence estimates in individual studies increased with longer study time frames (e.g. birth to 12 months postpartum yielded higher period prevalence rates than birth to 3 months postpartum) [9].

Maternal mental health is difficult to study because of the challenges associated with identifying these disorders during pregnancy. Assessing depression during pregnancy is complicated because some of the symptoms classically used to screen for depression, such as change in appetite or extreme fatigue, are also symptoms of pregnancy [4, 6]. In addition, many studies rely on retrospective report or do not have access to data related to co-morbid conditions that may also influence mental health symptoms, such as anemia or thyroid dysfunction [6]. Studies have screened women at various trimesters during pregnancy and during the postpartum [10-13]. Some found higher rates of depressive symptoms during pregnancy, with rates decreasing postpartum. A study of 559 women in Singapore found prevalence rates of 12.8% and 6.8% during the prenatal and postpartum periods, respectively [10]. A longitudinal cohort of 9,028

women found higher rates of depressive symptoms at 32 weeks gestation compared to other screening times of 18 weeks gestation, 8 weeks postpartum and 8 months postpartum [11]. However, these studies did not provide results that allowed for an examination of women who reported symptoms during all time frames compared to those who reported symptoms during one of the time frames of interest.

Rates of postpartum depression appear to range from 6-8% of women [7, 10-13], however one study found a 23% prevalence rate in low-income, Hispanic women. This prevalence was an outlier from rates found in most studies of postpartum depression. This could be the result of study design or may reflect the true rate of a specific population subgroup. Rates may be higher in population subgroups with other risk factors for depression, such as poverty. In a recent study of early postpartum depression risk, factors associated with postpartum depressive symptoms included a history of mental illness, including previous postpartum depression; premenstrual dysphoric disorder; and third trimester mood symptoms [12]. A study of depression in low-income, inner-city women found that stress was related to increased depression postpartum, while higher income and social support were related to decreased rates of depression [21].

Data suggest that prenatal depressive symptoms are linked to postpartum depression [4]. The National Institute for Health Care Management (NIHCM) Issue Brief on maternal depression concluded that undiagnosed prenatal depression was a strong risk factor for postpartum depression [4]. The NIHCM report listed the following as risk factors for maternal depression: history of mood disorders, previous substance abuse, poor marital relations, life stress, lack of social support and low socioeconomic status [4]. In addition, the authors suggest that a difficult delivery may be associated with

postpartum depressive symptoms [4]. Reported ranges of prenatal and postpartum depressive rates seem to be different, even when taking into account different measurement tools. It is possible that different mechanisms may be at work in triggering those depressive symptoms during the perinatal time frame. Ross et al. developed a bio-psychosocial model of late prenatal and postpartum mood and hormonal change in 150 women [22]. Biological factors, such as hormones, did not directly affect depressive symptoms but did seem to work indirectly through psychosocial stressors and symptoms of anxiety to affect prenatal depression. The model developed to describe prenatal depression did not fit the postpartum data, further suggesting that different factors may influence depression at these two time points [22]. Thus, while prenatal and postpartum depressive symptoms appear to be related, it is unknown whether different risk factors predispose women to experience symptoms at different points in their pregnancy or during the postpartum.

Some studies suggest that a history of depression during pregnancy or a family history of depression predispose women to experience depressive symptoms during pregnancy [23-26]. Researchers have hypothesized why pregnancy, and other reproductive events, may be a time of vulnerability for new onset of depression in some women. Hormonal shifts and psychosocial factors, such as a poor social support network, marital instability, unplanned pregnancy and pregnancy ambivalence, have been suggested as possible mechanisms for depression during pregnancy and it is plausible that these types of factors interact to enhance a woman's vulnerability [24, 25].

Maternal mental health may have important implications for maternal and infant health. Several maternal behaviors and outcomes have been attributed to maternal

depression, including: non-compliance with prenatal care; self-medication with tobacco, alcohol or other drugs; poor appetite and weight gain; insomnia; anxiety; worsening of depressive symptoms; suicide and suicidal ideation; impaired maternal-infant bonding; and subsequent postpartum depression [27-31].

To further complicate the measurement of maternal mental health, there is no gold standard measurement tool. The wide variety of definitions and tools used to define depression or depressive symptoms has practical and academic implications [3]. Most researchers use a screening tool, but may not confirm results via clinical validation using the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), which defines major depression [32]. Different instruments and varying interpretation of results lead to problems in comparing results across studies (please see Appendix A. for a summary of the most commonly used instruments to assess depression in pregnant or postpartum women). The observed prevalence differences may reflect true differences among population groups or be the result of using different instruments or scoring cut-offs. Depressive symptoms that do not meet the clinical diagnosis for depression (subsyndromal depressive symptomatology) may cause functional impairment or ongoing issues [33]. Is it important to try and identify women who do not meet the diagnostic criteria for major depression but demonstrate lesser symptoms? Mild to moderate depressive symptoms may be more prevalent than major depression among pregnant or postpartum women and may have health implications.

Taken together, the literature related to maternal mental health suggests that almost 20% of women may be affected by depressive mood symptoms at some point, either during or after pregnancy, and that these symptoms may influence health behaviors

or outcomes. Many of these studies rely on patient populations, e.g. women who are enrolled in prenatal care or attending a postpartum visit, which represents a particular subgroup of pregnant women. These women are likely not representative of pregnant or postpartum women overall.

B. Prenatal Substance Use

Alcohol, tobacco and methamphetamine were chosen as the substances measured to reflect prenatal substance use in this dissertation for two main reasons. First, alcohol and tobacco use are commonly measured during pregnancy, either by surveys or on the birth certificate. While data quality can differ between studies and instruments, it is largely assumed that women underreport use of these substances during pregnancy. Second, these topics were chosen because of their potential adverse affects on pregnancy and women's health. Alcohol and tobacco have both been linked to adverse birth outcomes. Methamphetamine remains largely unstudied among pregnant women, but study data of other illicit drugs indicates serious complications related to its use.

B.1. Alcohol

Alcohol use during pregnancy has been studied extensively. The NSDUH reported that among pregnant women aged 15-44, 11.6% reported drinking in the past month, 3.7% reported binge drinking and less than 1% reported heavy drinking for the combined years 2006-2007 (Figure 1.2) [2]. Data suggest that 14-22% of women report drinking alcohol at some point during their pregnancy [34]. While these rates remain below similarly-aged non-pregnant women, alcohol use during pregnancy represents a severe public health threat given the potential adverse effects on the infant. Drinking during pregnancy has been associated with major neurodevelopmental and other birth

defects, including malformations and dysplasias of the heart, bone, kidney, and vision or hearing problems [34].

Figure 1.2 Patterns in Alcohol Use for Past Month Among Pregnant Women, Aged 15-44 Years, NSDUH

Period	Current	Binge
2000-2001	12.9	4.6
2002-2003	9.8	4.1
2004-2005	12.1	3.9
2006-2007	11.6	3.7
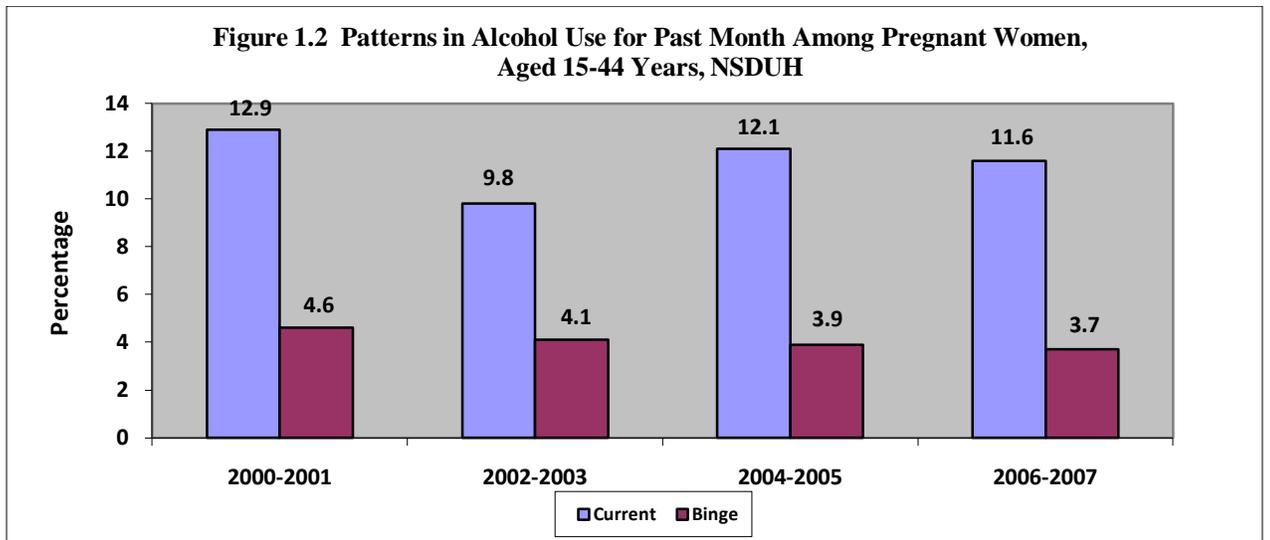
Fetal Alcohol Syndrome (FAS) has been recognized as the leading known preventable cause of mental retardation [34]. The CDC estimates that there are 0.2 to 1.5 cases of FAS per 1,000 live births in certain areas of the United States [35]. It is unknown how many cases of Fetal Alcohol Spectrum Disorders (FASDs) occur each year, but researchers estimate it may be three times the rate of FAS. Further, they estimate that the cost of FAS in the United States, not including the costs associated with FASD, is $4 billion annually [36].

B.2. Prenatal Tobacco Use

Prenatal tobacco use has also been explored extensively in the literature. 2006-2007 NSDUH data indicate that 16.4% of pregnant women aged 15-44 reported smoking in the past month, which compares to 28.4% of non-pregnant women in the same age category. This rate is a slight decrease from the years 2002-2003 which estimated 18% prevalence rates among pregnant women and 30.7% among non-pregnant women [2].

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Pregnant women aged 15-25 and aged 18-25 were more likely to smoke than those aged 26-44, with rates of 24.3%, 23.3% and 11.6%, respectively [2]. Care should be taken with self-reported rates of smoking during pregnancy. Validation studies of maternal self-report as compared to cotinine levels have consistently demonstrated underreporting [37]. Thus, these self-reported data likely underestimate true smoking rates during pregnancy. Smoking during pregnancy has been associated with fetal growth restriction, spontaneous abortions, ectopic pregnancy and placenta previa [37]. Increasing evidence suggests prenatal smoking may also contribute to stillbirth, preterm birth, placental abruption and sudden infant death syndrome [37].

B.2.1 Smoking Cessation during Pregnancy and Postpartum Relapse

National 2007 PRAMS reported state-specific smoking rates during the three months prior to pregnancy and the third trimester ranging from 10.6-40.5% and 4.7-30.0%, respectively [38]. Minnesota PRAMS data from 2002-2006 are in the middle of the national ranges (Table 1.2). Prenatal care may present an opportunity for smoking cessation intervention because concern about infant health may motivate some women to quit [39, 40]. Low smoking cessation rates during pregnancy and high rates of relapse suggest that current interventions aimed at pregnant and postpartum women may not be effective enough. An overview of the prenatal smoking literature highlights the need for further cessation research and in particular calls attention to the research gap in relapse prevention [41].

Table 1.2 Weighted Percentage of Respondents Self-Reporting Smoking by Time Period and Year, MN PRAMS, 2002-2006			
	3 Months Pre-Conception	3rd Trimester	Time of Survey (2-6 Months Postpartum)
2002	27.7%	15.4%	19.9%
2003	24.6%	14.9%	19.4%
2004	27.6%	15.9%	21.4%
2005	27.2%	15.6%	21.3%
2006	25.6%	13.6%	18.9%

Pregnancy represents an opportunity for smoking cessation intervention, given that most pregnant women have ongoing contact with the health care system. But even though women may be more motivated to quit smoking during pregnancy due to concerns about infant health, smoking cessation rates remain low [39]. Less than 50% of women quit smoking during pregnancy and of them, half will resume smoking after delivery [40]. Several correlates of prenatal smoking cessation have been studied, including pregnancy intention, level of nicotine dependence, smoking environment, income and education levels [41-43]. Some studies suggested there may be a positive association between prenatal smoking and poor maternal mental health, in particular depressive symptoms and stress [41-45].

Two studies examined postpartum tobacco relapse in the context of maternal mental health, in particular postpartum depression and stress [40, 45]. Allen et al. reported women were twice as likely to relapse if they reported postpartum depressive symptoms compared to women who did not [40]. One hypothesis is that women who quit smoking during pregnancy quit on a short-term basis and are actually postponing tobacco use [44]. Interventions that rely mainly on the health of the fetus to encourage smoking cessation during pregnancy may not be as effective at promoting long-term cessation. The 2005 Cochrane review of smoking relapse prevention strategies did not find a benefit from current interventions aimed at preventing tobacco relapse [46]. However, this review did not include any interventions that included a mental health component.

Ershoff et al. highlight the knowledge gap in relapse prevention and note that if a substantial portion of women who achieved cessation during pregnancy could translate that into lifelong cessation, the public health implications would be enormous [47]. They suggest that such cessation would result in decreased risk of health problems for the mother and infant; a reduction in environmental tobacco smoke (ETS) exposure for the newborn and other family members; and a decreased likelihood of future reproductive problems and adverse birth outcomes in subsequent pregnancies [47].

B.3. Prenatal Illicit Drug Use

The NSDUH reported 5.2% of women aged 15-44 years used illicit drugs during pregnancy for the years 2006 and 2007 [2]. Women who abuse drugs during pregnancy represent a population who often go undetected by providers [2]. Much of the literature relies on studies conducted in treatment programs, which by definition may include more

severely-impaired women than would be identified routinely in obstetrical practice. Many myths exist about who uses drugs during pregnancy, with a common perception that it is a problem of poor, ethnic minority youth [48]. Cocaine and its variants are probably the most studied illicit drugs with respect to pregnancy and birth outcomes. These studies have demonstrated an increased risk of miscarriage, preterm labor and birth, low birthweight (LBW), increased risk of infant death and birth defects among babies exposed to cocaine *in utero* [49].

B.4. Prenatal Methamphetamine Use

Methamphetamine has not been studied in as much detail as several other drugs with respect to pregnancy and birth outcomes. Some researchers have hypothesized that some drug use is in part self-medication by individuals suffering from depression or depressive symptoms [50, 51]. Thus, the assessment of major depression and lesser depressive symptoms in studies of methamphetamine-using pregnant women could provide information about initiation of methamphetamine use and barriers they may face in stopping.

Methamphetamine use has fluctuated, nationwide and in Minnesota [2, 52]. The NSDUH indicated less than 2% of adults used methamphetamine in 1994 compared to 5.2% in 2004 [2]. Minneapolis saw a 243% increase in emergency room mentions of methamphetamine between the years 1995-2002, the highest increase noted for any region in the nation [53]. Treatment Episode Dataset (TEDS) data indicate that drug treatment admissions for methamphetamine increased from less than 1% of all Minnesota drug treatment admissions in 1992 to 10% in 2003 [53]. Those rates were higher than national data that reported methamphetamine-related drug treatment admissions

comprised 7.3% of the total in 2003 [50]. Methamphetamine-related drug treatment admissions appeared to peak in 2005, with 12% of admissions [52], but are now on the decline. A reduction in methamphetamine labs is credited with a portion of that reduction [52]. Current data indicate 5.5% of patients receiving drug treatment in the Twin Cities metropolitan area listed methamphetamine as their primary substance for the first half of 2008 [52].

Methamphetamine use has significant effects on the individuals using it, their families and society. It is considered one of the most difficult substance abuse issues to treat, due to its protracted physiological and psychological problems caused by the drug's effect on neural pathways [53]. Of particular concern is the potential health risks associated with prenatal exposure to methamphetamine due to maternal use.

Data about the effects of methamphetamine use on newborns are limited to animal studies, some human studies, and the cocaine literature [51].   Methamphetamine use has been shown to have vaso-constrictive effects, reducing placental blood flow and causing fetal hypoxia [51]. It has also been shown to contribute to maternal anorexia, thus resulting in intrauterine growth restriction [51]. Animal studies have demonstrated an array of adverse health effects in offspring, including: increased maternal and infant mortality, retinal defects, cleft palate malformations, rib malformations, decreased physical growth and delayed motor development [51]. The few human studies of prenatal exposure to methamphetamine have found similar problems as in the animal studies, as well as increased rates of premature delivery and placental abruption [50, 54]. These limited results have raised serious concerns among providers who are seeing more methamphetamine-using mothers and their infants.

Few studies have been performed to ascertain the characteristics of methamphetamine-using mothers. The IDEAL Study, a prevalence study of substance use during pregnancy among high risk women, found that 5.2% of the women in their sample used methamphetamine sometime during their pregnancy, and that these women were more likely to be single, less educated, attend fewer than 11 prenatal visits and utilize public assistance [55]. One study in Toronto identified ecstasy-using pregnant women who contacted a drug helpline and also recruited non-using controls [56]. They found that the ecstasy-using women were more likely to be young, single, white, have psychological morbidity and report a cluster of risk behaviors, including smoking, alcohol use, other drug use and higher rates of unplanned pregnancies, as compared to non-users [56]. One-third of the ecstasy-using women reported psychological problems.

Few states have the capacity to perform surveillance activities of prenatal methamphetamine exposure, given the sensitive nature of the topic and difficulty in accessing the women. Trying to study methamphetamine use in relation to maternal mental health is very difficult from a surveillance perspective. Birth certificates have contained a check-box for methamphetamine use since 1994, but the quality of data is unknown. Methamphetamine use is likely underreported on birth certificates as the check-box relies either on maternal self-disclosure or strong evidence to convince the provider of maternal use.

A study of maternal methamphetamine use could provide important information for researchers, providers and public health practitioners with respect to maternal characteristics, including maternal mental health status, user patterns and pregnancy

experiences. Such studies could guide future research efforts related to maternal

methamphetamine use and neonatal health outcomes.

C. Co-Occurrence of Maternal Mental Health and Substance Use

Research on substance use and mental health suggests that depressed mood and

use of substances such as alcohol and tobacco, as well as other drugs, may co-occur [57-

59]. The co-occurrence and potential interactive effects of mental health conditions and

substance use could be important not only for the health of mothers, but also for infants.

Substance use has been shown to be harmful to the user and fetal exposure to alcohol,

tobacco or drugs can be teratogenic [60-64]. Study evidence suggests that mental health

can influence maternal behavior and infant health. The directionality of the relationship

between mental health and substance use has not been clearly described. It is unclear

whether substance use among persons with mental health conditions reflects self-

medication by the individual or whether substance use leads to depressed mood or other

psychological problems. Thus, the potential exists that the combined effect of prenatal

substance use and maternal mental health may be greater than the independent effects of

either factor alone. Conversely, substance use may mitigate the effects of mental health

on health outcomes.

Data from the 2007 NSDUH reported that adults with a major depressive episode

in the past year had higher rates of illicit drug use compared to those who did not (27.4%

vs. 12.8%) [2]. Similarly, heavy alcohol use (defined as drinking five or more drinks on

the same occasion on each of five or more days in the past thirty days) was higher among

adults with a major depressive episode as compared to those without (10.4% vs. 7.1%).

The rate of daily cigarette use was higher among those with a major depressive episode

compared to those without, 28.7% vs. 15.2% [2]. Minnesota PRAMS data for 2002-2006 indicate that women with low maternal mood during pregnancy were more likely to use tobacco in the third trimester compared to those with high mood (26.2% vs. 11.7%, p<0.0001). Alcohol use also varied by maternal mood for this population, with 7.6% of low mood respondents self-reporting third trimester alcohol use compared to 5.8% of high mood respondents (p=0.029).

Singer et al. determined that cocaine-users had more severe symptoms of psychological distress that were more likely to be clinically significant compared to non-users [65]. Depressive symptoms were more likely to be reported in cocaine users (36%) versus non-users (16%), and similar patterns were observed for moderate and severe anxiety [65]. This study did not examine the interactive effect of substance use and psychological distress on birth outcomes.

No studies were found that examined the interaction between substance use, mental health and birth outcomes. One study examined the combined effect of postpartum depression and prenatal cocaine use on infant neurobehavioral measures at one month of age [66]. 1,053 infants were recruited, and their mothers interviewed, to assess current postpartum depressive symptoms and history of prenatal substance abuse. This study used analysis of variance to assess both the independent and interactive effects of prenatal cocaine exposure and postpartum depression on infant self-regulation, stress, excitability and arousal [66]. The depressed group reported higher levels of cocaine use as opposed to the non-depressed, however the association was borderline statistically significant (p<0.07). The results of the interaction analyses were interesting in that an interactive effect with postpartum depression was only found among non-cocaine users

[66]. Among women who abstained from cocaine use, those with postpartum depression were more likely to have infants with lower self-regulation, higher stress, higher excitability and more arousal, as compared to those women classified as non-depressed. Prenatal cocaine use did not increase the effects of maternal depression on infant measures [66]. Thus, the relationship between depression and substance use may be more complex than realized, with some substances acting as buffers of the mental health-infant outcome association.

A literature review of mental health-substance use interactions in the general population yielded a few studies which suggest there may be an interactive effect. A study of 1,710 HIV-positive women found that women with both depression and illicit drug use (crack, cocaine, heroin and amphetamine) were less adherent to recent drug therapies for HIV, as compared to women with only one of the conditions [67]. A study of alcohol use and all-cause mortality among 5,177 men and women examined the interactive effect of heavy alcohol intake and depression on all-cause mortality [68]. Heavy male drinkers (>6 drinks on average per day) who were also depressed had a four-fold increased risk of mortality compared to non-depressed men who did not drink. A similar increased risk of all-cause mortality was found for former, female heavy drinkers who were also depressed as compared to non-depressed, no drinking females [68]. A study of 3,644 adolescents aged 15-19 examined determinants of the onset of sexual activity and whether these predictors interacted with depression to hasten age of first sexual activity [69]. Interestingly, increased alcohol use was associated with delayed onset of sexual intercourse among older female adolescents with depression [69]. The

authors hypothesized that alcohol use may have mitigated the effects of depression on adolescent sexual behavior, thus delaying initiation among girls as they matured.

It is possible there is a genetic component to the interactive effects of substance use and mental health. A study of 465 subjects with alcohol dependence, anxiety-depression and both alcohol and anxiety-depression were recruited to determine whether specific genotypes were associated with any of the above conditions [70]. The authors found that the main gene of interest, DRD2, was associated with the combined condition of alcohol dependence and anxiety-depression, but not with either of the individual conditions [70].

Individuals may have a genetic predisposition to mental health conditions and substance dependence. Further, these variables may influence the development of each other. The concept of a "dual diagnosis" has been gaining attention among researchers. Graham et al. discuss the hypothesis that secondhand tobacco exposure, either *in utero* or in early childhood, could influence the development of dual disorders in adulthood [71]. Prenatal exposure may alter gene expression and change the risk for several life-long psychiatric conditions, including attention-deficit disorder, substance use disorders and major depression [71]. Thus, the cycle of substance use and mental health conditions may be perpetuated in families, not only because of social and cultural norms, but because of genetic, physiological or environmental factors. The co-occurrence of these factors may be important for guiding future intervention efforts. If women are coping with both risk factors, intervention efforts may not be successful if they target mental health or substance use in isolation from the other.

D. Birth Outcomes

Despite advances in maternal and fetal medicine in the United States, rates of preterm and LBW births continue to rise. Infant mortality rates in the U.S. ranked 30th among developed nations, much of which was attributed to higher preterm birth rates [72]. When compared to a group of 20 European countries, the U.S. had the highest rate of preterm births, at 12.7%, compared to the lowest rate of 5.5% in Ireland [72]. It is estimated that one-third of U.S. infant deaths, which translates to approximately 8,000 infants per year, could be averted if the U.S. had Sweden's distribution of births by gestational age [72]. The dramatically lower rates of preterm and LBW births in other developed nations should galvanize health professionals to address these adverse outcomes in the U.S.

Infants born at less than 5 lbs, 8 oz. (2500 grams) are defined as LBW. Typically, LBW infants are born preterm (less than 37 weeks gestation) or are defined as small for gestational age, which can result from intrauterine growth restriction. Infants who are both preterm and small for gestational age face the largest health issues. Preterm birth and LBW can result in significant short-and long-term morbidity, as well as infant death [73-76]. Fertility interventions contribute to some of the observed increases, as they are associated with higher rates of multiple births which are at increased risk for being preterm and LBW deliveries. However, 96% of all births are singleton births and these adverse birth outcomes are increasing in singletons in the United States [72]. Minnesota reported increases in both preterm and LBW among singleton births from 1990 to 2006 [77]. In 1990, 4.1% of Minnesota singleton births were LBW and 6.7% were preterm. These percentages increased to 4.9% and 8.5%, respectively, in 2006. While LBW

remains just below the Healthy People 2010 goal of 5.0%, the preterm rate increased past the Healthy People 2010 goal of 7.6% preterm births [78].

Maternal health and nutritional status have been linked to LBW [79-81]. Infants with birth defects are at increased risk for LBW and preterm delivery [79, 80, 82]. Infants born at LBW have an increased risk for developing respiratory problems, retinopathy and intraventricular hemorrhage. A recent study suggests that LBW may be linked to respiratory problems that persist beyond infancy into childhood and young adulthood [83]. They found that individuals with very LBW (less than 3.3 lbs) or moderate LBW (3.3-5.5 lbs) had an 84% and 34% higher risk of hospitalization for respiratory diagnoses, respectively, after adjustment for covariates including demographics and maternal smoking status at delivery [83]. This study did not distinguish between LBW due to preterm delivery or intrauterine growth restriction.

Preterm birth can result in serious health problems for the infant, both in the short- and long-term. Preterm infants are at increased risk for newborn health complications, such as breathing problems and infant mortality. Most preterm infants require care in a Neonatal Intensive Care Unit (NICU), which can add $3,500 per day per infant to the cost of an uncomplicated delivery [84]. It is not uncommon for NICU costs to exceed $1M for an extended stay [84]. Preterm infants also face an increased risk of lasting disabilities, such as mental retardation, learning and behavioral problems and cerebral palsy. Two studies suggest that preterm infants may be at increased risk of symptoms associated with autism [85, 86]. Studies also suggest that infants born very prematurely may be at increased risk of certain adult health problems, such as diabetes, high blood pressure and heart disease [87].

Muraskas et al. note that while many advances have been made in infant survival, short- and long-term outcomes have not improved significantly in the past twenty years [84]. Preterm births account for approximately $26 billion in U.S. healthcare costs (1-2% of total health expenditures), which raises the question as to whether some of these dollars might be more effectively spent in preventing preterm birth [84]. In a Narrative Matters piece in *Health Affairs*, Lantos has the following insight into neonatology in the United States:

> *"Neonatal intensive care is one of the triumphs of modern medicine. Babies who inevitably would have died a few decades ago routinely survive today. But the success of NICUs should not lead us to see them as the only solution to infant mortality or as an adequate moral response to our children's health needs. We should constantly remind ourselves that the need for so much intensive care for so many babies is a sign of political, medical and moral failure in developing ways to address the problems that sustain an epidemic of prematurity" [84].*

Study data on the risks to infants of mothers with depressive symptoms are not conclusive. Infants of mothers who suffered from depressive symptoms during pregnancy may be at higher risk for preterm birth, LBW, operative delivery and admission to neonatal intensive care units [88-90]. A study that focused on infant nutrition found lower birth weight and subsequent weights (at 2 months, 6 months and 12 months) for infants of depressed mothers [91]. However, a recent population-based study of neonatal health outcomes among women experiencing depression during pregnancy did not find significantly higher rates of adverse outcomes in neonates of depressed and/or anxious mothers [14]. While this was one of a few large, population-based

studies, it had limitations. It used the DSM-IV diagnosis for clinical depression to identify the study population. Some of the participants were being treated for their depression during the study and the authors did not distinguish between women who received treatment and those who did not. Additionally, this study was conducted in Sweden which is renowned for its low rates of neonatal adverse events.   Therefore, social and environmental factors in Sweden may have minimized the effects of maternal depression on infant health outcomes.

Preterm birth remains an important public health priority, yet only half of all cases of preterm birth result from identifiable causes [92]. Although many factors have been associated with preterm birth, research that draws from a variety of risk factors, and how those factors may interact with each other, is necessary to further the field.

E. Measurement Strategies: The Use of Surveillance Data and Qualitative Studies

There has been growing clinical interest in the detection of depression in pregnant women, as well as in improving public health surveillance in this area. The U.S. Preventive Task Force recommends screening adults for depression in primary care clinics [93]. Recently, the American College of Obstetricians and Gynecologists (ACOG) released a recommendation to encourage physicians to screen pregnant women for depression, both during pregnancy and during the postpartum, although they did not specify a particular screening tool [94]. Many physicians agree a DSM-IV diagnosis for major depression warrants treatment, but do not necessarily follow-up on lesser depressive symptoms. It is not known whether lesser depressive symptoms or mood symptoms contribute to adverse maternal and infant health outcomes. In addition, no large-scale population surveillance tools are consistently being used at the state or local

level to track maternal mental health. Population-based data, at various levels of public health, are necessary for developing grant proposals, determining research allocation and development of interventions.

Thirty-seven states now operate PRAMS, which is funded and technically supported by the CDC. Minnesota has operated PRAMS since 2002 and this data system has greatly enhanced state-level surveillance. Yet can PRAMS be used for more than surveillance? In an era of limited resources, can PRAMS be used to address research questions around maternal mental health, substance use and birth outcomes? Although PRAMS has measurement and sample limitations, it also has a large sample size with the power necessary to examine some of the risk factor interactions of interest.

PRAMS does not include traditional screening questions for depression, such as those in the CES-D or the Edinburgh Postnatal Depression Screen (EPDS). Individual states can choose to include optional questions related to maternal mood or postpartum depressive symptoms [18, 19]. Low maternal mood is not a recognized DSM-IV clinical diagnosis of depression, yet the mood question may reflect some level of mental health impairment. It is possible that maternal mood, in and of itself, is important to birth outcomes and health behaviors. The PRAMS measures for postpartum depressive symptoms have been previously validated [95-97]. Are the prevalence estimates of maternal mood and postpartum depression reasonable for research purposes, even with their limitations? Should PRAMS be used for research of maternal mental health with the measures currently available? These questions are integral to assessing the quality of PRAMS as a data source for population-based research.

Qualitative data are not used as frequently as quantitative methods in traditional epidemiological studies. Yet, qualitative methods have a role in furthering the knowledge around health behaviors, in particular for topics that have not been extensively studied. Qualitative methods may be useful for studying maternal mental health and prenatal substance use. Mental health and substance use are sensitive topics in general and especially during pregnancy. Qualitative studies are typically less-structured than quantitative studies, and tend to take more time to complete, but they also generally yield much more data on a smaller number of participants [98]. Analysis is more explicitly interpretive, creative and personal [98]. Qualitative data can augment quantitative studies by allowing for the study of more complex phenomena [98]. While there are differences in approach, qualitative and quantitative studies can be undertaken together and be viewed as complementary rather than adversarial approaches [98].

Qualitative data have limitations, but one needs to consider whether they are enough to discourage the use of qualitative methods. First, qualitative methods promise ecological validity, but it is at the cost of classic epidemiological principles of reproducibility and generalizability [99]. Breadth and scale are sacrificed to obtain a deeper and more descriptive understanding of peoples' experiences [99]. A second limitation is the potential for bias or misrepresentation. Similar to quantitative data, qualitative information requires integrity and honesty by the respondents. For drug-using respondents, there is a genuine concern about their ability to recall events and emotions. However, it is possible that the trust and rapport resulting from qualitative research can help respondents produce more accurate recall [98]. Conversely, this rapport between the researcher and respondent could result in the respondent reporting

beliefs and behaviors that he or she feels the researcher wants to hear. Qualitative approaches also have practical limitations. The data collection, processing and coding, as well as the analysis, can be complex and requires a high level of organization. In addition, because of the amount of time required by respondents to participate in qualitative research, whether via focus groups or one-on-one interviews, there is often an expectation for some type of compensation for the respondent.

Qualitative data methods may be quite useful in studying substance abuse, particularly within specific population subgroups. Qualitative addiction research seeks "…both to describe the social meanings that participants attach to drug use and the social processes by which such meanings are created, reinforced, and reproduced. In particular, qualitative research focuses on exploring the details of people's lived experiences and on appreciating why drug-using behaviors occur and how they are understood in different contexts among different social groups" [98]. Qualitative research methods are unique in that they enable the researcher to better understand drug and alcohol use from the participants' perspective [98]. Qualitative research can further assist in identifying emerging trends in drug use.

Drug use and mental health conditions are highly sensitive topics, thus feelings of trust and rapport arising between the researcher and research participants can facilitate discussions about intimate information. Similarly, qualitative researchers' sensitivity to the social and cultural specificity of their study population can foster an awareness and empathy that encourages those being researched to disclose sensitive information [98]. The use of qualitative methods to explore issues around maternal mental health and

substance use on a deeper level may be a useful approach to expanding the literature, as well as for hypothesis-generating and future research design.

F. Theoretical Model to Guide Variable Selection and Analysis

The Theory of Triadic Influences (TTI) was used to frame the study design, guide in variable selection and analysis. The TTI was created by Flay [100, 101] to explain health behaviors. It combines elements from several models of health behavior, including health beliefs and social-cognitive models. The TTI assumes that decision-making and intent precede behaviors. Macro-environmental, micro-environmental and intrapersonal factors are thought to influence attitudes, social norms and self-efficacy, which in turn translate into intent and decisions to perform certain health behaviors. The main premise of the TTI is that several factors converge to influence health behaviors, which are represented by social, environmental and intrapersonal factors. These three streams of influence (triad of influence) are thought to arise from different origins and therefore are expressed through different variables.

Environmental influences are thought to arise from the macro-environment and flow through factors that affect attitudes such as health values, knowledge, expectations and evaluations about the consequences of health-related behaviors. *Social* influences originate in the more immediate social setting or microenvironment (e.g. family, school, and friends). This stream assumes that people engage in or imitate behaviors of those with whom people are most closely bonded. *Intrapersonal* influences originate in biological and genetic predispositions and assume that two individuals, when exposed to the same macro- and micro-environments, may not behave similarly. The TTI also proposes that elements in one type of stream (e.g. social competence/esteem) also can

directly and indirectly affect factors in one of the other two streams of influence (e.g., expectancies, motivations to comply).

In addition, the TTI assumes that there are levels of influence for the variables represented. Some variables, like intentions, have a direct effect on behaviors and are identified as proximal or immediate [101]. A second layer of variables are mediated through other variables, such as social normative beliefs, and are considered more distal. Other variables, such as taxes on cigarettes, are even more distally related to behavior. Finally, factors such as ethnic culture or neighborhood poverty represent the actual underlying or ultimate causes of behavior [101]. Thus, variables fall both within their stream of influence and as a level of influence.

The TTI proposes that the effects of ultimate and distal causes of behavior flow through the streams of influence, which act by a set of proximal indicators and are mediated by multiple factors in between [101]. This has important ramifications for intervention design. Ultimate or underlying causes are typically those that are most out of the realm of influence of the individual, but also have the most pervasive effects. Therefore, influencing these factors has the greatest potential to influence behaviors on a population basis [101]. Proximal level behaviors are less removed from the behavior, have fewer mediating variables and may be more amenable to individual change. However, as compared to ultimate-level influences, these factors are narrow and more behavior-specific.

The TTI was designed with interventions in mind, thus it provides a framework for translating analysis results into tangible intervention opportunities. The TTI provides a framework to examine multiple etiologic factors associated with specific factors as well

as guidelines for intervention. Although the proposed studies are descriptive in nature, their results could be useful to health educators or program planners in the development of targeted interventions. Because the TTI was developed to guide health educators, it is particularly relevant to these analyses if they can be translated into tangible intervention opportunities.

Separate theoretical models based on the TTI were created for each data set and are located in the Methods section under Variable Descriptions. The PRAMS model is found in Chapter 2, Study Design, as Figure 2.3. The Maternal Methamphetamine Study model is found in Chapter 2, Study Design, as Figure 2.4.

The theoretical model that guides these analyses attempt to provide a comprehensive view of the individual, societal and environmental factors that may influence the outcomes of interest. The TTI was appropriate for both PRAMS and the Maternal Methamphetamine Study because it allowed for the complexity of the potential relationship between mental health and substance use during pregnancy, how that relationship may be influenced by mediating factors, and how these combined factors may influence behaviors or outcomes.

G. Summary

While the literature is robust with respect to studying prenatal substance use and maternal mental health separately, the co-occurrence of these factors and potential interactive relationships, remain understudied. This dissertation aims to provide a first step, or foundation for future research in these areas, by utilizing existing surveillance data and qualitative methods.

PRAMS surveillance data has limitations based not only on the retrospective nature of the survey, but also in its measurement of the main variables of interest. Several biases can arise from retrospective designs, for example, recall bias. In addition, the mental health and substance use measures themselves reflect sensitive topics and may result in underreporting. PRAMS does not have biochemical validation of substance use. The maternal mood variable is not a clinical diagnosis for depression and it is unknown exactly what it represents with respect to maternal mental health. Although the two-question postpartum depressive symptoms algorithm has been previously validated, it is not a full clinical screen for depression. Yet even given these measurement limitations, PRAMS is population-based and has a large enough sample to study many of these variables in combination. Given this era of limited resources it may be that PRAMS can be useful in foundational work that seeks to further knowledge. This could consist of hypothesis generation, the design of future studies and also the ability to track these variables over time for surveillance purposes. Such information could prove valuable for targeting interventions and resources.

Qualitative data has both strengths and limitations. The results are specific to the population studied and cannot be generalized. Since qualitative methods are so involved and time-consuming, sample sizes are small and typically focus on a very specific population subgroup. There is the potential for misrepresentation by participants, particularly in situations where the topic is sensitive. Yet even given these limitations, qualitative methods can provide much more detail and deeper insights into health behaviors and conditions than many quantitative methods. In particular, qualitative data

are useful for hypothesis generation and as pilot information for the development of future studies.

Both of these methods have inherent limitations, whether these are based on measures used or the populations studied. Even with limitations, it is possible that these methods could further the research agenda for these topics. The results from the manuscripts presented in this dissertation could guide future research efforts as well as highlight important opportunities for intervention. However, this dissertation acknowledges the limitations of the methods used and seeks to evaluate their effectiveness for research purposes around maternal mental health and substance use. Thus, this dissertation aims to further the literature both with respect to the content area around the co-occurrence of maternal mental health and substance use and to critique the strengths and limitations of using qualitative and surveillance data to study these topics.

Chapter 2: Study Design

This dissertation used two different data sets to address the aims and objectives. The first dataset, the Minnesota (MN) PRAMS was used for the first two manuscripts (Chapters 3 and 4). The second dataset, the Maternal Methamphetamine Study, is comprised of both a qualitative and quantitative component, and was used for Manuscript Three (Chapter 5). The MN PRAMS studies were reviewed by the University of Minnesota and the Minnesota Department of Health (MDH) Institutional Review Boards (IRBs) and found to be exempt from full board review because they use existing data without personal identifiers. The Maternal Methamphetamine Study was reviewed and approved by the University of Minnesota IRB. Please see Appendix B for IRB documentation.

A. PRAMS Methods

The first two papers used existing data from the MN PRAMS. MN PRAMS is funded by the CDC and administered by the MDH. It is a state-level survey that is conducted by 37 states, with national data generated from the state surveys. MN PRAMS has been collecting surveillance data about pre-conception, pregnancy and the postpartum since mid-2002.

PRAMS Instrument

PRAMS is a cross-sectional survey conducted between months two and four postpartum among women in Minnesota who delivered live births; women are included if their infant subsequently died. PRAMS is a dual-modal survey, with an initial mailed, self-administered written questionnaire followed by telephone follow-up for non-responders. Survey data are linked to birth certificate data to provide a more complete

picture of the pregnancy experience [102]. Initially, the study over-sampled for African-American and American Indian populations, however due to low stratum-specific response rates in these population subgroups, the over-sample has been dropped for future survey years and stratum-specific analysis was not advised.

PRAMS consists of a standard set of core questions included by each state. In addition, states may include optional questions that CDC developed and standardized. The maternal mood question used for these analyses is not part of the core survey used by all PRAMS states, but was included by MN PRAMS for the survey years of interest. PRAMS surveys vary in length by state and year, because of optional questions, but typically comprise 75-85 questions with a set survey length of 15 pages. Maternal survey responses are linked back to their infant's birth certificate to create a dataset that includes birth outcomes. Please see Appendix C for selected questions from the Phase 4 (2002-2003) and Phase 5 (2004-2006) MN PRAMS surveys.

PRAMS Sample

Approximately 200 women were randomly selected for MN PRAMS participation each month from their infants' birth certificates. Women with infants who died during the early postpartum time fame were eligible and remained in the sample. The sampling file retained one birth certificate for women who had multiple births, thus such women were included in the sampling frame once. MN PRAMS sampled 11,891 women during the years 2002-2006, with 7,655 respondents overall. This corresponds to a 64.3% unweighted response rate, however weighted response rates achieved 76% consistently, by year. For the Paper 1 analysis, 7,475 women had complete data (97.6% of the

respondents), with 180 (2.4%) excluded due to missing data.   Please see Figure 2.1 for

the flow chart that describes the creation of the Paper 1 dataset.

Figure 2.1 PRAMS Mental Health, Substance Use and Birth Outcomes Sample

(Manuscript One, Chapter 3)

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                    │   11,891 Women Sampled    │
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    ┌─────────────────────────┐      ┌─────────────────────────┐
    │   7,655 Respondents     │      │  4,236 Non-Respondents   │
    │   (64.3% Unweighted)    │      │   (37.7% Unweighted)     │
    └─────────────────────────┘      └─────────────────────────┘
         ╱              ╲
┌─────────────────────────┐      ┌─────────────────────────┐
│   7,475 With Data       │      │  180 With Missing Data   │
│ Available for Multivariable│    │        (2.4%)            │
│  Logistic Regression    │      └─────────────────────────┘
│       (97.6%)           │
└─────────────────────────┘
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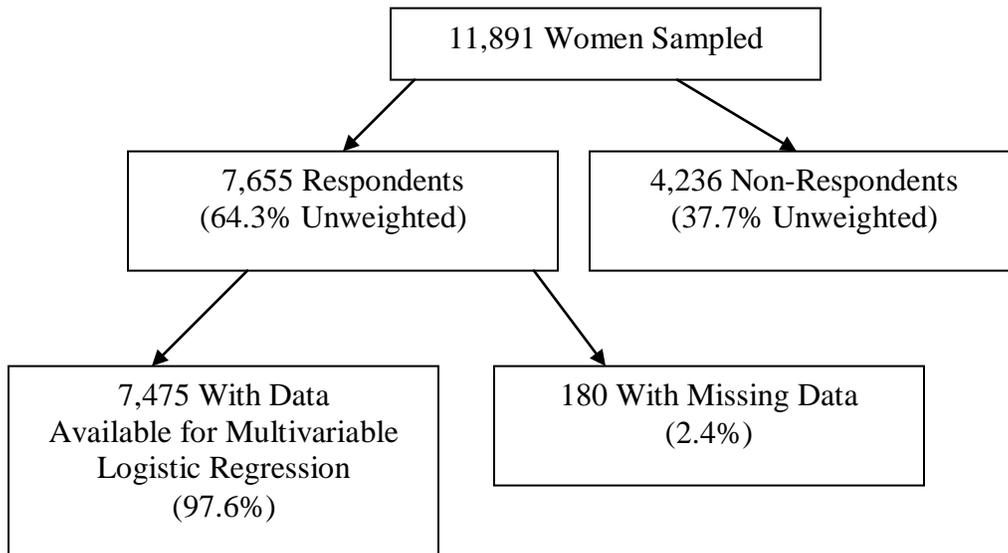
Manuscript Two used data from the PRAMS survey years 2004-2006. The variables used to assess postpartum depressive symptoms changed between the Phase 4 and Phase 5 of the PRAMS survey. The decision was made to use data from Phase 5 only, since the postpartum depression symptom questions differed enough between the two phases as to make it difficult to bridge that variable across the phases.

MN PRAMS sampled 6,853 women during the years 2004-2006, with 4,615 respondents completing the survey. Yearly weighted response rates ranged from 76.1%-76.5%. Smokers were initially identified as women who responded "yes" to the question: "have you smoked more than 100 cigarettes in the past two years?" Of respondents, 1,495 (32.4%) were defined as recent smokers on the basis of that question. Our analysis included women who reported smoking one or more cigarettes per day in the three months prior to pregnancy (n=1,416). Please see Figure 2.2 for the flow chart that describes the creation of the Manuscript Two dataset.

Figure 2.2 PRAMS Cessation/Relapse Sample (Manuscript Two, Chapter 4)

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                        ┌─────────────────────────┐
                        │   6,853 Women Sampled    │
                        └─────────────────────────┘
                           ↙                  ↘
        ┌──────────────────────┐      ┌──────────────────────────┐
        │   4,615 Respondents  │      │  2,238 Non-Respondents   │
        │  (67.3% Unweighted)  │      │   (32.7% Unweighted)     │
        └──────────────────────┘      └──────────────────────────┘
           ↙              ↘
┌──────────────────────────┐      ┌──────────────────────┐
│ 1,495 Smoked Greater than│      │  3,120 Non-smokers   │
│ 100 Cigarettes in Past 2 │      │      (67.6%)         │
│         Years            │      └──────────────────────┘
│       "Smokers"          │
│        (32.4%)           │
└──────────────────────────┘
```

1,495 Smoked Greater than 100 Cigarettes in Past 2 Years "Smokers" (32.4%) branches to:

- **1,416 Smoked Before Conception (96.7% weighted)**
- **42 Did not smoke before conception (3.2% weighted)**
- **37 Missing on Pre-Conception Smoking Status (1%)**

1,416 Smoked Before Conception (96.7% weighted) branches to:

- **606 Quit Smoking by 3rd Trimester (44.6%)**
- **810 Reported Smoking During 3rd Trimester (65.4%)**

606 Quit Smoking by 3rd Trimester (44.6%) branches to:

- **284 Remained Tobacco Free at Time of Survey (49.4%)**
- **322 Reported Smoking at Time of Survey (50.6%)**

PRAMS Sampling Design and Weighting Procedures

Minnesota employs stratified sampling by race/Hispanic ethnicity, but response rates were not high enough for stratum-specific analyses. The annual statewide sample is typically able to estimate population risks within 3.5% at a 95% confidence level. The estimates within strata are usually within 5% at a 95% confidence level. For each respondent, the initial sampling weight is the reciprocal of the sampling fraction applied to the stratum. Sampling fractions in PRAMS range from 1 in 1 (for very low birth weight strata in small states) to about 1 in 211 (for normal birth weight, non-minority strata in populous states) [102]. Corresponding sampling weights, then, would range from 1 to 211. Non-response adjustment factors attempt to compensate for the tendency of women having certain characteristics (such as being unmarried or of lower education) to respond at lower rates than women without those characteristics [102]. Where multivariate analysis shows that these characteristics affect the propensity to respond in a particular stratum, the adjustment factor is the ratio of the sample size in that category to the number of respondents in the category. If analysis shows that no characteristic distinguishes respondents from non-respondents, the adjustment factor is the ratio of the sample size in that stratum to the number of respondents in the stratum. In the first case, each category so identified has an adjustment factor; in the second, there is a single factor for the whole stratum.

The rationale for applying non-response weights is the assumption that non-respondents would have provided similar answers, on average, to respondents' answers for that stratum and adjustment category. So that cells with few respondents are not distorted by a few women's answers, small categories are collapsed until each cell

contains at least 25 respondents [102]. The magnitude of the adjustment for non-response depends on the response rate for a category. If 80% (or 4/5) of the women in a category respond, the non-response weight is 1.2 (or 5/4). Categories with lower response rates have higher non-response weights.

Frame omission studies are carried out to look for problems that occur during frame construction. The frame non-coverage weights are derived by comparing frame files for a year of births to the calendar year birth tape that states provided to the CDC. Omitted records are usually due to late processing and are evenly scattered across the state, but sometimes they are clustered by particular hospitals or counties or even times of the year. The effect of the non-coverage weights is to bring totals estimated from sample data in line with known totals from the birth tape. In mail/telephone surveillance, the magnitude of non-coverage is small (typically from 1% to 5%), so the adjustment factor for non-coverage is not much greater than 1 [102].

PRAMS Measures

The following is a brief discussion of the measures used for the first two manuscripts, with more in-depth information provided in Chapters 3 and 4. Measures of maternal stress prior to delivery [103], low mood during pregnancy [104] and postpartum depressive symptoms [95-97] were used to characterize maternal mental health. Maternal mood was dichotomized by combining responses to the question: "How would you describe the time during your pregnancy?" Women who responded that it was a "moderately hard time," "a very hard time" or "one of the worst times of my life" were classified as having a low mood level. Women with responses of "one of the happiest times of my life" or "a happy time with few problems" were classified as having a high

mood level [104]. Postpartum depressive symptoms were assessed using a previously

validated two-question screening tool [95-97]. Women were identified as having

postpartum depressive symptoms if they answered "always or often" to either of the

following questions: "Since your new baby was born, how often have you felt down,

depressed or hopeless?" or "Since your new baby was born, how often have you had little

interest or little pleasure in doing things?"

Smoking status was assessed for the three months before pregnancy, the last

trimester of pregnancy and at the time of the survey. The survey asked the same question

for the three time periods of interest: "how many cigarettes did you smoke on an average

day?" The response categories were: "41 cigarettes or more; 21-40; 11-20; 6-10; 1-5; less

than 1 cigarette; or none (0 cigarettes)." Women who reported smoking one or more

cigarettes were classified as smokers. Tobacco cessation was defined as using tobacco

during the pre-conception period but reporting zero cigarettes during the third trimester of

pregnancy. Tobacco relapse was defined as quitting tobacco use during pregnancy but

reporting being a smoker at the time of the survey.

Alcohol use was assessed for the third trimester of pregnancy with the question:

"How many alcoholic drinks did you have in an average week?" The response categories

were: "14 drinks or more; 7-13; 4-6; 1-3; less than 1; or didn't drink then." Women were

classified as using alcohol if they reported any alcohol use.

The main outcome measures, preterm (defined as less than 37 weeks gestation)

and LBW (defined as less than 2500 grams), were taken from the infant birth certificate.

Other covariates of interest included: maternal age at delivery (aged 18-24, 25-34, 35+

Years), marital status (yes/no), education level (some high school, high school, some

college, college or more), parity (multiparous, primiparous), prenatal care in the first

trimester (yes/no), pregnancy intention (intended=wanted to be pregnant at that time,

unintended=did not want to be pregnant at the time or ever, mistimed=wished to be

pregnant at a different time), history of pregnancy loss (yes/no), history of partner abuse

(yes/no) and income ($24,999 or less, $25,000-$49,999, $50,000 or more) and still

breastfeeding at time of survey (yes/no). Please see Figure 2.3 Theoretical Model to

Guide PRAMS Variable Selection, which illustrates the potential relationships of

variables of interest.

Figure 2.3. Theoretical Model to Guide PRAMS Variable Selection

Levels of Causation Ultimate

Biological/Nature   Nurture/Cultural

P1: Biology/Personality **(Age, Parity, Health Conditions, Maternal Mood, Postpartum Depressive Symptoms)**

Underlying Causes

S1: Social Situation **(Marital status)**

E1: Cultural Environment **(Income, Education Level)**

P2: Sense of Control & Social Competence

S2: Interpersonal Bonding & Others' Behaviors **(Partner Abuse, Stressful Life Events)**

E2: Interactions with Social Institutions & Information/ Opportunities **(Health Insurance, Adequacy of Prenatal Care)**

Distal Predisposing Influences

P3: Self Determination & Skills

S3: Motivation to Comply and Perceived Norms

E3: Values/Evaluations & Knowledge/Expectan

P4: Self-Efficacy and Behavioral Control

S4: Social Normative Beliefs

E4: Attitudes Toward the Behavior

Proximal Immediate Predictors

5: Decisions/Intentions **(Pregnancy Intention, Breastfeeding)**

6: Trial Behaviors and Experiences, Social Reinforcements and Psychological and Physiological Responses **(Smoking Intensity, Alcohol Intensity, Postpartum Depressive Symptoms, Maternal Mood)**

7b: Behavior **(Tobacco Use, Alcohol Use, Cessation, Relapse)**

7r: Related Behaviors

Outcomes: **Low birthweight, preterm**

PRAMS Analysis

Descriptive statistics were generated for the two PRAMS subsets used in Manuscripts One and Two. Multivariate logistic regression was used to examine the associations between variables of interest and outcomes. Final models were developed to answer the specific research questions for each study. Aside from the main variables of interest, covariates were retained in the final models if they achieved significance at the 0.05 level. Maternal age, parity and education were retained in all models to control for potential confounding. CDC provides each state with a final data file with analysis weights and adjustment for differences between respondents and non-respondents. Weighting was consistent across years and allowed for the combination of multiple data years for analysis. SAS 9.1.3 PROC SURVEYFREQ, PROC SURVEYMEANS and PROC SURVEYLOGISTIC for weighted data were used for all analyses.

B. Maternal Methamphetamine Study Design

Manuscript Three (Chapter 5) describes results from the Maternal Methamphetamine Study, which had two components: a qualitative, in-person interview and a self-administered, written questionnaire. The measurement tools were designed in an iterative approach by a collaborative workgroup, which included representatives from the MDH, Children's Hospital, Hennepin County Medical Center (HCMC) and the University of Minnesota.

The qualitative design evolved out of the recognition that such methods can provide information not readily obtained from quantitative methods. While there are differences in approach, qualitative and quantitative studies can be undertaken together and be viewed as complementary rather than adversarial approaches [98]. Questions for

the self-administered questionnaire were drawn largely from other standardized survey instruments, including those from Project IDEAL [55], Baby Steps [105] and PRAMS [102]. Dr. Barry Lester, from Project IDEAL, a large-scale study of prenatal substance use, gave permission to use their questions. Dr. Wendy Hellerstedt, from Baby Steps, a study of tobacco use and pregnancy, gave permission to use their questions. PRAMS questions are considered in the public domain. A sixteen-item CES-D was also included in the self-administered survey [19]. Please see Appendix D for copies of the interview and self-administered questionnaire.

Women were recruited through four outpatient drug treatment programs located within the Twin Cities Metro area and out-state Minnesota locations (Table 2.1). Women had already self-identified as methamphetamine or other substance users, thus there was not new identification of drug use. The rural and urban settings of these treatment programs allowed for the inclusion of women from both geographic settings. Incentives in the form of Target gift cards ($40 for participants completing both the qualitative and quantitative arms) were provided to participants.

Table 2.1. Methamphetamine Study Participation by Treatment Program Enrollment			
Treatment Program	**Number of Pregnant Women Receiving Treatment for Methamphetamine Addiction**		**Study Participants**
	July 2006-June 2007*	**July 2007-June 2008**	
Program A	n/a	17	9
Program B	12	8	2
Program C**	n/a	n/a	3
Program D	n/a	n/a	1

*Drug treatment programs report their numbers based on a July-June fiscal year.
**Joined study in July 2007.

Women aged 18 years and older, currently pregnant, planning to deliver their infant (i.e. not planning to adopt out or terminate the pregnancy), and have ever used methamphetamine were eligible for the study. Adolescents were excluded for two main reasons. First, they did not represent a significant portion of the client base of these human services programs. Second, pregnant minors who have not had previous children do not have the same emancipation status as minors who have already delivered. Thus the consent process would require parental consent for these few potential clients, which was not feasible for this project. Women did not need to be currently using methamphetamine to be included in the study as cessation during pregnancy is an outcome variable of interest.

Recruitment occurred at the drug treatment program locations. Study site programs agreed to post informational flyers, as well as discussed the study in support groups. No participants were asked to publicly express interest. Women were given the option of completing the survey at the treatment center (with study staff administering it), having it mailed to them or completing it over the phone. Although this introduced a multi-modal approach, other studies, such as PRAMS, have used a mailed/phone dual-modal approach successfully.

To enhance the integrity of the study instruments, this project piloted the written questionnaire and interview with women who already delivered their infants but met the other eligibility criteria for the study (i.e. are not eligible for the study). The intent was to test the understanding and palatability of the questions to then further refine the instruments. Six women participated in the pilot and their feedback was incorporated into the instrument design.

The qualitative, in-person interviews were conducted by Ms. Gyllstrom, a doctoral candidate in Epidemiology, and Dr. Wendy Hellerstedt, University of Minnesota faculty member. Deborah Durkin, MPH, formerly of MDH, who has extensive experience conducting qualitative studies in substance-using populations, trained Ms. Gyllstrom and Dr. Hellerstedt for the interviews. All interviews were audio-taped using digital voice recorders and those recordings were downloaded to two computers, one to serve as a back-up file. Ms. Gyllstrom and Dr. Hellerstedt transcribed the audiotapes, in accordance with the recommendation that the interviewer also be the transcriber, when possible [106]. Interview length averaged 25 minutes and followed a semi-structured format.

Participants completed the written questionnaires in 20-30 minutes. The University of Minnesota, School of Public Health, Health Survey Research Center completed the data entry and cleaning of the written questionnaires. Ms. Gyllstrom created a SAS dataset from the data file for analysis purposes. The informed consent process occurred before administration of the written questionnaire and again before the interview. The informed consent contained background information on the study, a discussion of risk associated with the disclosure of reportable information, such as child abuse or intent to harm oneself or another. Please see Appendix E for copies of the informed consent forms.

Methamphetamine Sample

Recruitment began in December 2006 and finished in December 2008, with fifteen women completing both the written questionnaire and interview. Eighteen women were identified as potential participants and completed the written questionnaire. Three

of those women were unable to complete the study interview and were therefore not included in any of the study analysis. Two of the eighteen women were determined to be ineligible after they completed the written questionnaire because they indicated on the questionnaire that they had not used methamphetamine either three months preconception or during pregnancy. One woman delivered her infant before she could be contacted for the interview and was therefore no longer eligible for the interview portion. Data collection was completed when the interviewers felt saturation had been reached and no new information was being obtained from the interviews.

Methamphetamine Measures

The written questionnaire contained socio-demographic information as well as measures of depression and social support. The mental health variables were derived from the embedded CES-D [19], as well as a question from PRAMS related to self-reported maternal mood during pregnancy [102]. Other variables of interest included: co-occurrence of other drugs; patterns of MA use and cessation; and pregnancy-related variables, such as initiation of prenatal care, pregnancy intent and previous pregnancy history. Covariates included: maternal age, marital status, health insurance status, household income, education level, neighborhood stability, social support, previous interactions with law enforcement and other questions related to social environment. Please see Figure 2.4 Theoretical Model for Methamphetamine Variable Selection.

The interview comprised a wide variety of questions, but for the purposes of this project the following measures were most relevant: methamphetamine patterns of use; experiences of participants while using methamphetamine; mental health history; family and social context of drug use, in particular onset of methamphetamine use; family

history of mental health problems and treatment; and participants' reasons for starting to use methamphetamine. More in-depth descriptions of the mental health-related questions asked during the interview, as well as the embedded CES-D, are provided in Chapter 5.

Figure 2.4 Theoretical Model for Methamphetamine Variable Selection

Levels of
Causation
Ultimate

Biological/Nature   Nurture/Cultural

Underlying
Causes

P1:
Biology/Personality
(Age, Parity, Health Conditions, Mental Health, History of Pregnancy Loss)

S1: Social Situation
(Marital status, Children At Home, Family History of Mental Health Conditions)

E1: Cultural Environment
(Income, Education Level)

P2: Sense of Control & Social Competence

S2: Interpersonal Bonding & Others' Behaviors
(Partner Abuse, Stressful Life Events, Use Patterns of Family & Friends)

E2: Interactions with Social Institutions & Information/Opportunities
(Health Insurance, Prenatal Care, Employment, Access to meth)

Distal
Predisposing
Influences

P3: Self Determination & Skills
(Self-esteem, self-worth)

S3: Motivation to Comply and Perceived Norms
(Family/friend use: others are doing it)

E3: Values/Evaluations & Knowledge/Expectancies

P4: Self-Efficacy and Behavioral Control
(Confidence in quitting)

S4: Social Normative Beliefs

E4: Attitudes Toward the Behavior
(Knowledge of Risks)

Proximal
Immediate
Predictors

5: Decisions/Intentions
(Pregnancy Intention, Reasons for Initiating Meth Use)

6: Trial Behaviors and Experiences, Social Reinforcements and Psychological and Physiological Responses
(Positives/negatives of Meth, Quit Attempts)

7b: Behavior
(Meth Use)

7r: Related Behaviors
(Other drug and alcohol use)

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Methamphetamine Analysis

Basic descriptive data is provided from the quantitative data. The main focus of this analysis involves the qualitative results obtained from the interviews. Interview transcription was performed by the interviewer and both Ms. Gyllstrom and Dr. Hellerstedt read and reviewed each transcript. A master document was created that contained all the transcripts. Both authors coded responses to identify recurring phrases and themes [98, 107]. The coding of responses used the approach outlined by Hahn, which focuses on identifying four levels of codes [107]. Level 1 codes are created rapidly and are eventually used to develop categories or themes. Level 2 codes are used to create categories from the Level 1 codes, therefore multiple Level 1 codes will be associated with every Level 2 code. This stage of coding allows for consideration of how the Level 1 codes may be interconnected. Level 3 and Level 4 coding represent theoretical concepts and are considered higher level coding. This higher level coding process is a distillation of highly significant points that address the research questions. The final coding levels represent the major themes. After the major themes were identified, Ms. Gyllstrom and Dr. Hellerstedt returned to the original data to select quotes that supported the identified themes.

Chapters 3: Independent and interactive associations of prenatal mood and substance use with infant birth outcomes

Abstract

Objective: To examine how prenatal mood and substance use are independently and interactively associated with rates of preterm birth and low birth weight (LBW) births.

Methods: We used the Minnesota Pregnancy Risk Assessment Monitoring System (PRAMS), a cross-sectional written and telephone survey of postpartum women, to examine women's experiences and behaviors during pregnancy. Of the 11,891 women sampled for the years 2002-2006, 7,457 had complete data for analysis. Yearly weighted response rates consistently achieved 76%.

Results: Women with lower levels of prenatal mood who used tobacco were twice as likely to have a LBW infant in multivariate models as women who did not smoke and reported higher mood. Lower prenatal mood was associated with an increased risk for preterm delivery, particularly among women who abstained from alcohol use during pregnancy.

Conclusions: Prenatal mood was associated with risks for preterm and LBW births in Minnesota PRAMS respondents. Substance use and prenatal mood co-occur and their combined effect on birth outcomes warrants further investigation.

Key Words: Low birthweight, preterm, substance use, mental health

Despite advances in maternal and fetal medicine in the United States, rates of preterm and low birth weight (LBW) births continue to rise. Preterm birth and LBW can result in significant short-and long-term morbidity, as well as infant death [73-79]. Fertility interventions contribute to some of the observed increases, as they are associated with higher multiple births and thus, higher rates of preterm and LBW deliveries. However, 96% of all births are singleton births and these adverse birth outcomes are increasing in singletons in the United States [108]. Minnesota reported increases in both preterm and LBW among singleton births from 1990 to 2006 [77]. In 1990, 4.1% of Minnesota singleton births were LBW and 6.7% were preterm. These percentages increased to 4.9% and 8.5%, respectively, in 2006.

Prenatal mental health, often measured by depressive symptoms, anxiety or stress, has been inconsistently associated with adverse birth outcomes. Dayan et al. did not find an association between anxiety and preterm birth [109], but Dole et al. found an association between pregnancy-related anxiety and preterm birth, which weakened slightly when medical co-morbidities were taken into account [8]. Glynn et al. found that patterns of prenatal stress and anxiety were associated with preterm birth in a prospective study of 415 women at a prenatal care clinic [110]. They measured prenatal stress and anxiety at a visit between 18-20 weeks gestation and again at a visit between 30-32 weeks gestation. They assessed stress using the Perceived Stress Scale and anxiety using a pregnancy anxiety scale specifically designed to measure stress during pregnancy [110]. They found that an increase in either perceived stress or anxiety, between the two measurement points, resulted in a three- or two-fold increase in preterm birth, respectively [110].

Women report depressive symptoms during their reproductive years at about twice the rate as men [111]. Researchers hypothesize that hormonal fluctuations during the onset of menarche, pregnancy, postpartum, perimenopause and menopause may make women vulnerable to depressive symptoms throughout the life cycle [112]. For example, a review article of studies examining prenatal depressive symptoms estimated a period prevalence of major and minor depressive symptoms during pregnancy at 18.4% [9]. Studies have focused on identifying women who meet the clinical diagnosis for depression, yet lower maternal mood may also be important to women and their infants.

Research on substance use and mental health has suggested that depressed mood and use of substances such as alcohol and tobacco, as well as other drugs, may co-occur [57-59]. Not only is substance use potentially harmful to the user, fetal exposure to substances could be teratogenic [60-64]. Thus, the potential exists that the combined effect of substance use and poor maternal mental health may be greater than the independent effects of either factor alone.

No studies were found examining the potential interactive association between maternal mental health, prenatal substance use and birth outcomes. However, Singer et al. examined postpartum psychological distress, prenatal substance use and infant birth outcomes among 415 women and their infants [65]. Postpartum maternal psychological stress was assessed as soon as possible after the delivery as a surrogate for prenatal stress and was measured by the Global Severity Index, a summary score of nine psychiatric symptom patterns including depression and anxiety. They found that psychological distress, as well as alcohol, tobacco and cocaine use, was independently associated with measures of fetal growth (i.e. head circumference, birthweight, microcephaly and small

for gestational age) [65]. Singer et al. determined that cocaine-users had more severe symptoms of psychological distress that were more likely to be clinically significant compared to non-users. Clinically significant depressive symptoms were more likely to be reported in cocaine users (36%) versus non-users (16%), which was highly statistically significant. Similar patterns were observed for moderate and severe anxiety [65]. Thus, substance use and psychological distress co-occurred in this population. This study did not examine the interactive effect of substance use and psychological distress on birth outcomes.

Our study examined the potential independent and interactive association between maternal mental health, measured by prenatal mood, and third trimester self-reported tobacco and alcohol use, on the risks for LBW and preterm delivery among women who participated in Minnesota's population-based survey, the Pregnancy Risk Assessment System (PRAMS). To our knowledge, such analysis of an interactive association has not been explored in the literature.

Methods

Study Design

We used the Minnesota (MN) PRAMS, a cross-sectional written and telephone survey of postpartum women, to examine women's experiences and behaviors during the pre-conception and prenatal periods. MN PRAMS is a component of the national state- and population-based PRAMS, administered by the Centers for Disease Control and Prevention (CDC). The Minnesota Department of Health (MDH) administers MN PRAMS [102]. Data were available for mothers and their infants who were born during

the years 2002-2006 (partial year data for 2002). This study has Institutional Review Board approvals from the University of Minnesota and the MDH.

Sample

Approximately 200 women were randomly selected for MN PRAMS participation each month from their infants' birth certificates. Women with infants who died during the early postpartum time fame were eligible and remained in the sample. The sampling file retained one birth certificate for women who had multiple births, thus such women were included in the sampling frame once. PRAMS sampled 11,891 women during the years 2002-2006, with 7,655 respondents overall. This corresponds to a 64.3% unweighted response rate, however weighted response rates achieved 76% consistently, by year. For this analysis, 7,475 women had complete data (97.6% of the respondents), with 180 (2.4%) excluded due to missing data.

Data Collection

MDH staff conducted the sampling and data collection, following CDC protocol for PRAMS administration [102]. A series of mailings began 2 to 4 months after delivery and was typically complete by 3-6 months postpartum. Because the questionnaire contained some items about the early postpartum period, mailings were timed to ensure that all women could respond for this period. If there was no response to repeated mailings, women were contacted and interviewed by telephone. The data collection cycle lasted approximately 60 to 95 days. Approximately 10% of the respondents participated in the phone interview.

Instrument

PRAMS consists of a standard set of core questions included by each state. In addition, states may include optional questions that CDC developed and standardized. The maternal mood question used for these analyses is not part of the core survey used by all PRAMS states. PRAMS surveys vary in length by state and year, because of optional questions, but typically comprise 75-85 questions with a set survey length of 15 pages. Maternal survey responses are linked back to their infant's birth certificate to create a dataset that includes birth outcomes.

Measures

The main outcome measures, preterm (defined as less than 37 weeks gestation) and LBW (defined as less than 2500 grams) births, were taken from the infant birth certificate. Prenatal mood comprised the maternal mental health measure [102, 104]. We dichotomized maternal mood by combining responses to the question: "How would you describe the time during your pregnancy?" Women who responded that it was a "moderately hard time," "a very hard" or "one of the worst times of my life" were classified as having a lower mood level. Women with responses of "one of the happiest times of my life" or "a happy time with few problems" were classified as having a higher mood level.

Smoking status was assessed for the last trimester of pregnancy with the question: "How many cigarettes did you smoke on an average day?" The response categories were: "41 cigarettes or more; 21-40; 11-20; 6-10; 1-5; less than 1 cigarette; or none (0 cigarettes)." Women who reported smoking one or more cigarettes were classified as smokers. Alcohol use was assessed for the third trimester of pregnancy with the question: "How many alcoholic drinks did you have in an average week?" The response

categories were: "14 drinks or more; 7-13; 4-6; 1-3; less than 1; or didn't drink then." Women were classified as using alcohol if they reported any alcohol use.

Interaction terms for lower maternal mood and substance use were created to assess the potential interactive associations of prenatal tobacco use and maternal mood and prenatal alcohol use and maternal mood on LBW and preterm outcomes. Categories for tobacco and mood were: high mood/no tobacco use (referent), high mood/tobacco use, low mood/no tobacco use and low mood/tobacco use. Categories for alcohol and mood were: high mood/no alcohol use (referent), high mood/alcohol use, low mood/no alcohol use, and low mood/alcohol use.

Maternal stress level, a covariate of interest, was assessed with a 13-item set of potential stressors, a subset of the Modified Life Events Inventory [103]. Stressors included moving, being homeless, financial problems, relationship problems and an illness or death in the family. Women received an overall stress score by summing the yes responses to the 13 items. We classified women as having no life stressors (31.9%), 1 or 2 stressors (41.9%) and 3 or more stressors (26.2%). Other covariates of interest included: maternal age at delivery (aged 18-24, 25-34, 35+ years), marital status (yes/no), education level (some high school, high school, some college, college or more), primiparity (yes/no), prenatal care as early as wanted (yes/no), prenatal care in the first trimester (yes/no), pregnancy intention (intended, unintended, mistimed), history of pregnancy loss (yes/no) and history of partner abuse (yes/no).

Analysis

We used multivariate logistic regression to examine the independent and interactive association of maternal mood and substance use on preterm birth and LBW.

CDC provides each state with a final data file with analysis weights. Weighting was consistent across years and allowed for the combination of multiple data years for analysis. We used SAS 9.1.3 PROC SURVEYFREQ and PROCSURVEY LOGISTIC to analyze the weighted data. Multivariate models included variables that were independently associated with the outcome variables in chi-square analysis, as well as maternal age, parity and education. We removed variables that were no longer statistically significant in multivariate analysis to arrive at the final models.

Results

Of the 11,891 women sampled from birth certificates for the years 2002-2006, 7,655 women (64.3%) completed the survey, either in written form or by telephone. Non-respondents were more likely than respondents to be unmarried, younger, multiparous and have lower education levels; they also had higher rates of LBW births (9.6% vs. 6.4%) and preterm births (11.1% vs. 8.6%) than respondents.

Of the respondents, 7,475 had complete data for logistic regression (97.6%). Measures of maternal age, marital status, education level, income level, pregnancy-related characteristics, lower maternal mood and stressful life events were consistent over the study years. Women reported rates of lower mood during pregnancy that ranged from 22.0%-24.7% over the survey years. Women who reported lower mood levels were more likely than those with higher levels to be unmarried, have lower income (2004-2006 data), have a history of pregnancy loss and a history of partner abuse. Women with lower mood were more likely to have had prior pregnancies and less likely to have obtained prenatal care as early as they would have liked. Substance use varied by maternal mood status. Women who reported lower mood levels were more likely than those with higher

mood to use tobacco during the 3rd trimester (26.2% vs. 11.7%) and to drink alcohol during the last trimester (7.6% vs. 5.8%) (Table 3.1).

The prevalence of tobacco use appeared stable over the study years. Third trimester alcohol use seemed to increase slightly over the study time frame, from 5.6% in 2002 to 7.2% in 2006. For all years combined, among the 6.2% of women who reported drinking in the last trimester, 59.6% reported drinking 7 or more drinks/week, 15.4% had 1-6 drinks per week and 25% had less than one drink per week. Less than 1% of women who reported alcohol use during the third trimester had more than 14 drinks per week.

Correlates of Low Birth Weight

Lower maternal mood and prenatal tobacco use were independently associated with LBW, after adjustment for maternal age, parity and education. Women with lower mood were almost twice as likely to have a LBW delivery as compared to higher mood women (OR=1.93, 95% CI: 1.47, 2.55, p<0.0001). Women who smoked during the last trimester were also more likely to have a LBW delivery as compared to non-smokers (OR=1.55, 95% CI: 1.12, 2.15, p=0.009). Maternal education and age were both associated with LBW in adjusted models. Third trimester alcohol use, alcohol intensity (7 or more drinks per week vs. 6 or less), smoking intensity (11 or more cigarettes per day vs. 10 or less), maternal stress, prenatal care in the first trimester, prenatal care as early as wanted in the pregnancy, pregnancy intention, history of pregnancy loss and history of partner abuse were not associated with LBW.

Lower maternal mood and prenatal tobacco use were interactively associated with having a LBW infant (Wald chi-square for interaction: 4.93, 1 d.f., p=0.03). Women with lower maternal mood levels who used tobacco during the third trimester were twice

as likely to have a LBW infant compared to women who reported having higher mood levels and who did not use tobacco (Table 3.2). LBW births were also associated with lower maternal mood levels and no tobacco use (OR=2.16) and higher mood levels and tobacco use (OR=1.92), as compared to those with no tobacco use and higher mood levels.   Maternal education, age and parity remained independent predictors of LBW in the interaction model.

Correlates of Preterm Delivery

Lower maternal mood was also independently associated with preterm delivery, after adjustment for maternal age, parity and education (OR=1.78, 95% CI: 1.42, 2.25, p<0.0001). Alcohol use during the third trimester was not independently associated with preterm delivery after adjustment for maternal age, parity and education. We found a weak interactive effect for prenatal maternal mood, alcohol use and preterm delivery (OR=0.68, Wald chi-square for interaction: 2.27, 1 d.f, p=0.13), after adjustment for maternal age, parity and education (Table 3.3). Women with lower mood levels during pregnancy who abstained from alcohol were almost twice as likely to have a preterm birth (OR=1.95), compared to women who reported higher mood levels and did not drink. Women in the highest age category were more likely to have a preterm delivery as compared to the 18-24 year group. More educated women were less likely to have preterm deliveries, as compared to women with less than a high school education. Third trimester tobacco use, smoking intensity, alcohol intensity, maternal stress, prenatal care in the first trimester, prenatal care as early as wanted in the pregnancy, pregnancy intention, history of pregnancy loss and history of partner abuse were not associated with preterm delivery.

Discussion

Women who reported lower mood levels during pregnancy were twice as likely to have a LBW infant, regardless of their smoking status, compared to women reporting higher mood levels. Women who had lower mood and used tobacco had similar risks for LBW infants as women with lower mood but no tobacco use, while the risk for LBW delivery for women reporting tobacco use and higher mood was slightly lower than those for the other categories. Thus, our findings suggest the relationship between tobacco use and maternal mood may be subtle and more complex than previous studies of these risk factors alone could demonstrate. Tobacco use has been shown to decrease intrauterine growth and lower maternal mood may affect maternal nutrition, which could also affect fetal growth [113]. However, tobacco use may also buffer the effects of lowered maternal mood. It is also possible that there are biological and behavioral responses to lower maternal mood that influence the growth of the infant, regardless of tobacco use.

Our finding of an association between substance use and LBW is consistent with previous studies that have examined the independent effects of alcohol and tobacco on birth outcomes [65, 103, 111]. A retrospective study nested in a cohort of 18,297 children reported a finding for smoking and LBW delivery similar to ours (OR=1.92, 95% CI: 1.6-2.29), after adjustment for maternal age, body mass index, parity, alcohol use, maternal education, ethnicity, income and gestational diabetes [104]. The magnitude of association for tobacco use and LBW in other studies was similar to the odds ratios generated from our study [113-115].

Women with lower mood during pregnancy who abstained from alcohol during the third trimester were almost twice as likely as their higher mood counterparts to

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deliver a preterm infant. Our borderline statistically significant interactive association between maternal mood, prenatal alcohol use and preterm delivery suggests that mood may be more important than third trimester alcohol use in predicting preterm delivery. Dayan et al. followed a prospective cohort of 681 women carrying singletons recruited during their second trimester [109]. They found higher rates of spontaneous preterm birth among women with higher depression scores, as measured by the Edinburgh Postnatal Depression Scale with a cut-off of 14 for prenatal depression, OR=3.3, 95% CI: 1.2-9.2, in multivariate analyses [109]. They did not find an association with anxiety.

Studies of alcohol use and preterm delivery are equivocal. Dew et al. found no association between alcohol use and preterm birth, however there was an association for women who used alcohol and tobacco, OR=1.46, 95% CI: 1.14-1.81 [116]. Lundsberg et al. reported protective effects of mild drinking on intrauterine growth restriction, but higher rates of preterm birth among women who drank during the seventh month [117]. Dole et al. found higher rates of preterm birth among women reporting more than 5 drinks per week compared to a reference group of women who consumed five or less drinks per week [8]. This fits with Goldenberg's conclusion that while heavy drinking could be associated with the risk of preterm delivery, mild or moderate alcohol use is typically not considered a strong risk factor [118]. Our study was unable to detect an association between intensity of alcohol use and preterm birth, however the majority of our population fit into low use categories.

Our measure of maternal mood is both a limitation and strength of this study. It does not fit the criteria for diagnosed clinical depression or even those of depressive symptoms, limiting comparison to other studies. Prenatal depressive symptoms may be

variable [119] and we do not know if women who experience mood variability during pregnancy retrospectively report the most positive or the most negative, or an average, of feelings when asked to recall a period that may be as long as nine months. It is also unknown as to how, or whether, lower maternal mood is related to clinical depression. While this measure does not fit clinical criteria, the prevalence of lower maternal mood in this study is only slightly higher than the estimates of major and minor depressive symptoms during pregnancy from other studies. In addition, it remained fairly stable over the study years. Our one-question measure may be useful for future surveillance efforts in that it requires little time for respondents to complete and a small amount of space within a surveillance tool, yet may be an appropriate proxy of depression in a specific population. Finally, while our measure of mood was simple, it allowed us to identify subsets of women who were at twice the risk for preterm delivery and LBW infants. Such surveillance data could assist in further identification of high-risk population subgroups, program development and update providers on trends or changes over time.

The generalizability of our findings is affected by the response rates. PRAMS is meant to be representative of resident births in Minnesota. The fairly high overall response rate provides confidence in the study results, however respondents and non-respondents differed on the outcomes of interest, as well as demographically. Our non-respondents were more likely to have adverse birth outcomes, thus we were missing some of the events of interest. A further limitation relates to biases associated with the design and retrospective nature of PRAMS. Women with adverse birth outcomes may be more likely than those with healthy birth outcomes to recall or to exaggerate prenatal risk

factors, including poor mood and substance use. The effect of such biases could exaggerate the associations between such exposures and birth outcomes. Conversely, misclassification bias could occur with respect to substance use and mental health. Underreporting of prenatal substance use has been documented [120]. The social expectation that pregnancy should be one of the happiest times of a woman's life may also influence women to answer the maternal mood question more positively. Such misclassification of predictor variables, if systematically related to the outcomes of interest, could bias our associations to the null. The PRAMS design focuses on women with a stable address and telephone number, thus there is the potential for selection bias, which can affect estimates of exposure-outcome associations. However, a recent study by Nilsen et al. found that selection bias influenced prevalence estimates of exposures and outcomes in a large pregnancy cohort as compared to all live births in Norway, but not estimates of exposure-outcome associations [121]. The fairly high response rate also minimizes the potential effects of selection bias.

Our study contributes to the literature by raising the question of how substance use and maternal mood may co-occur and influence birth outcomes. As maternal mental health continues to garner public awareness and the attention of public health professionals, it is important to devise strategies for assessing measures of maternal mood in populations. Ongoing surveillance tools are important for identifying potential trends and further identification of factors associated with lower maternal mood. The co-occurrence of substance use and lower maternal mood in our population indicate an opportunity for addressing both issues when developing interventions and screening strategies, as targeting either issue in isolation may not be as effective from a public

health perspective. The interactive relationship between tobacco use, maternal mood and LBW needs further exploration. Studies are also needed to determine how well non-clinical measures of depressive mood during pregnancy reflect true impairment. Our definition of lower maternal mood could influence treatment style and public health interventions by alerting professionals to women who may not meet a clinical diagnosis of depression during pregnancy but are still at risk for adverse birth outcomes.

	Lower Maternal Mood n=1,757	Higher Maternal Mood n=5,718	p-value
Table 3.1. Weighted Frequencies: Substance Use and Selected Demographic Variables by Maternal Mood [a], Minnesota PRAMS, 2002-2006 n=7,475			
3[rd] Trimester Tobacco Use	26.2%	11.7%	<0.0001
3[rd] Trimester Alcohol Use	7.6%	5.8%	0.029
Stressful Life Events			
None	14.4%	37.2%	<0.0001
1-2	34.8%	44.2%	
3 or More	50.8%	18.7%	
Maternal Age			
18-24 Years	32.4%	24.7%	<0.0001
25-34 Years	51.2%	59.4%	
35+ Years	16.2%	15.6%	
Marital Status: Married	55.8%	74.3%	<0.0001
Maternal Education			
Less than High School	12.1%	10.5%	<0.0001
High School	29.8%	25.9%	
Some College	28.5%	24.6%	
College or More	29.5%	38.0%	

Table 3.1. Weighted Frequencies: Substance Use and Selected Demographic Variables by Maternal Mood [a], Minnesota PRAMS, 2002-2006 n=7,475			
	Lower Maternal Mood n=1,757	Higher Maternal Mood n=5,718	p-value
Income Level (2004-2006)			
$24,999 or Less	44.1%	25.9%	<0.0001
$25,000-$49,999	23.9%	23.8%	
$50,000 or More	32.0%	50.3%	
Parity: Primiparous	35.9%	43.4%	<0.0001
Pregnancy Intention			
Intended	45.2%	71.6%	<0.0001
Unintended	18.3%	4.4%	
Mistimed	36.5%	24.0%	
History of Pregnancy Loss	26.3%	22.4%	0.006
First Trimester Prenatal Care	78.4%	82.3%	0.009
Prenatal Care as Early as Wanted	81.1%	87.6%	<0.0001
History of Partner Abuse During Pregnancy	8.3%	1.6%	<0.0001

[a] Maternal mood is a dichotomous variable created by combining response categories to the question "How would you describe the time during your pregnancy?" Women were

categorized as having lower maternal mood levels if they responded by stating it was either a "moderately hard time, a very hard time or one of the worst times of my life." Women were categorized as having higher maternal mood levels if they responded it was "one of the happiest times of my life or a happy time with few problems."

Table 3.2. Association of Maternal Mood, Tobacco Use and Low Birthweight, Minnesota PRAMS, 2002-2006 n=7,475			
	OR	**95% CI**	**p-value**
Age			
18-24 Years (ref)	1.0		
25-34 Years	1.28	0.93-1.75	0.13
35+ Years	2.06	1.38-3.08	0.0004
Education			
Less Than High School (ref)	1.0		
High School	0.76	0.53-1.09	0.14
Some College	0.49	0.33-0.73	0.0004
College or More	0.39	0.26-0.60	<0.0001
Parity [a]	0.60	0.46-0.77	<0.0001
Interaction:			
Higher Maternal Mood, Did Not Smoke (ref)	1.0		
Higher Maternal Mood, Smoked	1.92	1.30-2.84	0.001
Lower Maternal Mood, Did Not Smoke	2.16	1.60-2.92	<0.0001
Lower Maternal Mood, Smoked	2.12	1.35-3.33	0.001
Wald chi-square for interaction: 4.93, 1 d.f., p=0.03			

[a]Primiparity is referent

Table 3.3. Association of Maternal Mood, Alcohol Use and Preterm Delivery, Minnesota PRAMS, 2002-2006 n=7,475			
	OR	95% CI	p-value
Age			
18-24 Years (ref)	1.0		
25-34 Years	1.20	0.91-1.60	0.20
35+ Years	1.72	1.20-2.48	0.004
Education			
Less Than High School (ref)	1.0		
High School	0.65	0.46-0.91	0.01
Some College	0.59	0.42-0.84	0.004
College or More	0.57	0.40-0.81	0.002
Parity [a]	0.70	0.56-0.87	0.002
Interaction:			
Higher Maternal Mood, Did Not Drink Alcohol (ref)	1.0		
Higher Maternal Mood, Drank Alcohol	0.76	0.41-1.42	0.39
Lower Maternal Mood, Did Not Drink	1.95	1.54-2.45	<0.0001
Lower Maternal Mood, Drank Alcohol	0.68	0.30-1.52	0.34
Wald chi-square for interaction: 2.27, 1 d.f., p=0.13			

[a]Primiparity is referent

Chapter 4: The association of maternal mental health with prenatal smoking cessation and postpartum relapse in a population-based sample

Abstract

Objective: To examine the association between mental health factors with smoking cessation during pregnancy and postpartum relapse.

Methods: We used data from 1,416 women who participated in the Minnesota Pregnancy Risk Assessment Monitoring System (PRAMS) survey in 2004-2006 and reported smoking immediately prior to pregnancy. Maternal mood, stress and postpartum depression were the mental health variables. We used multivariate logistic regression to examine the association between these variables and two outcomes, smoking cessation during pregnancy and postpartum relapse.

Results: Stressful life events was associated with smoking cessation in multivariate regression models, however maternal mood was not. Smoking cessation was also associated with pre-conception smoking intensity, maternal education, and income. Maternal mood, stressful life events and postpartum depression were not associated with relapse in multivariate regression models. Breastfeeding at the time of the survey was the strongest correlate of relapse, with women who breast fed 60% less likely to resume smoking during the postpartum. Post-hoc analysis suggests that mental health variables may interact with other mitigating factors to influence smoking behavior during pregnancy.

Conclusions: Mental health variables may be important to successful prenatal smoking cessation. Further research with larger sample sizes is needed to explore the possibility of interactive relationships between mental health variables and other co-factors on prenatal smoking cessation and postpartum relapse.

Key Words: Pregnancy, tobacco, smoking cessation, postpartum depression

Pregnancy Risk Assessment Monitoring System (PRAMS) 2007 data show state-specific smoking rates during the three months prior to pregnancy and the third trimester ranging from 10.6-40.5% and 4.7-30.0%, respectively [122]. These rates remain far from the 2% prenatal smoking goal in Healthy People 2010 [78]. Healthy People 2020 includes two indicators that deal with reducing tobacco use during pregnancy. One relates to increasing prenatal cessation rates and the other encourages abstinence from tobacco use [123]. Tobacco use during pregnancy and the postpartum has been linked to several adverse infant health outcomes, such as low birthweight (LBW), fetal growth restriction, placenta previa, premature rupture of the membranes, preterm delivery and sudden infant death syndrome [37, 38]. Estimates attribute 20% of LBW, 8% of preterm births and 5% of all perinatal deaths to maternal tobacco use [124]. The direct medical costs of a complicated birth for a smoker are 66% higher than a complicated birth for a non-smoker, which reflect the greater severity of complications for smokers and their need for more intensive care [39].

Prenatal care may present an opportunity for smoking cessation intervention because concern about infant health may motivate some women to quit [39]. An overview of the prenatal smoking literature highlights the need for further cessation research and in particular calls attention to the research gap in relapse prevention [47]. Despite major efforts by researchers and policymakers, the majority of women who quit smoking during pregnancy will resume smoking within one year of delivery [47]. PRAMS 2004 data from 16 states reported a relapse rate of 50.3% within two to four months postpartum among women who had quit smoking during pregnancy [40].

Maternal mental health may influence prenatal smoking [41-45, 125], cessation behaviors and postpartum relapse. One study of 487 pregnant women in their second trimester found that current and former smokers were significantly more likely than never smokers to report depressive symptoms on the Center for Epidemiologic Studies (CES-D) scale [19]. Stressful life events were associated with higher rates of postpartum smoking in a study of data from 10 participating PRAMS states [126]. A clinic-based study of 87 women who had quit smoking during pregnancy found that higher levels of prenatal depression and stress were associated with postpartum smoking relapse [127]. The nature of the association between smoking and mental health is not clear, but a small study of 27 women who quit smoking during pregnancy and relapsed postpartum suggested that smoking was perceived as a way to manage emotions and stress [128].

A few studies have examined the role of postpartum depression, stressful life events and postpartum tobacco relapse. A small, clinic-based pilot of smoking cessation interventions found that women who were more likely to have clinical depression, i.e. they scored higher on a clinical depression screen, had a higher risk for relapse [129]. A recent population-based study using a subset of the national Pregnancy Risk Assessment Monitoring System (PRAMS) dataset found an association between postpartum depressive symptoms and smoking relapse [40]. A 2005 Cochrane review of smoking relapse prevention strategies, which included nine studies of pregnant or postpartum ex-smokers, did not identify a successful relapse prevention approach and noted that none of the reviewed studies addressed depression screening or treatment as part of their strategies [46]. MN PRAMS data from 2004-2006 contained several optional mental health variables that allowed us to examine the relationship between maternal mental

health, prenatal smoking cessation and postpartum relapse in a population-based sample of women who gave birth to a live infant.

Methods

Study Design

The MN PRAMS is a cross-sectional, multi-modal survey of postpartum women that measures women's experiences and behaviors during the pre-conception, pregnancy and postpartum periods. MN PRAMS is a component of the national PRAMS system, an on-going, state-based surveillance system, administered by the Minnesota Department of Health (MDH) and the Centers for Disease Control and Prevention (CDC) [102]. Data were from mothers and their infants born in 2004-2006.   The University of Minnesota, the MDH and CDC Institutional Review Boards (IRBs) approved our analyses.

Sample

MN PRAMS randomly selected approximately 200 potential participants each month from their infants' birth certificate. Women with infants who died shortly after birth were eligible and remained in the sample. MN PRAMS sampled 6,853 women during the years 2004-2006, with 4,615 respondents completing the survey. Yearly weighted response rates ranged from 76.1%-76.5%.

Data Collection

PRAMS is a cross-sectional survey comprised of a standard set of core questions about preconception, prenatal, and postpartum health that is used by every participating state. States may add optional questions that CDC developed and standardized. The MN PRAMS survey contained 78 questions, including optional questions about mental health, and was 15 pages in length. Survey responses were linked back to the birth certificate

file. MDH staff conducted the sampling and data collection, following CDC protocols [102]. The survey was sent to women 2 to 4 months after delivery, with responses usually received 3 to 6 months postpartum. Approximately 10% of the respondents did not respond to repeated mailings and completed the survey by telephone with a trained interviewer.

Measures

From the sample of 4,615 women, we identified 1,495 (32.4%) recent smokers on the basis of an affirmative response to the question, "Have you smoked more than 100 cigarettes in the past two years?" Of those women, we limited analyses to the 1,416 women who reported smoking one or more cigarettes per day in the three months prior to pregnancy. We then examined smoking status during the last trimester of pregnancy and at the time of the survey (i.e. 2 to 4 months postpartum) for these women. The survey asked the same question for the three time periods of interest (i.e., pre-conception, last trimester, and early postpartum): "How many cigarettes did you smoke on an average day?" The response categories were: "41 cigarettes or more; 21-40; 11-20; 6-10; 1-5; less than 1 cigarette; or none (0 cigarettes)." Women who reported smoking one or more cigarettes were classified as smokers for the time period. The definition of prenatal tobacco cessation was using tobacco during the immediate pre-conception period but reporting zero cigarettes during the third trimester of pregnancy. The definition of tobacco relapse was smoking cessation during pregnancy and smoking at the time of the survey. We had no biochemical validation of smoking status. We created a dichotomous variable for smoking intensity that reflected the number of cigarettes smoked/day three

months prior to conception, with values reflecting 10 or fewer cigarettes/day and 11 or more cigarettes/day [120, 126-128].

Maternal stress during the year prior to delivery was derived from a 13-item set of potential stressors, a subset of the Modified Life Events Inventory [103]. Stressors included moving, being homeless, financial problems, relationship problems and an illness or death in the family. Women received an overall stress score by summing the "yes" responses to the 13 items. Based on the distribution of responses, we classified women as having no life stressors (31.9%), 1 or 2 stressors (41.9%) or 3 or more stressors (26.2%).

We dichotomized maternal mood by combining responses to the question: "How would you describe the time during your pregnancy?" Women who responded that it was a "moderately hard time," "a very hard" or "one of the worst times of my life" were classified as having a low mood level. Women with responses of "one of the happiest times of my life" or "a happy time with few problems" were classified as having a high mood level [104].

We used a previously validated two-question screening tool to assess postpartum depressive symptoms [95-97]. We identified women as having postpartum depressive symptoms if they answered "always or often" to either of the following questions: "Since your new baby was born, how often have you felt down, depressed or hopeless?" or "Since your new baby was born, how often have you had little interest or little pleasure in doing things?"

Other covariates of interest included: still breastfeeding at time of survey (Y/N) [44, 129], maternal age at delivery (aged 18-24, 25-34, 35+ Years) [130, 131], marital

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status (yes/no) [125, 127], education level (some high school, high school, some college, college or more) [125], parity (multiparous, primiparous) [97, 126], prenatal care in the first trimester (yes/no) [126], pregnancy intention (intended=satisfied with pregnancy timing; unintended/unwanted=occurred sooner than desired or did not wish to become pregnant then or at any time), and income ($24,999 or less, $25,000-$49,999, $50,000 or more). In the relapse analyses, all of these covariates were examined, as well as whether women were breastfeeding at the time of the survey (yes/no) [44, 129].

Analysis

We used multivariate logistic regression and chi-square analyses to examine the potential correlates of prenatal smoking cessation and postpartum relapse. The final models included the mental health variables and other covariates that were statistically significant at the 0.05 level, as well as maternal age, multiparity and education, to control for potential confounding. CDC provides each state with a final data file with analysis weights. Weighting was consistent across years and allowed us to combine data for the years 2004, 2005 and 2006. We performed analyses with SAS 9.1.3 PROC SURVEYFREQ and PROC SURVEYLOGISTIC for weighted data.

Results

Non-respondents were more likely than respondents to be younger (mean age 25.5 years vs. 27.4 years), unmarried (32.8% vs. 59.2%), multiparous (65.2% vs. 59.1%) and to have attained lower education levels (33.3% vs. 58.7% with thirteen or more years of education) (p<0.0001 for each chi-square comparison). Non-respondents had higher rates of LBW births (11.1% vs. 6.1%, p<0.0001) and preterm births (12.7% vs. 8.5%, p<0.0001) than respondents.

Of the 1,416 women who reported smoking during the three months prior to pregnancy, 606 (44.6%) reported abstaining from smoking by the third trimester. Tobacco cessation rates during pregnancy differed significantly for women by level of tobacco use during the three months prior to conception, maternal mood, stress level, age, education, income, marital status and pregnancy intention (Table 4.1).

In multivariate regression, a greater number of stressful events was inversely associated with cessation, with women who reported three or more stressful events half as likely to quit smoking as compared to women who reported no stressful events in the previous year (OR=0.53, 95% CI: 0.34-0.84, p=0.007). Women with low maternal mood appeared less likely to quit smoking (OR=0.74, 95% CI: 0.51-1.07, p=0.11). Smoking cessation during pregnancy was strongly associated with pre-conception smoking intensity, with light smokers almost four times as likely to quit as moderate to heavy smokers (OR=3.89, 95%CI: 2.81-5.35, p<0.0001). Maternal education level was also strongly associated with cessation. Women who had a college degree or more were over four times as likely to quit smoking compared to women with less than a high school education (Table 4.2). Women reporting a household income of $50,000 or more were more likely to quit smoking compared to the lowest income group (OR=1.86, 95% CI: 1.20-2.88, p=0.005). Younger women were more likely to quit smoking compared to women in the older age categories. Post-hoc analysis suggests that maternal mood and smoking intensity had an interactive effect on smoking cessation in this sample. Women classified as smoking 11 or more cigarettes per day who also reported low mood were much less likely to quit smoking in multivariate models (OR=0.32, 95% CI: 0.19, 0.53,

overall test for interaction: Wald chi square=60.8, 1 d.f., p<0.0001) as compared to low intensity, high mood women.

Of the 606 women who quit smoking during the third trimester, 322 (50.6%) were current smokers at the time of the survey and were classified as relapsed. Tobacco relapse rates differed by many of the same factors as cessation rates, as well as by postpartum depression symptoms and breastfeeding, but did not differ by pre-conception smoking intensity (Table 4.3). The relapse rate of women with postpartum depressive symptoms was 65% compared to a rate of 46% among women without such symptoms (p=0.009).

Maternal mood, stressful life events and postpartum depressive symptoms were not associated with relapse in multivariate regression models (Table 4.4). Post-hoc analyses suggest that there may be an interactive effect between postpartum depressive symptoms and breastfeeding on tobacco relapse. Women who did not breastfeed and reported postpartum depressive symptoms over twice as likely to relapse compared to those who did breastfeed and did not have symptoms (Test for interaction: Wald chi-square=1.25, 1 d.f., p=0.26).

Discussion

Women who experienced more stressful life events were less likely to quit smoking during pregnancy as compared to those with none, which supports previous study data [44, 45]. Women with low maternal mood were 30% less likely to quit smoking during pregnancy compared to those with high mood levels, but this association was not statistically significant. Maternal education, pre-conception smoking intensity and maternal age were the strongest predictors of prenatal cessation in our study.

Smoking intensity and maternal mood were strongly associated in our sample. Post-hoc analyses suggest that smoking intensity and maternal mood have an interactive effect on cessation during pregnancy. Thus, the relationship between mood, smoking intensity and cessation may be more involved than previously determined.

Maternal mood and stress were not associated with relapse in our sample. Because women with higher numbers of stressful life events were less likely to quit smoking, they were less represented in the sample of women who quit and had the potential to relapse. Our association between postpartum depression symptoms and relapse was slightly higher and statistically significant when breastfeeding was not included in the model: (OR=2.06, 95% CI: 1.09, 3.92, chi-square=4.91, p=0.0268). This is consistent with another PRAMS study that found a statistically significant association between postpartum depression symptoms and relapse, (OR=1.77, 95% CI: 1.21, 2.59), but did not include breastfeeding as a covariate in the analysis [40].

Breastfeeding was the strongest correlate of relapse in our sample. Women who were breastfeeding at the time of the survey were 60% less likely to report relapse. The motivation to quit smoking during pregnancy may be largely influenced by concern for the infant [132]. Those intentions often change after delivery or when their child has been weaned from breastfeeding [132]. Post-hoc analyses did not have adequate power to detect a statistically significant interaction between breastfeeding and postpartum depressive symptoms on relapse. Yet the analyses suggest that there may be an interactive effect. It is also possible that breastfeeding is a confounder of the association between postpartum depressive symptoms and postpartum relapse, since breastfeeding and postpartum depression may be linked [104, 132-134]. A PRAMS study of 14,609

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mothers from three states for the years 1996-1999 found that maternal mood during pregnancy was a strong predictor of postpartum depression and that postpartum depression and breastfeeding were also linked [104]. The authors hypothesized that maternal mood may have influenced breastfeeding patterns, thus resulting in an association between breastfeeding and postpartum depression [104]. Further study with larger sample sizes is warranted to fully explore the relationship between postpartum depressive symptoms, breastfeeding and smoking relapse. In addition, these studies would benefit from more in-depth information as to women's reasons for stopping breastfeeding and if that decision was influenced by their mental health status.

Study Limitations

Our measures of smoking status relied on maternal self-report and did not include biochemical validation of tobacco use. Our estimates of prenatal smoking, prenatal cessation and postpartum relapse correspond to those found in other studies [37, 40, 124, 126]. In studies like ours, women who reported using tobacco during pregnancy likely did smoke. Cessation rates were likely over-reported, while relapse and intensity data were probably underreported. A study of the validity of self-report found that 21.6% of 737 pregnant women who reported that they had quit using tobacco during pregnancy had urinary cotinine levels consistent with active smoking [135]. Another study determined that 6% of women who reported being non-smokers showed evidence of tobacco use measured via cotinine levels [120].

Our measure of maternal mood is not a standard question, which makes comparison with other studies difficult. Another PRAMS study, which used the same question about maternal mood, found a 25% prevalence of low maternal mood, similar to

our finding of 23.4% [104]. One review estimated that 18.4% of pregnant women experienced depression sometime during pregnancy [9]. We believe that the mood question reflects some sort of psychological distress, but cannot assume that it is a marker for depressive symptoms.

Another potential limitation relates to the differences between respondents and non-respondents. The 76% response rate was good, but respondents and non-respondents differed demographically and by rates of preterm and LBW, which could mean they may have differed in smoking status. Women who were included in the relapse analysis represent smokers who were able to quit smoking during pregnancy. Thus, they may have differed from smokers who continued to smoke during pregnancy on mental health measures, which could affect the association between mental health and smoking behavior. It is also possible that the association itself between mental health and smoking may have differed between the groups of women who were able to quit smoking and those who continued to smoke during pregnancy.

Conclusion

Prenatal tobacco use is associated with adverse maternal and infant health outcomes [37, 124], which makes pregnancy-related tobacco cessation a public health priority [78]. Cessation rates in our population were 45% and relapse rates were 51%, similar to those found in other studies, and in 18 other states who conduct PRAMS [38, 124]. So while pregnancy may provide an increased opportunity for smoking intervention, sustained cessation rates remain low among pregnant women [47]. Questions remain about the role of mental health and patterns of prenatal smoking behavior, particularly in the context of other covariates that may modify those

associations. Our data suggest that the relationship between mental health variables and tobacco use patterns may be influenced by these other factors. This could have implications for intervention, for example, cessation efforts may want to address mood in addition to sending a message of decreasing intensity. This study relied on retrospective, cross-sectional data that do not allow for conclusions related to temporality or causality. Studies are needed that can both examine these variables and their potentially complex relationships, as well as establish temporality. Our study suggests that PRAMS provides reasonable measures of maternal mood and postpartum depression for population-based surveillance, as well as for more in-depth studies of their associations with other variables of interest.

	Quit Smoking During Pregnancy n=606	Did Not Quit Smoking During Pregnancy n=810	p-value
Age			
18-24 Years	42.4%	46.4%	0.06
25-34 Years	51.3%	44.1%	
35+ Years	6.3%	9.5%	
Education			
Less than High School	10.8%	19.2%	<0.0001
High School	36.9%	46.4%	
Some College	29.5%	28.4%	
College or More	32.8%	6.0%	
Income			
$24,999 or Less	38.9%	58.5%	<0.0001
$25,000-$49,999	26.1%	24.5%	
$50,000 or More	45.0%	17.0%	

Table 4.1. Correlates of Smoking Cessation Among Pregnant Women (n=1,416) Minnesota PRAMS 2004-2006

	Quit Smoking During Pregnancy n=606	Did Not Quit Smoking During Pregnancy n=810	p-value
Table 4.1. Correlates of Smoking Cessation Among Pregnant Women (n=1,416) Minnesota PRAMS 2004-2006			
Marital Status			
Married	50.4%	34.8%	<0.0001
Unmarried	49.6%	65.2%	
Pre-Conception Smoking Intensity (Cigarettes/Day)			
10 or Fewer	72.4%	61.9%	<0.0001
11 or More	27.6%	38.1%	
Pregnancy Intention			
Intended	53.6%	42.6%	0.002
Unintended	46.4%	57.4%	
Parity			
Primiparous	53.9%	43.9%	0.004
Multiparous	46.1%	56.1%	

	Quit Smoking During Pregnancy n=606	Did Not Quit Smoking During Pregnancy n=810	p-value
Table 4.1. Correlates of Smoking Cessation Among Pregnant Women (n=1,416) Minnesota PRAMS 2004-2006			
First Trimester Prenatal Care			
Yes	79.7%	72.6%	0.09
No	20.3%	27.4%	
Maternal Mood During Pregnancy [a]			
Low	35.8%	60.4%	<0.0001
High	74.2%	39.6%	
Stressful Life Events One Year Prior to Delivery			
None	22.9%	12.6%	<0.0001
1-2	42.9%	36.8%	
3 or More	44.2%	50.6%	

[a] Maternal mood is a dichotomous variable created by combining response categories to

the question "How would you describe the time during your pregnancy?" Women were

categorized as having low mood levels if they responded by stating it was either a

"moderately hard time, a very hard time or one of the worst times of my life."   Women

were categorized as having high mood levels if they responded it was "one of the

happiest times of my life or a happy time with few problems."

Table 4.2. Multivariate Logistic Regression: Correlates of Prenatal Tobacco Cessation [a], Minnesota PRAMS 2004-2006 n=1,416			
	AOR*	**95% CI**	**p-value**
Age			
18-24 Years (ref)	1.0		
25-34 Years	0.70	0.48-1.02	0.06
35+ Years	0.42	0.21-0.82	0.01
Education			
Less Than High School (ref)	1.0		
High School	1.45	0.89-2.37	0.14
Some College	1.75	1.02-3.02	0.04
College or More	4.64	2.36-9.12	<0.0001
Income Level			
$24,999 or Less (ref)	1.0		
$25,000-$49,999	1.28	0.85-1.93	0.24
$50,000 or More	1.86	1.20-2.88	0.005
Smoking Intensity Before Pregnancy [b]	3.89	2.82-5.35	<0.0001
Multiparous	0.71	0.51-0.97	0.03
Maternal Mood [c]	0.74	0.51-1.07	0.11

Table 4.2. Multivariate Logistic Regression: Correlates of Prenatal Tobacco Cessation [a], Minnesota PRAMS 2004-2006 n=1,416			
	AOR*	95% CI	p-value
Stressful Life Events One Year Prior to Delivery			
None (ref)	1.0		
1-2	0.69	0.46-1.06	0.09
3 or more	0.53	0.34-0.84	0.007

[a] Defined as cessation among respondents who smoked during the three months before pregnancy but did not during the last trimester.

[b] Number of cigarettes/day in the 3 months prior to pregnancy dichotomized into a high category of 11 or more cigarettes per day and a low category of 10 or less cigarettes per day.

[c] Maternal mood is a dichotomous variable created by combining response categories to the question "How would you describe the time during your pregnancy?" Women were categorized as having low mood levels if they responded by stating it was either a "moderately hard time, a very hard time or one of the worst times of my life." Women were categorized as having high mood levels if they responded it was "one of the happiest times of my life or a happy time with few problems."

*AOR=Adjusted odds ratio

	Remained Smoke-Free After Pregnancy n=284	Resumed Smoking After Pregnancy (Relapsed) n=322	p-value
Age			
18-24 Years	35.9%	50.1%	0.02
25-34 Years	56.9%	43.4%	
35+ Years	7.2%	6.5%	
Education			
Less than High School	7.9%	12.6%	0.006
High School	31.2%	44.6%	
Some College	33.8%	23.7%	
College or More	27.1%	19.1%	
Income			
$24,999 or Less	29.3%	47.0%	0.0006
$25,000-$49,999	27.9%	26.6%	
$50,000 or More	42.8%	26.4%	
Marital Status			
Married	57.5%	42.8%	0.003
Unmarried	42.5%	57.2%	

Table 4.3. Correlates of Smoking Relapse in Women Who Quit Smoking During Pregnancy (n=606) Minnesota PRAMS 2004-2006

Table 4.3. Correlates of Smoking Relapse in Women Who Quit Smoking During Pregnancy (n=606) Minnesota PRAMS 2004-2006			
	Remained Smoke-Free After Pregnancy n=284	Resumed Smoking After Pregnancy (Relapsed) n=322	p-value
Pre-Conception Smoking Intensity (Cigarettes/Day)			
10 or Fewer	25.7%	29.4%	0.43
11 or More	74.3%	70.6%	
Pregnancy Intention			
Intended	55.3%	47.5%	0.009
Unintended	44.7%	52.5%	
Parity			
Primiparous	62.5%	45.6%	0.001
Multiparous	37.5%	54.4%	
First Trimester Prenatal Care			
Yes	83.8%	75.7%	0.009
No	16.2%	24.3%	

Table 4.3. Correlates of Smoking Relapse in Women Who Quit Smoking During Pregnancy (n=606) Minnesota PRAMS 2004-2006			
	Remained Smoke-Free After Pregnancy n=284	**Resumed Smoking After Pregnancy (Relapsed) n=322**	**p-value**
Still Breastfeeding at Survey			
Breastfeeding	59.9%	33.9%	<0.0001
Not Breastfeeding	40.1%	66.1%	
Maternal Mood [a]			
Low	22.0%	30.7%	0.05
High	78.0%	69.3%	
Stressful Life Events One Year Prior to Delivery			
None	29.2%	17.9%	0.02
1-2	41.1%	43.6%	
3 or More	29.7%	38.5%	
Postpartum Depressive Symptoms[b]			
Symptoms	9.9%	19.1%	0.009
No Symptoms	90.1%	80.9%	

[a] Maternal mood is a dichotomous variable created by combining response categories to the question "How would you describe the time during your pregnancy?" Women were categorized as having low mood levels if they responded by stating it was either a "moderately hard time, a very hard time or one of the worst times of my life." Women were categorized as having high mood levels if they responded it was "one of the happiest times of my life or a happy time with few problems."

[b] Women were identified as having postpartum depressive symptoms if they answered "always or often" to either of the following questions: "Since your new baby was born, how often have you felt down, depressed or hopeless?" or "Since your new baby was born, how often have you had little interest or little pleasure in doing things?"

Table 4.4 Multivariate Logistic Regression: Correlates of Postpartum Smoking Relapse [a] Minnesota PRAMS 2004-2006 n=606			
	AOR*	**95% CI**	**p-value**
Low Maternal Mood [b]	1.32	0.75-2.41	0.33
Stressful Life Events One Year Prior to Delivery			
None (ref)	1.0		
1-2	1.25	0.62-2.56	0.53
3 or More	1.03	0.47-2.25	0.95
Postpartum Depressive Symptoms[c]	1.71	0.82-3.57	0.15
Breastfeeding at Time of Survey	0.38	0.23-0.63	0.0002
Income Level			
$24,999 or Less (ref)	1.0		
$25,000-$49,999	0.76	0.39-1.48	0.42
$50,000 or More	0.53	0.25-1.12	0.09
Multiparous	2.03	1.20-3.44	0.008

[a] Defined as women who were smokers prior to pregnancy, who quit smoking during the third trimester and were current smokers at the time of the survey (postpartum).

** AOR = adjusted odds ratio; adjusted for every variable in the table, as well as maternal age and maternal education.

^b Maternal mood is a dichotomous variable created by combining response categories to the question "How would you describe the time during your pregnancy?" Women were categorized as having low mood levels if they responded by stating it was either a "moderately hard time, a very hard time or one of the worst times of my life." Women were categorized as having high mood levels if they responded it was "one of the happiest times of my life or a happy time with few problems."

^c Women were identified as having postpartum depressive symptoms if they answered "always or often" to either of the following questions: "Since your new baby was born, how often have you felt down, depressed or hopeless?" or "Since your new baby was born, how often have you had little interest or little pleasure in doing things?"

Chapter 5: Factors related to prenatal methamphetamine use:

Mental health, self-esteem and accomplishing women's work

Publication Status: Submitted

Gyllstrom ME, Hellerstedt WL

A portion of these analyses were presented at the

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Abstract

Aims: To describe maternal methamphetamine use, with an emphasis on its co-occurrence with mental health conditions.

Design/Setting: Structured qualitative interviews in outpatient drug treatment centers in Minnesota.

Participants: Fifteen pregnant women from outpatient drug treatment programs who reported pre-conception or prenatal methamphetamine use.

Measurements: Participants completed written questionnaires and in-person or telephone structured interviews.

Findings: The majority of women reported family histories of mental health and drug use problems, as well as personal mental health conditions that may have preceded their drug use. Participants noted methamphetamine increased self-esteem and helped them accomplish physical and domestic tasks. Emotional instability and lack of knowledge about the implications of methamphetamine use may have contributed to participant vulnerability to friends and family members who first offered them methamphetamine. Although our participants were in recovery and described methamphetamine's negative effects, many still voiced their attraction to methamphetamine and their fear that they would use again.

Conclusions: Successful interventions should focus on feasible alternative methods for women to experience the benefits of methamphetamine use, including weight loss/maintenance, energy for domestic tasks, and improved self-esteem.

Key Words: Methamphetamine, mental health, pregnancy

Introduction

Illicit drug use rates are two to three times higher for men than women [136], except for methamphetamine, for which there are no sex differences in reported prevalence [137]. Prenatal methamphetamine use is of interest because methamphetamine is highly addictive and harmful to women and their offspring [48, 138, 139]. Correlates of methamphetamine use are poorly understood because some providers do not always effectively screen for illicit drug use and women may be reluctant to admit their drug use during pregnancy [138]. The co-occurrence of mental health problems with methamphetamine use is unstudied, although studies of other illicit drugs show strong correlations [57-59]. Data are also lacking about the social environments that may encourage use, women's knowledge about the drug, and rationalizations for starting or maintaining methamphetamine use.

Methamphetamine is one of the most difficult substance abuse issues to treat, due to its protracted physiological and psychological problems on neural pathways [53]. In addition to its health effects on the user, it also affects fetal growth and viability through its vasoconstrictive effects and its association with maternal anorexia [51]. A case-control study found higher rates of prematurity, intrauterine growth restriction and perinatal complications among infants born to women who used cocaine, methamphetamine or both during pregnancy compared to a drug-free, but high-risk, control group [140]. Another study compared children exposed to methamphetamine *in utero* to those who were not [141]. Children with methamphetamine exposure showed differences in brain structure that correlated with poorer attention and delayed verbal memory [141]. DeRauf et al. suggest that the psychosocial risks of female

methamphetamine users (e.g. poor quality of life, legal difficulties), may result in maladaptive parenting and caregiving, which could influence outcomes in their children [138].

There are few studies about the characteristics of methamphetamine-using pregnant women. Five percent of the women in the IDEAL Study reported prenatal methamphetamine use [55]. These women were more likely to be single, less educated, receive less prenatal care and use public assistance as compared to pregnant women in the 1992-1993 National Pregnancy and Health Survey [55].

Some researchers have hypothesized that illicit drug use may be self-medication for depression or depressive symptoms [50, 51], especially given the high co-occurrence of substance use and mental health issues [142, 143]. In addition to our poor understanding of why women sustain use, beyond physical addiction, it is not clear whether mental health problems contribute to the initiation of methamphetamine use among women of reproductive age. We developed a study to examine patterns of use, pregnancy experiences and psychosocial factors in pregnant women who have used methamphetamine immediately prior to conception or during pregnancy. We specifically explored the mental health status of women both at the time they initiated methamphetamine use and at the time of the survey.

Methods

Study Design

This study was developed through discussions with providers and public health professionals who were concerned about prenatal methamphetamine use in Minnesota. These professionals approached University researchers to design and conduct the study.

Participants completed a self-administered, written questionnaire and an interview, either by telephone or in-person. This study has Institutional Review Board (IRB) approval from the University of Minnesota. Women provided informed consent prior to completing the written questionnaire and again before participating in the interview.

Sample

Participants were recruited from four outpatient drug treatment programs. Study personnel provided treatment sites with fliers describing the study, after which interested women contacted study staff or representatives at the treatment sites to coordinate study participation. All study participants were known by drug treatment staff to have used methamphetamine. Women were eligible if they were currently pregnant and planned to carry their baby to term; were aged eighteen years or older; and used methamphetamine either during the current pregnancy or within the three months prior to conception. Recruitment began in December 2006 and finished in December 2008, with 15 out of 18 potential participants completing both the written questionnaire and interview. Two of the 18 women were determined to be ineligible after they completed the written questionnaire because they had not used methamphetamine during the specified time frame. One woman delivered her infant before she could be contacted for the interview. We concluded recruitment when information became repetitive and reached saturation.

Data Collection

Participants completed self-administered written questionnaires in 20-30 minutes. The authors conducted interviews, either in-person or by telephone. Interview length averaged 25 minutes and followed a structured format. All interviews were audio-taped

and transcribed verbatim by the interviewer. Women received a $40 store gift card for participation.

MEASURES

The self-administered questionnaire and structured interview were developed in collaboration with an advisory committee comprised of representatives from the University of Minnesota, Childrens' Hospitals and Clinics, Hennepin County Medical Center and the Minnesota Department of Health (MDH). The instruments were pilot-tested with six women at one of the study sites in December 2006. These women met all of the eligibility criteria to be in the study except that they had recently delivered their infants.

The self-administered written questionnaire contained sociodemographic information as well as measures of depression. It incorporated portions of other standardized surveys and screening tools, including: the Project IDEAL study [55], the Center for Epidemiologic Studies Depression Screen (CES-D) [19] and the Minnesota Pregnancy Risk Assessment Monitoring System (PRAMS) [102].

The depression measure was derived from the embedded CES-D [19]. We identified women as being depressed at the time of the survey if they had a CES-D score >=16. The questionnaire also asked about participant history of treatment for psychological conditions, family history of psychological problems and physical or emotional abuse by a partner. Sources of stress were assessed by asking participants to respond with "not at all," "a little," "somewhat" or "very much of the time" to a list of possible stressors. These included financial stress, unemployment, relationship problems, feeling depressed or hopeless, pregnancy-related worries, lacking transportation, drug

cravings, grief or loss, job stress, and difficult living situations. Women who reported a stressor as either "somewhat" or "very much of the time" were identified as being stressed about that issue.

A measure of social support asked women to report how frequently they had different kinds of support available, with responses ranging from "none of the time," "a little of the time," "sometimes," "most of the time" or "all of the time." Sources of support included having someone to confide in/talk to about problems; someone to get together with for relaxation; someone to help with daily chores if the participants became sick; someone to turn to for suggestions about how to handle a personal problem; and someone to love and make the participant feel wanted.

We asked several questions about methamphetamine use and mental health. One question asked "In what situations did you use meth?" Responses included: "when I wanted to feel confident or good about myself," "because I liked feeling numb," "when I felt depressed, "when I wanted to feel in control," "when I felt sad or lonely," "when I felt stressed or anxious," "when I needed energy to do things, like housework, errands, etc," "when I wanted to forget my problems," and "when wanted to lose weight or control my weight." A second question asked "Thinking about your meth use in general, were any of the following true for you during the last year you used meth?" Responses included: "feeling more in control because of my meth use," "feeling I could connect with people better because of meth" and "needing to use meth every day to function."

Several questions were specific to patterns of methamphetamine use and the situations in which participants used methamphetamine. Other drug and alcohol use was assessed by trimester. Binge drinking was defined as drinking four or more drinks at one

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time. The final question of the survey asked participants: "how honest were you when answering these questions?" Responses included: "I answered all or almost all of the questions honestly," "I answered most of the questions honestly," and "I answered less than half the questions honestly."

Descriptive variables of interest included: maternal age, race/ethnicity, marital status, health insurance status, household income, education level, employment status, number of dependent children at home, living situation, pregnancy intent, pregnancy history, trimester of prenatal care initiation, and gestation at time of survey.

The interview focused on methamphetamine use patterns and experiences; mental health history; pregnancy-related experiences; and perceptions about health and potential risks associated with methamphetamine use. Participants were asked a series of open-ended questions that related to their first experiences using methamphetamine and the people with whom they used it.   Other questions focused on their typical patterns of use once they were established users as well as their perceived benefits of use. Further questions asked about negative experiences participants had related to their methamphetamine use and participants' attempts at quitting use. The interview ended with the question "what is your greatest fear about your meth use?"

Analysis

For the qualitative data analysis, both authors read and reviewed the interviews and created a master document with the transcript text. We coded responses to identify recurring phrases and themes using the methods outlined by Hahn and Neale [98, 107]. Microsoft Word was used to organize and highlight phrases that were identified as Level 1, Level 2, Level 3 and Level 4 codes [107].   Level 4 codes were further categorized to

represent major themes. Both authors agreed upon the major themes that were identified. The authors then returned to the original data to select quotes that supported the identified common themes.

Results

Participant Characteristics

Participants ranged in age from 18-32 years, with a mean age of 25.4 years (Table 5.1). Thirteen participants reported their race as white, while the others reported themselves as Asian or American Indian. Seven participants had less than a high school education, six reported being high school graduates or having a GED and two had some college. Only one respondent reported being currently employed at the time of the interview and the majority of respondents reported household incomes less than $24,999 per year. Nine respondents reported moving in the past two years, and of those, 7 moved two or more times. All respondents reported they answered all or most of the questions honestly.

There was a high level of other drug and alcohol use in this sample, particularly during the first trimester (Table 5.2). Ten of the women reported drinking alcohol during the first trimester, 8 of whom reported binge drinking. The majority of participants smoked cigarettes throughout their pregnancy.

Ten of the women reported their pregnancies were either unwanted or mistimed (Table 5.3). Twelve of the women had been pregnant previously. Five of the women reported taking prescription medication for depression and four for anxiety during their current pregnancy. Eleven women first used methamphetamine when they were aged 18

years or younger. While all women reported using methamphetamine with friends, family members were also using with them.

Mental Health

Eight of the women scored 16 or more on the CES-D depression scale, which indicates they may have been clinically depressed at the time of the survey (Table 5.4). Fourteen participants reported ever having been in drug treatment and 12 reported receiving help for psychological or emotional problems. In addition, 11 participants stated that a close relative had been treated for psychological or emotional problems. Eleven participants stated they experienced emotional abuse and seven reported physical abuse by their current husband or partner. Our respondents reported fairly high levels of stress. Fourteen reported financial stress, 10 reported pregnancy-related worries, 11 said they were stressed about depression or feeling hopeless, and 10 reported stress related to finding a place to live.

The majority of participants indicated they used methamphetamine because they wanted to feel better about themselves, liked feeling numb, felt depressed, to help unwind or relax, to feel in control, felt sad or lonely or felt stressed or anxious. All participants stated they used methamphetamine when they wanted to forget about their problems. Thirteen participants reported needing to use methamphetamine every day to function.

Information from Interviews

Depression, anxiety and low self-esteem were frequently mentioned in the context of participants' methamphetamine use. Many of the participants had a history of psychological problems. One participant commented that methamphetamine allowed her to hide from her emotional problems, instead of working on them. Others stated:

"When I was using, when I was high, I felt good about myself. But when I came down, I would feel like I hated myself and my depression, my bipolar would kick in."

" Going through depression like I have been for the past 12 years… [methamphetamine] helps me get out of bed when I don't feel like getting out of bed with the depression."

Thirteen participants attributed their use to when they felt stressed or anxious. One participant described the stress she was feeling in her life as a major contributor to her starting to use drugs:

"I felt really low about myself. That's why I started using drugs. I had a lot of family problems. Boyfriend and girlfriend problems. I was in an abusive relationship."

Participants described a feeling of numbness, which allowed them to avoid dealing with the pressures in their lives.   It was not always clear, from participant comments, whether mental health issues were present before the drug use or if they resulted from it.

Familial and Social Cultures of Substance Use and Psychological Problems

Six of the women reported using methamphetamine for the first time with family members, including siblings, parents or cousins:

"My mom was an addict and she used meth the whole time. I would see how she would act and how she was happy and stuff… I used it."

"You know, [my family], who have [sic] been on crank, and coke and heroin, and everything. It wasn't a big deal in my family."

The familial and social context of drug use appeared to contribute to women's ability to access methamphetamine. Most of the women indicated that the first time they used methamphetamine they obtained it either from friends or family members. In addition, a drug-selling culture existed within some of the families:

"The first three times [participant used meth] literally, I was driving a family member around while he was doing his rounds. I had no interest in meth but I had to stay up while I was running him around because I was the designated sober driver."

Many participants reported a history of mental health problems in their families. Twelve participants reported having been treated for psychological or emotional problems and 11 reported that a close relative had undergone psychological or emotional treatment. Participants' responses to a question about whether they had good role models for motherhood may also reflect their familial history of drug use and mental health conditions. It was more common for them to cite drug counselors or grandparents as their role models, as opposed to their own mothers. One woman was so appreciative of her drug counselor that she named her daughter after her. Many participants stated that

their own mothers were more likely to demonstrate what not to do in a parental role, some of which was attributed to their mothers' poor mental health and substance abuse.

Lack of Knowledge About Methamphetamine and its Addictive Properties

Many participants stated they had little or no knowledge about methamphetamine before using it and in particular did not realize it was highly addictive. In response to the question "Did you think [methamphetamine] was addictive or that it could become a big part of your life?" one participant stated:

"… no, actually, I've always known the addiction problem with cocaine but I never figured that it would ever be more powerful, I mean so much more powerful than cocaine…when I did get addicted to it…it totally caught me off-guard. I was kind of warned that it'll grab you. I've had an addiction to cocaine and I was able to break it. I [thought I] won't have a problem with this. Wrong."

Methamphetamine for Women's Work, Energy, Invincibility and Weight Control

Participants described their ability to clean their homes and get many things accomplished during the long hours they were high on methamphetamine:

"Basically, because when I got married I had a lot of new responsibilities. A house, being a wife, plus my job, required between 50-64 hours a week. I started getting tired. One of my cousins introduced me to meth and I stayed awake and was able to get more done. That's one of the reasons I feel like I believe why I got addicted to it in the first place."

"I started learning to being able to control myself where it would be cooking, cleaning, taking care of the kids during the day."

Participants reported an ability to focus for long periods of time, which they attributed to the properties of methamphetamine:

"I could pay attention to something and I could actually start, you know, a project…I found new hobbies while I was on it that I still enjoy doing now."

Participants described feelings of invincibility. Methamphetamine appeared to convey a sense of self-confidence and social ease that these participants claimed to lack while sober:

"I just started seeing myself as more beautiful. I started seeing myself as better, a better person, if you can understand that. I don't know why, but… I felt kind-of invincible. I would talk amongst people I normally wouldn't talk with or would shy away from before."

"My confidence sky-rocketed. It went through the roof. I just looked at myself different when I was high. When I started using and started coming down, that was way different. I viewed myself as evil and icky and ugly and fat and overweight and a loser, and….I guess that should have kept me from using anymore, but it didn't. I wanted that [good] feeling back again."

"It gave me energy and made me feel good… I could clean, I thought I could do anything."

Participants frequently mentioned the weight control benefits of using methamphetamine. One participant described having had a weight issue throughout her life and that methamphetamine made her feel better. Other participants stated:

"…[I] lost weight…I guess when I stayed up on it I'd get a lot of things done."

"I just heard it makes you lose weight. It makes you not eat, it makes you lose weight..."

One participant described the weight gain associated with methamphetamine rehabilitation:

"A lot of women use meth to lose weight, but you can never quit, because when you quit you will gain back twice as much as you lost."

Repercussions of Methamphetamine Use

Participants listed many adverse results of their methamphetamine use, including losing their jobs, dropping out of school, losing their homes, alienation from family and friends, and losing custody of their children, as well as interactions with law enforcement. In addition, there were psychological sequelae, such as paranoia:

"I get really bad anxiety so like physically I'd get pseudo-seizures, they're called. And be shaking a lot. I almost got arrested. People came after me, tried to kill me, me and my boyfriend [she thought] …I'd get really paranoid."

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"The paranoia was bad, really bad. It was, you know, it'd start out where oh no, I [would] think somebody would know I was high and then it would go to I'm hiding in the trees waiting for someone to come. They were almost like hallucinations."

The final content question of the interview asked participants to describe their greatest fear related to their methamphetamine use. Every participant expressed apprehension that they would relapse and resume using methamphetamine in the future.

"I've got seven and half months clean right now, but sometimes it still feels like the first twenty-four hours."

Discussion

A major theme from our interviews was the tremendous pressure many of our participants felt before they began using methamphetamine. Some were in abusive relationships, many mentioned the pressures of maintaining a home and getting things accomplished, and others struggled with their weight. Many of our participants reported low self-esteem and persistent mental health conditions, such as depression and anxiety. A reported lack of knowledge about the dangers of methamphetamine use and its highly addictive properties seemed to contribute to initiation of methamphetamine use. Initially, many of our participants reported that methamphetamine was readily available and often given to them at no monetary cost. The majority of our participants reported social environments that included familial drug use, as well as a culture of friends who readily used many drugs, not just methamphetamine.

Women, and specifically pregnant women, may have unique experiences and challenges with respect to drug use and treatment. Women may be more susceptible than men to substance-related interpersonal difficulties, trauma and medical consequences [145]. Despite this, women remain underrepresented in traditional drug treatment settings and often an obstetrician/gynecologist is the only point of medical contact for women [145]. Women may face unique challenges in accessing drug treatment, such as unmet childcare needs or fear of losing child custody [144, 145]. Eight of the women in this study accessed prenatal care in the first trimester and only five of the fifteen women reported that they wanted to be pregnant at the time of conception. It may be important to consider gender- and pregnancy-specific factors that influence women's drug use and their course of treatment when designing interventions.

The high prevalence of mental health conditions in our participants raises the issue of whether they were self-medicating with methamphetamine or whether mental health issues followed the drug use. Some participants reported feelings of depression and anxiety prior to their use and many also scored fairly high on the embedded CES-D, indicating they may have been depressed at the time of the survey while in recovery. A social context of familial mental health issues and drug abuse was common for our participants. Studies of other drugs and mental health have demonstrated similar findings, particularly among adolescents who developed substance abuse problems [146-148]. Studies that seek to establish a temporal relationship between mental health problems and drug use are important.

Our finding that methamphetamine use is linked to weight control is not novel in the literature about women and substance use. The literature about nicotine use for

weight control is particularly well-developed [149-152]. The weight control aspect of methamphetamine use is important to intervention efforts, particularly for young women who may be influenced by social messages about ideal weight and body image.

No other studies were found that discussed the role of methamphetamine, or other drugs, in allowing women to accomplish tasks or to maintain their homes. There is a strong body of research on "women's work" and the health effects related to women managing multiple paid and unpaid work responsibilities [153-157]. The research findings are mixed about whether women thrive because they work in different environments or whether juggling paid work, unpaid work and family responsibilities contributes to stress or adverse health effects [153-157]. As women have moved into the workplace, it appears that women's total workloads are greater and more widely varied than those of men [158]. There is evidence that women invest much more time into household and family tasks than men [158]. Killien et al. found that the transition to parenthood resulted in women reporting more negative experiences with respect to the interplay between work and family [159]. Seven of our participants already had children prior to this pregnancy, which may have contributed to pressures. Not surprisingly, women reported that work and family demands used all of their limited time and energy, leaving little time for exercise or recreational activities [159]. It may be that the properties of methamphetamine conducive to promoting high energy and the ability to remain awake for long periods of time fit the needs of young women and provide them with increased functionality, at least for a time.

All of our participants provided us with information on the negative impact methamphetamine use made on their lives. In addition to job loss, family erosion, legal

difficulties and mental health problems, it was apparent during the interview process that many of these women had long-term memory and cognitive issues, possibly influenced by their methamphetamine use. Even though our participants were in recovery and could describe methamphetamine's negative effects, many still voiced their desire to use methamphetamine and their fear that they would use again. While not uncommon sentiments among drug users, this suggests that the benefits of methamphetamine use remain clear, even after the toils of addiction are experienced and an attempt at recovery is made. Successful interventions may need to focus on feasible alternative methods for women to experience the benefits of methamphetamine use, including weight loss/maintenance, energy for domestic tasks, and self-esteem.

Our study aimed to give a voice to women who had used methamphetamine immediately prior to, or during, their pregnancies. The nature of the study brought inherent limitations. Recruitment proved difficult in this population. Potential participants would express an interest in doing the study and then not show up to take the survey. This may reflect challenges they faced in securing childcare for older children, transportation issues or ambiguous feelings about participation.

Our participants appeared to be forthcoming in their responses and all participants reported they had answered all or almost all of the quantitative questions honestly. It was evident during the interview process that some participants had cognitive deficits, possibly linked to methamphetamine use, which impaired their ability to recall past experiences and respond to some of the questions. It is unclear whether we would have been able to elicit further details or information had our participants been able to think more clearly during the interview. This sample comprised women who had committed to

continuing their pregnancies, although nine participants indicated they had considered abortion to terminate the study pregnancy. Women who used methamphetamine but continue their pregnancies may differ from those who terminate them.

Another limitation was that we were only able to identify women who had been identified as methamphetamine users through a formal system, which in this case resulted in low-income women enrolled in publicly funded treatment centers. Previous data suggests that methamphetamine use crosses sociodemographic boundaries [137]. Thus, these results may differ significantly for women with different sociodemographic backgrounds who use methamphetamine during pregnancy. Future studies need to recruit a more diverse population, in particular, women who may go undetected by health care providers and the legal system or who may not be interested in quitting. In addition, these studies should delve more deeply into the motivations women have for using methamphetamine and the needs that this drug meets, if only initially. This future work is imperative for building a body of research that can be used to formulate effective intervention strategies. Finally, research into the temporality of mental health problems and substance use is needed. Do mental health problems exist before initiation of methamphetamine use? Does methamphetamine use trigger and/or exacerbate mental health problems? Is the relationship multi-directional? Future work should aim to clarify the relationship between maternal mental health and methamphetamine use.

Table 5.1. Maternal Characteristics of Women Who Used Methamphetamine 3 Months Prior to Pregnancy or During Pregnancy, n=15	
Characteristic	**#**
Maternal Age (mean)	25.4 years
Maternal Age	
18-24 Years	6
25-29 Years	6
30-35 Years	3
Race: White	13
Have Health Insurance During this Pregnancy	11
Maternal Education Level	
Less than high school	7
High School Degree or GED	6
Some College	2
Number of Dependent Children at Home	
None	6
1-2	4
3 or More	4
Low Household Income: Less than $24,999	13
Married, Engaged or Living with Father during Pregnancy	10

Table 5.1. Maternal Characteristics of Women Who Used Methamphetamine 3 Months Prior to Pregnancy or During Pregnancy, n=15	
Characteristic	#
Living Arrangements (Check all that Apply)	
With Family	7
Infant's Father	6
Friends	1
Residential Program	4
No Stable Home	2
Mobility in Past Two Years	
Moved Once	2
Moved Two or More Times	7
Didn't Move	6
Currently on Probation or Parole	6
Receive Monetary Support from Father	6
Employed at Time of Survey	1

Table 5.2. Other Substance Use and Patterns of Methamphetamine Use Among Women Who Used Methamphetamine 3 Months Prior to Pregnancy or During Pregnancy, n=15	
Characteristic	**#**
Tobacco Use	
Smoked During 1st Trimester	14
Smoked During 2nd Trimester	14
Smoked During 3rd Trimester[a]	9
Any Alcohol Use	
Drank Alcohol in 1st Trimester	10
Drank Alcohol in 2nd Trimester	2
Drank Alcohol in 3rd Trimester[a]	0
Binge Drinking[b]	
1st Trimester	8
2nd Trimester	1
3rd Trimester	0
Marijuana Use	
1st Trimester	7
2nd Trimester	2
3rd Trimester[a]	0

Table 5.2. Other Substance Use and Patterns of Methamphetamine Use Among Women Who Used Methamphetamine 3 Months Prior to Pregnancy or During Pregnancy, n=15	
Characteristic	**#**
Age When First Used Methamphetamine	
12-15 Years	5
17-18 Years	6
20-22 Years	4
Methamphetamine User Situations (All that Apply)	
Friends	15
Mom	5
Dad	4
Other Family Member (sibling, grandparent)	6
Husband/Spouse	11
Strangers	8
People Only Used Meth With	9
Co-Workers	5
Tried to Quit Using Prior to Study Pregnancy	8
# Quit Attempts During Study Pregnancy	
1 Time	9
2 Times	1
3 or More Times	2

[a] Six women had not reached their 3rd trimester at the time of the survey.

[b] Binge drinking was defined as four or more drinks at one time.

Table 5.3. Pregnancy Characteristics of Women Who Used

Methamphetamine 3 Months Prior to Pregnancy or During Pregnancy, n=15

Characteristic	#
Maternal Pregnancy Intent[a]	
Intended	5
Mistimed	5
Unwanted	5
Pregnancy History	
Ever Pregnant	12
Had Live Birth	7
Had Miscarriage	6
Had Abortion	7
Initiation of Prenatal Care	
1st Trimester	8
2nd Trimester	7
Gestational Week at Time of Survey	
19-26 Weeks	5
27-38 Weeks	10

[a] Pregnancy intent was measured by the question: "Thinking back to just before you got

pregnant, how did you feel about becoming pregnant?" Women who responded "I

wanted to be pregnant sooner" or "I wanted to be pregnant then" were defined as having

an intended pregnancy. Women who responded "I wanted to be pregnant later" were

defined as having a mistimed pregnancy. Women who responded "I didn't want to be

pregnant then or at anytime in the future" were defined as having an unintended

pregnancy.

Table 5.4. Factors Associated with Mental Health Among Women Used Methamphetamine 3 Months Prior to Conception or During Pregnancy, n=15	
Characteristic	**#**
CES-D Score[a]	
>=16 (depressed)	8
<16	7
Ever Received Treatment for Psychological or Emotional Problems	12
Close Relative Ever Treated for Psychological or Emotional Problems	
Yes	11
No	3
Don't Know	1
Emotional Abuse by Husband, Boyfriend or Partner	
Yes	11
No	4
Physical Abuse by Husband, Boyfriend or Partner	
Yes	7
No	8
Physical Abuse by a Family Member	8

Table 5.4. Factors Associated with Mental Health Among Women Used Methamphetamine 3 Months Prior to Conception or During Pregnancy, n=15	
Characteristic	**#**
Sources of Stress[b]	
Financial	14
Unemployment	11
From a Relationship	12
Boredom	10
Feeling Depressed or Hopeless	11
Worried about Pregnancy	10
Lacking Transportation	11
Craving Drugs or Alcohol	8
Grief or Loss of Someone Loved	5
Job Stress	5
Finding a Place to Live	10
Unable to Think or Concentrate	10
Difficulty Falling Asleep or Staying Asleep	10

Table 5.4. Factors Associated with Mental Health Among Women Used Methamphetamine 3 Months Prior to Conception or During Pregnancy, n=15	
Characteristic	**#**
Social Support[c]	
Someone to Confide In/Talk About Problems	13
Someone to Get Together for Relaxation	7
Someone to Help with Daily Chores if Sick	10
Someone to Turn to for Personal Problems	11
Someone to Love and Make Her Feel Wanted	11
Reasons for Using Methamphetamine	
Feel Better about Herself	11
Feel Numb	12
Felt Depressed	13
To Unwind or Relax	9
To Feel in Control	9
Felt Sad or Lonely	13
Felt Anxious or Stressed	13
To Forget Problems	15
Needed Energy to Do Things, e.g. housework	14
To Lose Weight or Control Weight	14

[a] Center for Epidemiologic Depression Screen. A score of 16 or more is commonly defined as screening positive for depression.

[b] Women who reported they felt worried about a particular type of stress either "somewhat" or "very much" of the time.

[c] Women who reported they had people to support them "most of the time" or "all of the time" over the past month.

Chapter 6: Conclusions

This dissertation addressed the topic of maternal mental health and substance use in the context of birth outcomes from two perspectives: content-specific and methodological. The three studies presented in this dissertation focused on three research questions: the potential interactive effects of maternal mental health, substance use (tobacco and alcohol use), and infant health outcomes (LBW and preterm delivery); the role of maternal mental health with respect to smoking cessation during pregnancy and postpartum smoking relapse; and the experiences of women who used methamphetamine, either immediately prior to conception or during pregnancy. The methodological goal of this dissertation was to critique the effectiveness of maternal mental health measures and methods used for these studies. In particular, it focused on the use of PRAMS surveillance data for research and the use of qualitative methods to examine maternal methamphetamine use.

This chapter summarizes the findings from each study in the context of the current literature. Common themes from the three papers are also explored. A discussion of the methodological issues associated with using PRAMS surveillance data for research purposes follows. This section addresses indicator-specific concerns, as well as strengths and limitations related to study design and implementation. It poses and answers the question: should PRAMS data, in its current format, be used for mental health research? This methods discussion goes on to explore the use of qualitative data, specifically in-person interviews, to assess maternal methamphetamine use. Finally, public health implications, including recommendations for future research and intervention strategies, are suggested.

Summary of Findings

Independent and interactive associations of prenatal mood and substance use with infant birth outcomes

Manuscript One (Chapter 3) found an interactive relationship between low maternal mood, substance use and birth outcomes among MN PRAMS respondents. Women who reported low mood levels during pregnancy were twice as likely to have a LBW infant, regardless of their smoking status, compared to women reporting high mood levels. Women with higher mood had lower rates of LBW, even if they smoked, as compared to the women reporting low mood. The odds ratios for the three interaction terms are fairly similar as compared to the referent of non-smoking, high mood women. The odds ratios are slightly higher among the low mood women compared to high mood women, but were not statistically significant. It is possible that a threshold exists, whereby the contributions of low mood and smoking status increase the risk of LBW to a certain degree and their combined effect does not result in further increases. No other published studies were found that examined the potential interactive effect of substance use, maternal mental health and birth outcomes. Salisbury et al. found similar antagonistic results in their study of postpartum depression and cocaine use on infant neurobehavioral measures [66]. They concluded that the influence of early postpartum depressive symptoms on infant measures of arousal and self-regulation may have been buffered by maternal cocaine use [66].

Dayan et al. found higher rates of spontaneous preterm birth among women with higher depression scores, as measured by the EPDS with a cut-off of 14 for prenatal depression in multivariate analyses [109]. Low maternal mood may affect maternal

nutrition, which could also affect fetal growth [113]. The finding of an association between substance use and LBW is consistent with previous studies that have examined the independent effects of tobacco on birth outcomes [109, 113-115]. Tobacco use has been shown to decrease intrauterine growth. The *a priori* hypothesis was that the joint effect of using tobacco and having low mood would result in a higher risk of LBW than would be expected by either of them alone. In this study, the interaction was antagonistic and did not result in a greater than expected joint effect. Some researchers have suggested that substance use may be self-medication for mood disorders or other mental health conditions. Because PRAMS is a retrospective, cross-sectional survey, temporality cannot be assessed. It is unknown whether substance use precedes mental health problems or conversely, whether mental health problems lead to substance use. The relationship between tobacco use and maternal mood may be subtle and more complex than previous studies of these risk factors alone could demonstrate.

PRAMS participants who abstained from using alcohol during the third trimester but reported low mood levels were twice as likely to have a preterm delivery compared to women with high mood. This association was borderline statistically significant. Study data for preterm birth and maternal mental health remains inconsistent [8, 109, 110, 160]. Similarly, mixed results are presented in the literature with respect to alcohol use and preterm birth. Lundsberg et al. found slight protective effects of moderate drinking on intrauterine growth restriction [117]. Goldenberg concluded that heavy drinking could be a risk factor for preterm birth, while mild to moderate drinking may not [118]. The majority of the PRAMS study population was classified into the alcohol abstention category, which lowered the power for this particular analysis. The small percentage of

total drinkers overall did not allow for categorization of this PRAMS sample into mild/moderate or heavy drinkers. This may have affected the ability to detect a relationship between third trimester alcohol use and preterm delivery.

There are a few possible explanations for the lack of a synergistic interaction for alcohol use and maternal mood on preterm birth. It is possible there is not a synergistic effect. Methodological issues, specifically those associated with the measurement of maternal mood and alcohol use, may have hindered the ability to detect an increased combined effect. Alcohol use has been linked with developmental issues during the first trimester. Therefore, preterm births that may result from these developmental issues may be more highly associated with first trimester alcohol use as opposed to third trimester. Unfortunately, PRAMS does not assess first trimester alcohol use. The maternal mood measure is a general measure of mood, not a specific mental health diagnosis. Another consideration is that alcohol use may have mediated the association between low maternal mood and preterm delivery (i.e. that the antagonistic interaction is a true reflection of the relationship). This fits with the theory that people with mental health problems may self-medicate with non-prescribed substances.

Similar to the findings with tobacco and LBW, third trimester alcohol use may have alleviated some of the symptoms associated with low mood in this population. As Salisbury et al. conclude, differences in maternal mood may explain many of the inconsistencies that have been found in the literature with respect to substance use and birth outcomes [66]. A two-fold increased risk of LBW and preterm is important, particularly when one considers both the short- and long-term health consequences. LBW and preterm deliveries often result in increased health care costs, both during the

time frame following delivery and in the long-term, if children have developmental delays or other chronic health conditions [83-87]. This association between low maternal mood and birth outcomes suggests that maternal mood may be important to infant health.

The association of maternal mental health with prenatal smoking cessation and postpartum relapse in a population-based sample

Manuscript Two (Chapter 4) examined the role of mental health variables with respect to smoking behavior. The rates of smoking cessation and relapse in this study were similar to those found in other study populations [38, 124]. Tobacco cessation was inversely associated with higher levels of self-reported stressful life events, which supports previous work [44, 45, 161, 162]. The finding that smoking intensity was strongly associated with cessation was consistent with other studies [41-43]. Older, more educated, higher income and primiparous women were also more likely to quit smoking during pregnancy.

Low maternal mood was borderline statistically significantly associated with cessation (p=0.11), indicating that lower mood may have been a barrier to cessation efforts. Previous studies have found a positive association between prenatal smoking and clinical depression [41-43, 88]. In this study, low mood women were much more likely than the high mood women to be classified as moderate to heavy smokers (e.g. they smoked 11 or more cigarettes per day compared to light smokers who smoked 10 or fewer cigarettes per day), 62% vs. 54%, respectively (chi square=12.05, 1 d.f., p=0.0005).

Low maternal mood was positively associated with smoking intensity in univariate analysis, with an OR=1.68, 95% CI: 1.25, 2.26, p=0.0006. This finding fits with results from Goodwin et al., which used data from the 2001-2002 National

Epidemiologic Survey of Alcohol and Related Conditions [163]. They found that women with higher levels of nicotine dependence during pregnancy were twice as likely to have major depression (OR=2.07, 95% CI: 1.3, 3.4), six times as likely to have dysthymia (OR=6.2, 95% CI: 2.9, 13.1) and three times as likely to have a panic disorder (OR=3.1, 95% CI: 1.6, 6.1) in the past year [163]. Among pregnant women who met the criteria for nicotine dependence, 57.5% met the criteria for at least one mental disorder [163].

Post-hoc analysis of the PRAMS data presented here tested for an interaction between maternal mood and smoking intensity on cessation, while including all the variables used in the main effects cessation analysis presented in Manuscript Two. The test of interaction was highly statistically significant (Wald chi square=60.84, 1 d.f., p<0.0001). Women categorized as moderate to heavy smokers who also reported low mood were much less likely to quit smoking, as compared to the referent group of low intensity/high mood women (OR=0.32, 95% CI: 0.196-0.528, p<0.0001).

Postpartum depressive symptoms were weakly associated with an increased risk of postpartum tobacco relapse among women who had quit smoking during pregnancy. Previous study data is mixed on the role of depression and relapse. A prospective study of 7,089 women, in which smoking status was assessed at two points during pregnancy as well as at three time-points postpartum, found mixed results for depression and smoking trajectory [164]. They did not find a strong association, either between baseline depression (measured at 20 weeks) or change in depression scores, and smoking status [164]. They found that depression scores dropped slightly in the early postnatal time frame which may explain the lack of association. Another prospective study followed 65 women who had quit smoking during pregnancy for 24 weeks after delivery [165].

Baseline factors (assessed shortly after delivery in the hospital) associated with relapse at 24 weeks postpartum included: not being happy about the pregnancy, multiparity, receiving counseling for depression or anxiety during pregnancy, and ever having struggled with depression [165]. An increase in stress and depressive symptoms between baseline and 12 weeks postpartum resulted in a higher risk of smoking by 24 weeks [165]. A small, clinic-based study found that symptoms of depression and stress measured toward the end of pregnancy were associated with postpartum relapse [127].

Women who were still breastfeeding at the time of the survey were less likely to report postpartum smoking relapse, which is not surprising in light of previous studies. Hannover et al. reported a strong influence of breastfeeding on women's intentions to remain tobacco-free [132]. Stotts et al. suggested that pregnant women who quit smoking do so for the benefit of their infant, therefore after delivery or weaning, that inducement becomes obsolete [166]. Researchers have concluded that relapse may be more common among postpartum women who are no longer breastfeeding, even if women have the intent to remain abstinent [166, 167].

The link between breastfeeding and postpartum depressive symptoms in other studies suggests that breastfeeding may moderate the association between postpartum depressive symptoms and relapse [104, 134]. Studies have found an inverse association between breastfeeding and postpartum depression [104, 134]. This could explain why postpartum depression has been more strongly associated with relapse in another PRAMS study, which did not include breastfeeding as a variable [40]. Postpartum depressive symptoms and breastfeeding were associated in the MN PRAMS dataset. Women who met the criteria for having postpartum depressive symptoms were less likely to be

breastfeeding at the time of the survey (unadjusted OR=1.83, 95% CI: 1.13, 2.99, p=0.015).

Post-hoc analyses tested for an interaction between breastfeeding, postpartum depressive symptoms and smoking relapse using a multivariable model that included all the main effects variables in the relapse model presented in Manuscript Two. Women who were not breastfeeding at the time of the survey and reported postpartum depressive symptoms were twice as likely to relapse as compared to the referent group of women who breastfed and did not report symptoms of postpartum depressive symptoms. This interaction was not statistically significant (Wald chi square=1.24, 1 d.f., p=0.26). However, the small numbers for this particular analysis reduced the power to detect an interaction. Further study with larger sample sizes is warranted to explore the potential interactive relationship between breastfeeding and postpartum depressive symptoms.

It was surprising that stressful life events were not associated with postpartum relapse. One explanation is that the stressful life events variable was highly associated with cessation in the first place. Thus, women with higher stress levels may not have quit smoking during pregnancy and would not be eligible for the relapse analysis. This is supported by the positive, statistically-significant association between high stress levels and current smoking at the time of the survey (data not shown), which would include women who continued smoking during pregnancy and those who relapsed postpartum. Another methodological issue related to how stress was measured may have influenced the lack of association. The stressful life events variable asked women to indicate events that occurred over the course of the past year. Thus, that time frame included both pregnancy and the first 2-4 months postpartum.

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Overall, this manuscript suggests that mental health status may influence smoking cessation during pregnancy and may mediate the association between breastfeeding and postpartum smoking relapse. Further, this paper suggests that the study of postpartum depression and relapse may be enhanced by further exploring the role of breastfeeding. This study provides strong support for the association between breastfeeding and lower rates of tobacco relapse.

Factors related to prenatal methamphetamine use: mental health, self-esteem and accomplishing women's work

Manuscript Three (Chapter 5) provided insights into the lives of women who used methamphetamine pre-conception or during pregnancy. Respondents reported feeling an overwhelming sense of responsibility, which paired with mental health problems and feelings of inadequacy, appeared to fuel women's use of methamphetamine. The first theme that emerged emphasized the high prevalence of mental health problems among the participants and raised the question of how those may be associated with their methamphetamine use. Feelings of depression and anxiety were widely described by women who had used methamphetamine during pregnancy, yet it was not fully known for all the women whether those problems preceded their drug use. In addition, many of these women had received treatment for psychological issues at some point in their lives.

The qualitative nature of this study makes comparison to other studies difficult. The level of information is more complex, because it was drawn from interviews in which participants could reflect on their drug and mental health histories in greater detail. The finding of a high prevalence of mental health problems corroborates results from studies of other drugs, particularly among adolescents [146-148]. This study focused on

a very select group of women with a history of serious substance abuse. Many of them were multi-drug users and all were in formal treatment programs. While these participants represent a small subset of the population, they offer some insights into the complexity of drug use.

A second theme centered on a familial and social context of psychological problems and substance use. Many participants described a life in which pervasive drug use and mental health problems formed a social and familial culture that seemed more the norm than an exception. The idea of a drug culture focused within families and social networks is not new. Yet the additional information related to family history of psychological problems presents another perspective for examining serious drug use. Mental health problems may have a genetic component, but it is also possible that parental drug use contributed to the development of psychological problems in children. A cycle of mental health and drug problems within families appeared to work in concert among these participants.

A third theme focused on participants' lack of knowledge about methamphetamine and its addictive properties prior to their first use. Participants frequently stated they knew little or nothing about methamphetamine and did not necessarily believe it to be highly addictive. Given the self-described drug culture that many of these participants lived in, this finding was somewhat surprising. It is unknown whether participants wanted to present themselves as naïve users the first time or whether they truly did not know much about the adverse or addictive properties of methamphetamine. Their responses may also reflect the fact that many were fairly young

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when they first tried methamphetamine and perhaps did not give much thought to the dangers or consequences of particular drugs.

Finally, a theme related to the increase in energy resulting from methamphetamine use, as well as benefits such as weight loss and feelings of invincibility, was common among participants. The weight control and nicotine literature is well-developed, which provides support to the theme of methamphetamine use for weight loss and management [149-152]. Many of these women described lives in which they were overwhelmed by their responsibilities. Methamphetamine appeared to assist these participants in accomplishing the tasks associated with paid and unpaid work, in particular household tasks and childrearing. Women shoulder many responsibilities with respect to maintaining family life, in addition to other work demands, and participants stated that methamphetamine allowed them to fulfill those demands.

No other studies were found that focused specifically on the benefits of drug use for accomplishing domestic tasks and managing responsibilities. The literature is well-developed on the pressures women may feel with respect to juggling paid and unpaid work, including childcare [153-159, 168]. The theme of using methamphetamine to accomplish many tasks, especially related to household chores and childcare, was voiced consistently among participants as a reason they used methamphetamine. Participants expressed feeling overwhelmed by the demands on them, whether by employers, spouses or children. They reported an increase in self-esteem related to their methamphetamine use, which may reflect their perception that they were meeting societal expectations with respect to having a clean house, maintaining a paid job and parenting responsibilities.

It is not clear whether mental health issues always preceded drug use in this group, although some participants made it clear that depression and anxiety were present before they tried methamphetamine. Methamphetamine allowed these women to accomplish many tasks around the house, as well as contributed to their feelings of self-esteem and body image. At least initially, methamphetamine seemed to be viewed positively by participants who were often plagued with low self-esteem, depression, and anxiety before they began using. These women were in drug treatment programs and described the negative experiences they had while using methamphetamine. But even in the context of recovery, all participants stated they were afraid they would begin using methamphetamine again and could readily list perceived benefits from using methamphetamine. Thus, it is important to recognize that while methamphetamine is a destructive drug for women, their families and society in general, it does appear to have an appeal to some women.

Finally, this group of women represents a very specific subgroup of drug users, namely women who use illicit drugs during pregnancy. The Methamphetamine Study presented here did not ask women about their cultural norms surrounding drug use during pregnancy, but it did ask whether they felt there were risks to their infants related to methamphetamine use. All of the respondents stated they believed there must be some risk to the infant, but very few could articulate any specific health risks. This population was in recovery when the question was posed to them. It is possible that they have received counseling or information that asked them to consider the health of their infants as part of their drug treatment programs.

Manuscript Three contributes to the literature by describing a social context in which drug use and mental health problems are the norm, rather than the exception. It identifies a strong familial and social component to methamphetamine use and also the many perceived benefits that participants reported from its use. This paper provided a voice to women who continue to live with their addiction to methamphetamine and their desire to help other women avoid that experience.

Common Themes

Taken together, these manuscripts suggest a correlation between mental health problems and substance use among pregnant women. They indicate that pregnant women may feel overwhelmed and pressured by their daily responsibilities, particularly during the life stage of starting a family or having young children. The women in the Methamphetamine Study reported feeling stressed about their daily responsibilities, particularly the stress related to maintaining a household. PRAMS did not ask questions specific to stressors such as running a household and caring for small children. PRAMS data do indicate, however, that multiparous women had higher levels of stressful life events, lower levels of maternal mood and higher rates of postpartum depression.

A recent study using two longitudinal data sets attempted to characterize the co-occurrence of alcohol use and depression among pregnant women [169]. The authors analyzed data from two studies of low-income women who reported first trimester alcohol use. The early cohort had a prevalence of alcohol use and depression co-occurrence of 56% (1982-1985), but no significant predictors of co-occurrence were identified. The later cohort (2002-2004) had a co-occurrence prevalence of 10% and in that group illicit drug use predicted the co-occurrence of alcohol use and depression in

the second and third trimesters. Although the literature is inconclusive with respect to maternal mental health, substance use and birth outcomes, previous research provides support for the co-occurrence of substance use and mental health problems [57-59, 169].

These studies were not able to assess temporality between mental health and substance use, thus it is unclear whether women's mental health issues pre-dated substance use or resulted from it. Manuscripts Two and Three suggest that maternal substance use may in fact be an attempt by women to self-medicate themselves for mental health problems. Tobacco use, alcohol use or more serious drug use may provide a level of relief from feelings of depression, anxiety and stress. While pregnancy may be a motivator for women to quit using substances [47], it appears that once the infant has been born, a strong motivation for abstinence is removed. The large percentage of women in PRAMS who reported tobacco relapse in the postpartum indicates that tobacco continued to exert a powerful influence on women, particularly once their infants are delivered. Almost all of the methamphetamine participants reported that their greatest fear is using methamphetamine again and not being able to quit.

Pregnancy may be an important motivator for women to quit using substances, yet cessation may not be sustainable without providing other motivation or support to women to remain substance-free in the postpartum [132, 166]. Stotts et al. determined that there was very little difference between pregnant women's reported self-efficacy to remain smoke-free and non-pregnant women who do not intend to quit smoking, as compared to non-pregnant women who did want to quit [166]. Thus, the main influence on pregnancy-related cessation appears to be the health of the infant and societal norms

about substance use during pregnancy, which may result in a suspension of behavior, as opposed to true behavior change [166, 170].

The results from these papers suggest that the relationship between maternal mental health and substance use among pregnant women is complex and warrants further exploration. Mental health problems and substance use may be an ongoing struggle for some women, perhaps because of family history or because they live in an environment that contributes to both. Maternal mental health appears to affect birth outcomes, as well as substance use behaviors. There is a need for further study of pregnant women who may be dealing with mental health problems, as well as the cultural and societal demands that contribute to their substance use. Addressing both maternal mental health and prenatal substance use could be more effective than focusing on either issue in isolation.

PRAMS Measurement Issues

Lack of a Gold Standard Instrument to Assess Mental Health

Maternal mental health has developed a higher profile among researchers and health care providers, yet measurement issues persist with respect to population-based mental health assessment. This is especially the case in specific population subgroups, such as pregnant women. A major limitation is the lack of a standard, population-based tool for assessing mental health and substance use among pregnant and postpartum women. The CES-D, EPDS, and Primary Care Evaluation of Mental Disorders Patient Questionnaire (PRIME-MD PHQ) are frequently used to assess depressive symptoms, but are not the only tools used. In addition, researchers often use their discretion to determine scale cut-points when classifying participants as either depressed or not depressed. Although there are standard cut-points, they are not universally observed and

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differences in definition can complicate comparisons across studies that used the same screening tool.

There is no universally accepted tool for assessing maternal mental health in surveillance systems. Small, clinic-based studies are often able to use clinical diagnoses of mental health conditions. Population-based studies typically do not have the resources to incorporate lengthy screening tools into study instruments, nor the ability to follow-up with participants who screen positive to determine their clinical status. Thus, the variety of measurement tools used to identify and define maternal mental health problems, whether for clinical or screening purposes, makes comparison across studies difficult. Measurement differences are likely one important reason why prevalence estimates vary widely between studies.

PRAMS Mental Health Indicators: Critique and Recommendations

The main indicators of maternal mental health in PRAMS are comprised of maternal mood, postpartum depressive symptoms and stressful life events. It can be difficult to change indicators once they have been created and included in on-going surveillance systems. Certainly, consistency is important if one hopes to track indicators over time. However, consistency across surveillance years is not a good enough rationale to perpetuate the use of poor measures. All datasets have limitations and caveats, but if those limitations begin to outweigh the strengths, it is time to re-evaluate the use of particular indicators and work to improve them.

Maternal Mood

The PRAMS papers used maternal mood/happiness as a broad marker of emotional state during pregnancy [104]. The prevalence of low mood for the 2002-2006

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Minnesota PRAMS data was 23.4%, which was comparable to the 25% prevalence rate generated from another study using this variable [104]. Yet it is not necessarily a marker of clinical depression and no studies were found that validated this measure against accepted depression screens or clinical tools. The maternal mood variable seems to be measuring something of clinical value, as evidenced by its association with LBW, preterm birth and subsequent postpartum depressive symptoms, but it is unclear what it truly measures.

The mood question asks women to retrospectively characterize their pregnancy with regard to their level of happiness and uses a Likert-type response scale. Does it measure lesser depressive symptoms? Does it reflect happiness with the pregnancy itself? Is it a proxy for pregnancy intent? The inability to identify what the maternal mood indicator actually measures limits its utility for surveillance and research purposes. How can effective interventions be designed if the problem isn't clearly defined?

One study examined pregnancy intention and happiness about pregnancy among 1,044 women enrolled in prenatal care clinics [171]. They asked respondents to rate their happiness level with respect to being pregnant on a scale of 1 to 10 and then created a dichotomous variable comparing "happy" to "unhappy." In multivariate analyses, women who reported being unhappy about being pregnant were more likely to report prenatal substance use, including tobacco, alcohol and illicit drugs, and were also more likely to have been depressed or experienced intimate partner violence [171]. They determined that happiness about pregnancy was more highly correlated with behavioral and psychosocial risk factors than pregnancy intention [171]. However, this measure was not the happiness measure used in PRAMS, as it relates very specifically to the woman's

perspective on being pregnant as opposed to happiness level over the course of the pregnancy.

The PRAMS measure piques curiosity and suggests there is something important within it. Unfortunately, that is not enough to make it an effective measure. This measure of maternal mood should be used cautiously for research around maternal mental health. The CDC made the effort to improve measures of postpartum depressive symptoms starting with the 2004 survey (Phase 5). While that resulted in a break in trend data between questionnaire phases, over the long-term the data obtained will be more useful. A similar approach should be taken with respect to assessing prenatal depressive symptoms.

Possible Alternatives for Assessing Prenatal Mental Health in PRAMS

Most existing depression screening tools are comprised of too many questions than is practical for a survey tool like PRAMS. Researchers have worked to identify shorter surveys or subsets of questions that assess depression. Whooley et al. evaluated the PRIME-MD PHQ two-question depression screen, which is the tool that was adapted for assessing postpartum depressive symptoms in PRAMS. They determined that a positive response to either of the following two questions is a fairly good depression screen, as compared to the Quick Diagnostic Interview Schedule (QDIS-III) [95]:

1. During the past month, have you often been bothered by feeling down, depressed or helpless? (Y/N)

2. During the past month, have you often been bothered by little interest or pleasure in doing things? (Y/N)

The sensitivity and specificity for these questions were 96% and 57%, respectively, as compared to the QDIS-III [95]. The PRIME-MD PHQ screen was also evaluated among pregnant and postpartum women [172]. The authors compared the two-question screen to the EPDS at 15 and 30 weeks gestation and again at 6 to 16 weeks postpartum. They determined that a positive two-question screen had a sensitivity of 93%, 82% and 80% and a specificity of 75%, 80% and 86% compared to an EPDS score of greater than or equal to 13 at 15 weeks, 30 weeks and postpartum, respectively [172]. The positive/negative predictive values were 44/98, 24/91 and 30/98 at each time point, respectively. Finally, they determined by area under the receiver operating characteristic curve analysis that the two-item questions at each time point had approximately equal diagnostic validity [172].

Arroll et al. validated the same two-question depression screen as Whooley et al., however it was implemented verbally as opposed to in written form, against interviews among 421 general practice patients using a cross-sectional design [173]. They reported the two questions were 97% sensitive (95% CI: 83%-99%) and 67% specific (95% CI: 62%-72%) [173]. The authors felt this was a reasonable trade-off between true and false positives. Thus, this two-question screen appears valid even when completed either in writing or verbally, which is of value for a survey like PRAMS since it is administered either in writing or by telephone.

These studies suggest that this two-question screen is good at detecting depression, but could result in false positives without follow-up confirmation. For research purposes, including women who do not actually have depression in a subgroup of depressed women, i.e. false positives, would likely result in an underestimate of

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measures of association. This conservative result is preferred from an epidemiological perspective. From a surveillance perspective, trends over time are typically valued over point prevalence estimates. Thus, if a question resulted in slightly higher prevalence levels than is truth, as long as the degree of over-estimation remained stable over time, trends in prevalence should be valid. It is unlikely that prevalence over-estimates would change over time, unless there was a secular event that influenced depression prevalence rates.

Another limitation related to assessing prenatal mental health in PRAMS is the timing of the question. The current mood question relates to the pregnancy overall, yet some researchers suggest that depressive symptoms may vary over the course of the pregnancy. A series of questions that ask about depressive symptoms during each trimester would provide a deeper level of detail and allow for tracking mood changes over the course of the pregnancy. For example, one of the two-screen questions could be modified: "During the first three months of your pregnancy (1st trimester), how often did you feel down, depressed or hopeless?" Responses would be "always," "often," "sometimes," "rarely," "or never."

The myriad of issues related to the measurement of prenatal mental health in PRAMS suggests that the creation of an advisory committee to explore various options would be valuable. This group could address indicator specifics, as well as placement of these indicators within the survey. Currently, the maternal mood question is considered an optional question. This topic is important and could have serious implications for maternal and infant health. The Phase 6 PRAMS survey (started in survey year 2007) moved the postpartum depressive symptoms measures to the core. CDC should consider

replacing the current measure of prenatal mood with a more robust question or questions, and these should be placed in the core survey.

Postpartum Depressive Symptoms

PRAMS uses a two-question algorithm to identify women with postpartum depressive symptoms. This measure was introduced in the 2004 (Phase 5) version of PRAMS and replaced previous indicators that were less defined. The two-question algorithm has been previously validated [95-97]. Gjerdingen et al. validated the two-question screen against the depression component of the Structured Clinical Interview for the DSM-IV [97]. The two-question screen was found to be 100% sensitive and 44% specific. It likely captures most women with postpartum depressive symptoms, but has a high false positive rate. If postpartum depressive symptoms are truly associated with an outcome of interest, but the measure includes false positives, it is likely that measures of association will be biased towards the null. This would bias results conservatively, with an underestimate of association. The postpartum depressive symptoms algorithm appears reasonable for surveillance and research purposes, although it should be noted that it may overestimate prevalence. For surveillance purposes, the degree of overestimation should not vary with time. Thus, trend data should be accurate for tracking changes in this measure over time.

Maternal Stress

The PRAMS measure of maternal stress was derived from a 13-item subset of the Modified Life Events Inventory [103]. Stressors are measured over the past year and included moving, being homeless, financial problems, relationship problems and an illness or death in the family. Women received an overall stress score by summing the

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"yes" responses to the 13 items. Whitehead et al. examined whether these stressful events followed a linear pattern, i.e. risk of preterm birth increased with each additional "stressor" or whether there was a threshold level. They did not find a threshold effect for the stressors measured, but found that among multiparous women, the risk for preterm birth increased by 7% for each additional stressor [103]. They noted that this measure is limited in that it weighs all stressors equally and does not take into account the timing of the stressor(s) with respect to the adverse birth outcome.

The stressful life events variable currently in use in PRAMS has strengths and weaknesses. It has been widely used and previously validated and it also allows for the examination of specific stressors individually. Yet the current survey lacks stressors that could be pregnancy- or maternal-specific, such as concern about the health of the baby or stress associated with caring for other small children. Traditionally, definitions of stress have focused on two major components: stressors themselves and a person's reaction to stress [174]. Debate continues as to which aspect of stress is best to measure. Stress research that has focused on the effects of life events or daily hassles on health has been inconsistent [174]. Stress is a subjective topic, thus what might be stressful to one person (e.g. moving), may not be perceived as stressful to another. Measures that assess stress primarily from the perspective of the individual have emerged as an important area of study. It was against this framework that Levenstein et al. created the Perceived Stress Questionnaire (PSQ) [175] and Cohen developed the Perceived Stress Scale (PSS) [176].

Possible Alternative Stress Measures for PRAMS

For continuity purposes, it would be wise to retain the stressful life events measure, even with its limitations. PRAMS does not contain any measures of perceived

stress, thus it would enhance the survey to include a measure of perceived stress. Cohen et al. developed a four-item scale from the PSS [176]. This scale included whether individuals felt they could control important things in their life, their confidence in their ability to handle personal problems, whether things in life were going their way, and whether difficulties were piling up so they could not overcome them. Responses were on a Likert scale that ranged from 1 ("never") to 5 ("very often") [176]. Four items may be too many to include on a survey like PRAMS but they could be included as optional state questions.

Recently, Littman et al. validated a two-question stress measure against existing stress measurement tools [177]. The two questions were:

1) "On a scale of 1 to 6, how would you rate your ability to handle stress?" The responses ranged from 1 "I can shake off stress" to 6 "stress eats away at me."

2) "In the past year, how would you rate the amount of stress in your life (at home and at work)?" Responses ranged from 1 "no stress" to 6 "extreme stress."

For the validation study, 220 respondents (76% response rate) completed the two-question stress screen, Cohen's four-item, limited PSS, a revised hassles scale based on the Hassles and Uplifts Scale, and a measure of life events, based on the Women's Health Initiative Life Events questionnaire [177]. Test-retest reliability measures were also fairly good. The weighted kappa for the ability to handle stress was 0.71 (95% CI: 0.64-0.77) and for the amount of stress was 0.66 (95% CI: 0.57-0.73). The measure of ability to handle stress was correlated both with scores for perceived stress (PSS) and hassles (Pearson correlation coefficient of 0.39 for both). It was less correlated with the life

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events measure (r=0.24). The question on amount of stress was strongly correlated with the hassles questionnaire (r=0.50), but also correlated with perceived stress (r=0.36) and life events (r=0.38). The authors concluded that their single-item measures of stress appeared to fairly well at measuring stress as compared to the longer questionnaires, both in terms of validity and reliability [177]. PRAMS may want to explore the addition of single-item perceived stress measure for future surveys.

PRAMS Substance Use: Alcohol Use

The PRAMS alcohol use questions could be improved upon, largely based on the time frames during which they are asked. For example, while researchers have not determined a safe amount of alcohol use at any stage of pregnancy, most would concur that first trimester alcohol use is especially dangerous with respect to teratogenic effects [35]. PRAMS does not ask about first trimester alcohol use, yet that time frame may be important with respect to birth outcomes. Women who continue to drink during pregnancy may represent a population with a higher risk profile. Conversely, they could be women who believe that first trimester alcohol use is most dangerous and that drinking during the third trimester actually poses a low or non-existent risk. In the PRAMS 2002-2006 dataset there was a distinct difference in education level between women who reported drinking in the third trimester as compared to those who did not. Of women who reported third trimester alcohol use, 55% had sixteen or more years of education as compared to 35% of women who did not (p<0.0001). A first trimester alcohol question would be a valuable addition to the PRAMS questionnaire.

Bias in PRAMS

The PRAMS study design may give rise to different biases. Selection bias may be an issue for PRAMS in that it samples from a population that has a stable home address. Women who do not have a stable home address or phone number would not be identified using PRAMS sampling techniques, and those same women may be more likely to display risk factors for the outcomes of interest. For the first PRAMS manuscript (Chapter 3), non-respondents were more likely than respondents to be unmarried, younger, multiparous and have lower education levels; they also had higher rates of LBW births (9.6% vs. 6.4%) and preterm births (11.1% vs. 8.6%) than respondents. Similarly, in PRAMS Manuscript 2 (Chapter 4), non-respondents were more likely than respondents to be younger, unmarried, attain lower education levels and be multiparous. Non-respondents had higher rates of LBW births (11.1% vs. 6.1%, $p<0.0001$) and preterm births (12.7% vs. 8.5%, $p<0.0001$) than respondents. Thus, PRAMS represented women with higher levels of socioeconomic status and lower rates of adverse birth outcomes.

PRAMS attempts to control for major differences between respondents and non-respondents by using adjustment factors, such as marital status or education level, in the creation of the final dataset [102]. The overall response rate is fairly high, which creates confidence in the generalizability of these results. It is possible, however, that differences in the responders and non-responders affected the measures of association, even after trying to control for those differences. A study examining the effects of selection bias, which is traditionally thought to affect the exposure-disease association, found that selection bias influenced prevalence rates but not the measure of association [121]. This has different implications for PRAMS, depending on whether it is being

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used for surveillance purposes or for research. For the purposes of the analyses in this thesis, if previous study data is accurate and PRAMS was able to adjust for differences in non-response, it is unlikely that measures of association were affected by selection bias.

Surveillance bias, a form of selection bias, could also influence PRAMS results. Surveillance bias can arise if case ascertainment is incomplete and differs according to an exposure of interest. It can result in biased exposure-outcome measures of association. For PRAMS, this could relate to the mode of survey implementation. For example, bias could result if participants differed systematically in some way based on whether they completed the survey by mail or phone, and this difference was related to the exposure or outcome of interest. It is unknown how such bias would affect the directionality of measures of association. For example, if women who responded by phone instead of by mail (the first attempts are by mail) were more likely to identify themselves as low mood during pregnancy, the association between mood and LBW could be biased towards the null because the majority of respondents respond by mail.

Bias could also result if the mail and phone respondents differed in the completeness of their survey responses. For example, if respondents completed the survey by phone, with trained interviewers, were more likely to fully complete the survey compared to women who completed the written version, and they differed on either the exposure or outcome of interest, results could be biased. Women with incomplete data for the outcome or exposures studied were excluded from these analyses. However, it is unlikely that this type of bias was a problem for these analyses since the total percentage of respondents excluded from the analysis due to missing data was quite low, at 2.4% and 1% for the first and second PRAMS manuscripts, respectively.

Recall bias could be a problem because of PRAMS' retrospective design. Mental health evaluation largely requires participants to self-report their mental health status. Mental health diagnoses are subjective and do not typically rely on a biological test result, thus they are subject to interpretation by clinicians or participants' responses to screening tools. For women who are retrospectively assessed for mental health status during pregnancy, recall could be affected by pregnancy outcomes and their postpartum mental status. For example, women with adverse infant health outcomes may be more likely to search for a reason for that adverse event. A woman experiencing postpartum depressive symptoms at the time of the survey may recall her mental health status during pregnancy differently than if she were not experiencing depressive symptoms. If a woman were more likely to report low mood during pregnancy based on her postpartum depressive symptoms, which may also be linked to having an adverse infant health event, the associations between mood and infant outcomes would be biased away from the null.

Substance use studies also rely heavily on participant self-report. Substance use during pregnancy is not typically socially accepted, thus many pregnant women may underreport their use. This could result in misclassification bias, which could bias the PRAMS results to the null. Recall bias may also be an issue with respect to assessing past substance use, particularly at different time points. It is possible that women with adverse birth outcomes may recall their substance use differently than those women with healthy birth outcomes. If women are searching for a reason for their infants' problems, they may report higher substance use which in turn would strengthen measures of association between substance use and birth outcomes. Conversely, if they feel to blame

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for the adverse outcome or try to minimize their previous use by underreporting substance use, measures of association could be biased towards the null.

Methamphetamine Measurement Limitations

The Methamphetamine Study presented in this dissertation faced challenges with respect to recruiting this highly specific population. The approach used to generate the sample focused on a unique subgroup of pregnant women who were younger, less educated and of lower average income than the general population of pregnant women in Minnesota. The Methamphetamine Study relied on participant recruitment through drug treatment programs. These women may represent a specific subgroup of methamphetamine users; a group that often was identified by law enforcement and was receiving drug treatment. Further, within the subgroup of women receiving treatment, the high mobility of this population may have resulted in women with a more stable living situation or women further along in their program being more readily willing and able to participate in the study. These women may have differed in some way from the women who did not show up to complete the surveys, even after expressing an interest in participation, or in the women who simply did not respond to recruitment messages. While this study aimed to provide a foundation for future research, it is important to note that the results are not intended to be generalizable.

The Project IDEAL study characterized methamphetamine-using pregnant women, relying on quantitative survey data [55]. They found that women using methamphetamine had lower education levels, were more likely to be single, less likely to attend the recommended number of prenatal visits and use public assistance, as compared to a general survey of pregnant women [55]. That description is similar to the

women represented in Manuscript Three. The study design contributed to the demographic recruited, since it made use of publicly-funded, drug treatment programs that frequently obtained their clients from the law enforcement system. Yet previous research indicates that methamphetamine use crosses socioeconomic boundaries [48]. Thus, it is unknown whether the themes generated from the study presented in Manuscript Three would also apply to more educated women with higher levels of socioeconomic status. Terplan et al. suggest the need for clinicians to broaden their view on who is at risk for methamphetamine addiction and realize that it is not necessarily a drug of less educated, lower socioeconomic status women [178].

There were specific measurement limitations related to the Methamphetamine Study. Participants were in formal drug treatment programs, which were usually associated with previous encounters with law enforcement and potentially child protection services. Participants may have been less likely to report if they were currently using drugs or to over-emphasize the negative aspects of methamphetamine use if they felt concerned their responses could jeopardize their standing in the treatment program or with respect to child custody issues. Some participants in the Methamphetamine Study appeared to be dealing with long-term memory and mental health problems that may have been associated with prolonged addiction. This may have influenced their ability to recall and report on their experiences, even if they are trying to be as honest and accurate as possible. Further, methamphetamine addiction in MN decreased over the study time frame, which was largely attributed to laws restricting the sale of products that could be used to manufacture methamphetamine locally. This may have contributed to lower study recruitment rates.

Public Health Implications

Future Research

Overall, studies of substance use and mental health during pregnancy would benefit from expanding their focus on the mother and infant to the environmental and cultural factors that may influence maternal behavior and health. For example, do the mother's family and friends use substances such as alcohol, tobacco or drugs? Research indicates that women who quit smoking during pregnancy are more likely to be exposed to environmental tobacco smoke as compared to never smokers [179, 180]. If women change their smoking behavior but remain in an environment that does not support cessation, sustained change may be difficult [179]. Studies that explore the environmental and cultural factors associated with substance use could broaden the knowledge base about prenatal substance use, mental health and health outcomes.

Similar contextual issues arise with respect to mental health. Does the mother's family have a history of psychological conditions? Studies that further explore the hypothesis that certain women may be predisposed to mental health problems during certain phases of their reproductive cycles deserve attention. If women at higher risk could be identified, it is possible that the progression to mental health conditions that cause impairment could be reduced. The adverse consequences of substance use during pregnancy have been well-documented and the body of literature about the role of mental health problems during pregnancy is growing.

Questions of Causality

The causal pathway of the co-occurrence of substance use and mental health, particularly with respect to pregnancy, has not been firmly established. A major question

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that remains unanswered relates to the temporality of substance use with respect to mental health issues. Do women with mental health conditions turn to substances in an attempt to cope with their condition? Do certain types of substance use result in mental health problems? Munafo suggests that the relationship between smoking and depression or subclinical depressive symptoms may be quite complex and bi-directional [164]. For example, mood disorders may influence smoking initiation and dependence while chronic tobacco use may contribute to the development of major depression [164]. Munafo et al. found evidence that the tobacco-depression relationship may be one of confounding as well as multi-directional causality. Chronic methamphetamine use has been shown to have long-term effects on brain activity [136]. Methamphetamine appears to alter dopamine activity and recent studies have suggested that chronic use may affect emotions and memory [137, 138]. It is possible that women who choose to use methamphetamine already have mental health problems. These studies suggest that methamphetamine may result in persistent changes in brain function and emotion.

The association found between breastfeeding and decreased risk of postpartum tobacco relapse raises a similar question of temporality. Does breastfeeding cause women to refrain from smoking or do the same women who choose to breastfeed also decide to delay resumption of tobacco use? Breastfeeding is often considered from the perspective of benefits to the infant. Yet if breastfeeding results in women postponing tobacco use, that is important to maternal health.

Research that arises from the needs of communities deserves more funding and resources. The Methamphetamine Study first arose through a research agenda that was guided by Minneapolis-based physicians, who felt they were treating more infants

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exposed to methamphetamine *in utero*. They were concerned about the increase that they observed anecdotally, but felt that to truly influence infant health they needed to learn more about the mothers who used methamphetamine during pregnancy. This form of community-generated identification of public health priorities is good for research. Academic researchers play an important role in formulating research questions and developing and implementing well-designed, scientific studies. Yet community members may also be able to identify and articulate public health needs in their community, as well as those topics upon which intervention may be possible. The collaboration between community representatives and academic researchers in the field of pregnancy-related substance use and maternal mental health has the potential to yield important information necessary to truly intervene on these problems.

While methamphetamine use remains a fairly low-prevalence occurrence, the health and societal implications of its use are tremendous. The results from this dissertation suggest that some pregnant women live in a social environment where drug use is considered normative and often pervades family structures. Complex familial psychological histories also appear to influence these women's experiences with mental health conditions and substance use. This dissertation provided formative work, but clearly much more research is needed. Further information is needed to be able develop interventions that use a comprehensive approach that aims to stop the cycle of substance use and undiagnosed or untreated mental health conditions. Grella et al. identify residence in neighborhoods in which drug use is prevalent as a major risk for substance relapse [145]. They further state that the environmental context of maternal addiction, such as family and neighborhood, can have negative consequences for children, in

addition to the direct effects of substance abuse on parental behavior [145]. The women in the methamphetamine study often spoke of their grandparents as being their role models, as opposed to their own mothers. Future work needs to focus on how to influence the environment in which many of these women were reared and how to give them skills to maintain their sobriety in a culture infused with mental health conditions and drug use.

More research is needed to study that focuses on preventing initiation of methamphetamine use. Drug treatment is likely a series of intervention strategies, which may be necessary over the course of a lifetime [145, 181]. The concept of drug use as a chronic, relapsing disorder that requires long-term intervention may be important in developing strategies to help pregnant women in their recovery. Qualitative study designs, in particular the one-on-one interview, may be especially conducive to studies of mental health and substance use, particularly among pregnant women. These topics are highly sensitive and difficult to measure quantitatively. Mental health is often subjective and for many cultures still carries a social stigma. Substance use is considered socially unacceptable during pregnancy in most cultures and social settings. Establishing trust and rapport through qualitative methods may result in better information than what can be gathered through a survey. Qualitative research can be more expensive and time-consuming compared to quantitative designs, but if targeted properly, can result in more in-depth results. For example, PRAMS could consider developing qualitative, follow-up modules to address the topics of substance use and maternal mental health in more detail. Study personnel maintain contact information on participants and could therefore re-

contact targeted women at a later date to further explore these topics in specific subgroups of respondents.

Intervention

Prevention is a core component of public health. Preterm birth and LBW continue to be problems in the United States, yet resources are often directed toward neonatal interventions aimed at improving survival among infants born preterm or LBW. Proven risk factors deserve more focus and intervention effort. Yet there is still a major knowledge gap surrounding many of the causes of preterm delivery in the United States. It is probable that known and unknown risk factors interact to stimulate preterm labor. Further research, based on multi-factorial models such as Flay's TTI [100, 101], could be useful for better understanding the enigma of preterm birth in the United States.

The data on mental health and birth outcomes, as well as health behaviors, remain inconsistent. Strong measures and tools are needed to further the literature on a population basis. Most would agree that unidentified mental health problems are a problem among pregnant women. A first step toward improved intervention would be increasing the identification of pregnant women at risk for or experiencing mental health problems. Studies suggest that women differ in their ability to recognize their own depression and communicate it to providers [182, 183]. Chaudron studied women both pre- and postpartum about interactions with their health care providers and found that less than half of women discussed their depression with their providers [182]. Sleath et al. found 29% of depressed women in their sample discussed their symptoms with providers and 34% reported barriers to raising these issues with providers [183]. Although maternal depression has become more widely studied, providers are still not screening

their pregnant or postpartum patient aggressively for depressive symptoms [4]. A recent study of obstetrician/gynecologists reported that 44% of providers always screened for depression, 41% sometimes screened and 15% never screened for depression [184]. Only 32% of those respondents reported using a short, validated screening tool [184]. Another study examined the use of the EDPS in outpatient settings after a program was initiated to encourage universal screening [185]. In this study, providers recorded an EDPS score in charts for only 39% of the visits and reported counseling patients on their scores and/or depression for only 35% of visits [185]. Nurse practitioners and midwives had the highest rate of documentation at 94% and 67% respectively, followed by attending physicians (42%) and residents (17%) [185]. Finally, one study suggests that pediatricians have the lowest screening rates and often rely on observation as opposed to a standardized screening tool [186].

Poor screening rates are only part of the problem with respect to treating maternal depression. Women may not be referred for treatment, even after screening positive for depression or depressive symptoms. The EDPS study found that only 75% of patients with an extremely high score were referred onto psychiatric follow-up [185]. Another study found that of the 38% of women who screened positive for depression and/or substance use, only 23% had documented evidence of a referral or follow-up in their chart [187, 188]. An analysis of the 2001-2002 National Epidemiologic Survey on Alcohol and Related Conditions determined that lifetime and past-year treatment-seeking rates for any psychiatric disorder were significantly lower among past-year pregnant women, as compared to non-pregnant women with psychiatric disorders [189]. The authors emphasize that the high prevalence of mental health disorders in pregnant

women, combined with low rates of maternal mental health care, reinforce the need to improve recognition and treatment for mental disorders occurring during pregnancy and the postpartum [189].

Lack of follow-up is not solely the provider's responsibility. Women themselves may be reluctant to access follow-up care or may face true barriers to accessing it, such as a lack of health plan coverage. One study reported that only 50% of women who had received a referral for depression accessed the treatment [190]. Intervention strategies need to explore ways to minimize barriers women face in discussing their mental health with their providers, since there are treatment options available. Treatment strategies include psychotherapy, pharmacotherapy or both. The first line of treatment typically addresses partner, social and environmental support, in addition to psychotherapy [191]. Studies indicate that providers prefer antidepressants, thus it is the most common form of treatment for depression during and after pregnancy [4]. However, women appear to prefer psychotherapy over antidepressants, often because of concern about the health of the infant [4]. It is understandable that women may be reluctant to use antidepressants during pregnancy. However, in cases of severe depression or when behavioral approaches are not effective, pharmaceutical interventions may be warranted [191]. The association between low mood and birth outcomes identified in Manuscript One suggests that relying on a strict, clinical diagnosis of major depression may not be adequate. The PRAMS mood measure is methodologically limited, but did suggest that lesser mental health impairment may be important. Providers may need to consider mood symptoms that do not meet the DSM-IV clinical criteria for a diagnosis of major depression.

Alcohol and drug treatment strategies often need to incorporate many treatment components, given the complexity of addiction [181]. Addiction treatment must help a woman quit using the substance, maintain a drug-free lifestyle and achieve productive functioning within family and work roles and society. Addiction is viewed as a chronic condition which requires treatment over the long-term to achieve abstinence [181]. Overall, effective treatments are those that recognize the complexity of addiction, are readily available, attend to the multiple needs of the individual (not just drug or alcohol abuse) and are frequently monitored [181]. Counseling and drug therapies are the most frequently used modes of treatment, and they are often most effective when used together [181]. With respect to pregnant women, prenatal care could be a prime opportunity to initiate chemical dependency treatment.

Identification of women with co-morbid mental health and substance use problems is an important priority. A recent study examining short-term outcomes of mothers and infants, in which mothers had co-morbid psychiatric disorders and drug use, estimated that 45% of the 879 drug-dependent women studied had a dual diagnosis [192]. The most common co-morbid psychiatric condition was depression (79% of those with a psychiatric diagnosis) [192]. Further, women with a dual diagnosis were more likely to use amphetamines, less likely to have antenatal care and more likely to have experienced domestic violence [192]. Their infants were more likely to be admitted to a NICU [192].

With respect to tobacco cessation and relapse prevention interventions, more work is needed to determine whether strategies that combine a mental health focus with more traditional approaches to address nicotine dependence are effective. Tobacco use reflects an addiction to nicotine, but is also a lifestyle habit and perhaps a tool for coping

with stress or other mental health conditions. Interventions geared at pregnant women have the advantage of women's concerns about their unborn infant, which can be a strong motivator. Yet the high levels of postpartum relapse in this population indicate that cessation efforts are not producing long-term lifestyle changes. Cessation efforts may need to focus on changing women's attitudes toward pregnancy cessation, so that it truly becomes a lifestyle change as opposed to a short-term break. Interventions focused on the postpartum time frame are crucial for extending successful cessation during pregnancy into a lifelong change. Identification of effective relapse prevention interventions could have long-range public health implications. Not only would women's health benefit, but preventing relapse could influence the health of the infant and other children in the household by reducing exposure to environmental tobacco smoke and may also influence future smoking patterns of the children in the household [43].

Surveillance

Surveillance is another important core public health function. It identifies public health issues, compares population subgroups and examines trends over time. It is crucial that policymakers and interventionists have a clear idea of the scope of public health problems and the relative demands these problems make on the health system. If surveillance data is to be used effectively it is important that it is an accurate representation of the population studied. This means that better measures need to be developed that can be used effectively in surveillance tools. In addition, surveillance tools would be more cost-effective if they were designed to allow for more in-depth research. The larger upfront cost associated with constructing valid indicators, increasing the sample size or the diversity of sample represented, could translate into savings if

surveillance data sets were more useful in academic and research settings. Public health resources are limited, therefore efforts should be made to maximize the utility of surveillance data for research purposes.

It is important to know the quality of the surveillance data being collected if one plans to make policy recommendations based upon it. PRAMS response rates and the consistency of the maternal mental health measures, as well as their comparability to study data, provide greater confidence in PRAMS quality. As with any data, the results related to maternal mood must be presented in the context of potential limitations. These studies suggest that maternal mental health may be an important component of pregnancy-related surveillance and research activities in Minnesota. A thorough review and potential revision of these important measures would greatly enhance the validity and quality of this data.

Concluding Thoughts

There is a moral obligation for society to improve the health of women and their infants, with the best opportunities represented by prevention strategies. For a country with vast resources and sophisticated medical and public health infrastructures, the United States lags behind the developed world with respect to infant health [72]. The focus on neonatal medicine and its successes does not preclude the need for a focus on primary prevention. Such efforts will require a comprehensive approach that takes into account the individual, social and environmental factors that influence health outcomes. With the proposed expansion of health insurance to more segments of the population, paired with rising health costs as technology continues to improve, the need to prevent preterm and LBW births becomes a financial consideration, as well as a moral

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imperative. A fundamental shift from fixing health problems once they occur to preventing or reducing them has long been the goal of public health. That approach should be re-emphasized in the context of pregnancy-related mental health, health behaviors and the prevention of adverse birth outcomes.

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Appendix A.

**Summary of Instruments Used to
Assess Maternal Depression**

Screening Tool	Description
Beck Depression Inventory (BDI)	• Used to detect depressive symptoms • Self-administered • Seven items, takes approximately 5 minutes to finish
Center for Epidemiologic Study Depression Scale (CES-D)	• Measures depressive symptoms and feelings over past week • Self-Administered • Often 20 questions, but have shorter versions. Takes approximately 5 minutes to complete
Edinburgh Postnatal Depression Scale (EDPS)	• Created specifically for patients at risk for postpartum depression • Assesses depression and anxiety • Self-administered • Ten questions, takes 5-10 minutes to complete
Hamilton Rating Scale for Depression (HAM-D)	• Patient's level of depression before and after treatment • Administered by clinician • 21 items, but scored on first 17 items • 15-20 minutes to complete
Patient Health Questionnaire-2 (PHQ-2)	• Asks two questions about mood (currently in PRAMS for postpartum depressive symptoms) • Self-administered or administered by clinician • Takes less than one minute to complete • In clinical setting, positive result should receive follow-up screen • Endorsed by ACOG
Patient Health Questionnaire-9 (PHQ-9)	• Screens for depression and symptom severity • Self-administered • 9-item questionnaire, approximately 5 minutes to complete
Postpartum Depression Screening Scale (PDSS)	• Identify women at high risk for postpartum depression • Self-administered • 35-item questionnaire, typically completed in 5-10 minutes
Primary Care Evaluation of Mental Disorders Patient Questionnaire (PRIME-MD)	• Screens for signs and symptoms of mental health disorders • 26 items (2 questions related to depression) • Self-administered
Adapted in part from NIHCM Issue Brief [4]	

Appendix B.
Institutional Review Board Documentation
for PRAMS and Maternal Methamphetamine Study

The IRB: Human Subjects Committee renewed its approval of the referenced study listed below:

Study Number: 0607S90130

Principal Investigator: Wendy Hellerstedt

Expiration Date: 07/15/2009

Approval Date: 07/16/2008

Title(s):
Maternal Methamphetamine Use in Minnesota
_____

This e-mail confirmation is your official University of Minnesota RSPP notification of continuing review approval. You will not receive a hard copy or letter. This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

You may go to the View Completed section of http://eresearch.umn.edu/ to view or print your continuing review submission.

For grant certification purposes you will need this date and the Assurance of Compliance number, which is FWA00000312 (Fairview Health Systems Research FWA00000325, Gillette Childrens Specialty Healthcare FWA00004003). Approval will expire one year from that date. You will receive a report form two months before the expiration date.

In the event that you submitted a consent document with the continuing review form, it has also been reviewed and approved. If you provided a summary of subjects' experience to include non-UPIRTSO events, these are hereby acknowledged.

As Principal Investigator of this project, you are required by federal regulations to inform the IRB of any proposed changes in your research that will affect human subjects. Changes should not be initiated until written IRB approval is received. Unanticipated problems and adverse events should be reported to the IRB as they occur. Research projects are subject to continuing review.

If you have any questions, please call the IRB office at (612) 626-5654.

The IRB wishes you continuing success with your research.

MINNESOTA
MDH
DEPARTMENT OF HEALTH

Protecting, maintaining and improving the health of all Minnesotans

June 11, 2009

M. Elizabeth Gyllstrom
5041 Garfield Avenue S.
Minneapolis, MN 55419

Re: IRB: 06-148
IRB Original Review Date: August 7, 2006
Re-Review due in IRB Administrative Office: June 4, 2010
Approval Expires: August 7, 2010

Dear Beth:

Thank you for submitting the Re-Review of Exempt Research form for your proposal IRB #06-148, entitled "Maternal Depression: Analysis of Minnesota PRAMS data" to the Minnesota Department of Health's Institutional Review Board (IRB) for review.

The Board reviewed the materials and determined it to still be exempt from IRB review in accordance with 45 CFR 46.101(b). Your approval for this project will expire on **August 7, 2010**. A Re-review form will be sent to you two months before the expiration date.

As Principal Investigator of this project you are required by federal regulations to inform the IRB of any proposed changes in your research that will affect human subjects. Changes should not be initiated until written IRB approval is received. Adverse events must be reported to the Board as they occur. Should the focus of your study change, please notify the Board.

Please note that your project has been assigned a five-digit code number (above). Please use the five-digit code number **and** the title of your study in all future communication with the IRB office.

Thank you for your cooperation and good luck with your project.

Cordially,

Peter Rode
IRB Administrator
PO Box 64882
St. Paul, MN 55164-0882
651-201-5942

cc:
Ann Kowski

Appendix C.

Selected Questions from
PRAMS Phase 4 and Phase 5

Appendix C. Selected PRAMS Questions and Responses		

2002-2003	2004-2006	Question	Response Categories
Social Variables			
Q1	Q1	Just before you got pregnant, did you have health insurance (do not count Medicaid/Medical Assistance/MinnesotaCare)?	Y/N
Q2	Q2	Just before you got pregnant, were you on Medicaid/Medical Assistance/Minnesota Care?	Y/N
	Q66	During the 12 months before your new baby was born, what was your total household income before taxes? Include your income, your husband's or partner's income, and any other income you may have used.	Please check one answer: -Less than $10,000 -$10,000-$14,999 -$15,000-$19,999 -$20,000-$24,999 -$25,000-$34,999 -$35,000-$49,999 -$50,000 or more
Q81	Q74	Since you delivered your new baby, who would help you if a problem came up? (For example, who would help you if you needed to borrow $50 or if you got sick and had to be in bed for several weeks?)	Please check all that apply: -My husband or partner -My mother, father or in-laws -Other family member or relative -A friend -Someone else -No one would help me
Health Status			
Q7	Q7	Would you say that, in general, your health is--	-Excellent -Very good -Good -Fair -Poor
Q27	Q27	a. High blood sugar (diabetes) that started before this pregnancy b. High blood sugar (diabetes) that started during this pregnancy c. Vaginal bleeding d. Kidney or bladder (urinary tract) infection e. Severe nausea, vomiting, or dehydration f. Cervix had to be sewn shut	N/Y for all sub-questions

Appendix C. Selected PRAMS Questions and Responses			
2002-2003	2004-2006	Question	Response Categories
		(incompetent cervix) g. High blood pressure, hypertension (including pregnancy-induced hypertension [PIH], preeclampsia or toxemia h. Problems with the placenta (such as abruptio placentae or placenta previa) i. Labor pains more than 3 weeks before my baby was due (preterm or early labor) j. Water broke more than 3 weeks before my baby was due (premature rupture of membranes [PROM]) k. I had to have a blood transfusion l. I was hurt in a car accident	
Q28	Q28	Did you do any of the following things because of these problems? a. I went to the hospital or emergency room and stayed less than 1 day b. I went to the hospital and stayed 1 to 7 days c. I went to the hospital and stayed more than 7 days d. I stayed in bed at home more than 2 days because of my doctor's or nurse's advice	N/Y for all sub-questions
Q40	Q40	When was your baby due?	MM/DD/YYYY
Q41	Q41	When did you go into the hospital to have your baby?	MM/DD/YYYY
Q42	Q42	When was your baby born?	MM/DD/YYYY
Health Behaviors			
Q29	Q29	Have you smoked at least 100 cigarettes in the past 2 years?	Y/N
Q30	Q30	In the 3 months before you got pregnant, how many cigarettes did you smoke on an average day? (A pack has 20 cigarettes)	-41 cigarettes or more -21-40 cigarettes -11-20 cigarettes -6-10 cigarettes -1-5 cigarettes -Less than 1 cigarette -None (0 cigarettes)
Q31	Q31	In the last 3 months of your pregnancy, how many cigarettes did you smoke on an average day? (A pack has 20 cigarettes)	-41 cigarettes or more -21-40 cigarettes -11-20 cigarettes

Appendix C. Selected PRAMS Questions and Responses			
2002-2003	**2004-2006**	**Question**	**Response Categories**
			-6-10 cigarettes -1-5 cigarettes -Less than 1 cigarette -None (0 cigarettes)
Q32	Q32	How many cigarettes do you smoke on an average day now?	-41 cigarettes or more -21-40 cigarettes -11-20 cigarettes -6-10 cigarettes -1-5 cigarettes -Less than 1 cigarette -None (0 cigarettes)
Q33	Q33	Have you had any alcoholic drinks in the past 2 years? (A drink is 1 glass of wine, wine cooler, can or bottle of beer, shot of liquor, or mixed drink)	N/Y
Q34a	Q34a	During the 3 months before you got pregnant, how many alcoholic drinks did you have in an average week?	-14 drinks or more a week -7-13 drinks a week -4-6 drinks a week -1-3 drinks a week -Less than 1 drink a week -I didn't drink then
Q35a	Q35a	During the last 3 months of your pregnancy, how many alcoholic drinks did you have in an average week?	-14 drinks or more a week -7-13 drinks a week -4-6 drinks a week -1-3 drinks a week -Less than 1 drink a week -I didn't drink then
Q51	Q49	Did you ever breastfeed or pump breast milk to feed your new baby after delivery?	N/Y
Q52	Q50	What were your reasons for not breastfeeding your new baby?	Please check all that apply: -My baby was sick and could not breastfeed -I was sick or on medicine -I had other children to take care of -I had too many household duties

Appendix C. Selected PRAMS Questions and Responses			
2002-2003	**2004-2006**	**Question**	**Response Categories**
			-I didn't like breastfeeding -I didn't want to be tied down -I was embarrassed to breastfeed -I went back to work or school -I wanted my body back to myself -Other
Q53	Q51	Are you still breastfeeding or feeding pumped milk to your new baby?	N/Y
Q54	Q52	How many weeks or months did you breastfeed or pump milk to feed your baby?	___weeks or ___ months ___Less than 1 week
Q55	Q53	What were your reasons for stopping breastfeeding?	Please check all that apply: -My baby had difficulty nursing -Breast milk alone did not satisfy my baby -I thought my baby was not gaining enough weight -My baby got sick and could not breastfeed -My nipples were sore, cracked or bleeding -I thought I was not producing enough milk -I had too many other household duties -I felt it was the right time to stop breastfeeding -I got sick and could not breastfeed -I went back to work or school -I wanted or needed someone else to feed the baby

Appendix C. Selected PRAMS Questions and Responses			
2002-2003	**2004-2006**	**Question**	**Response Categories**
			-My baby was jaundiced -Other:
Emotional Factors			
Q12	Q12	Thinking back to before you got pregnant with your new baby, how did you feel about becoming pregnant?	Check one answer: -I wanted to be pregnant sooner -I wanted to be pregnant later -I wanted to be pregnant then -I didn't want to be pregnant then or at any time in the future
Q13	Q13	When you got pregnant with your new baby, were you trying to get pregnant?	N/Y
Q76	Q70	How did you feel when you found out you were pregnant with your new baby?	Were you— -Very unhappy to be pregnant -Unhappy to be pregnant -Not sure -Happy to be pregnant -Very happy to be pregnant
Q75	Q69	Thinking back to just before you got pregnant with your new baby, how did your husband or partner feel about your becoming pregnant?	Check one answer— -He wanted me to be pregnant sooner -He wanted me to be pregnant later -He wanted me to be pregnant then -He didn't want me to be pregnant then or at any time in the future -I don't know -I didn't have a husband or partner
Q36	Q36	This question is about things that may have happened during the 12 months before your new baby was born. a. A close family member was very sick and had to go into the hospital b. I got separated or divorced from my	Y/N for each

195

Appendix C. Selected PRAMS Questions and Responses			
2002-2003	**2004-2006**	**Question**	**Response Categories**
		husband or partner c. I moved to a new address d. I was homeless e. My husband or partner lost his job f. I lost my job even though I wanted to go on working g. I argued with my husband or partner more than usual h. My husband or partner said he didn't want me to be pregnant i. I had a lot of bills I couldn't pay j. I was in a physical fight k. My husband or partner or I went to jail l. Someone very close to me had a bad problem with drinking or drugs m. Someone very close to me died	
Q37	Q37	a. During the 12 months before you got pregnant, did an ex-husband or ex-partner push, hit, slap, kick, choke or physically hurt you in any other way? b. During the 12 months before you got pregnant, were you physically hurt in anyway by your husband or partner?	N/Y for both
Q38	Q38	a. During your most recent pregnancy, did an ex-husband or ex-partner push, hit, slap, kick, choke or physically hurt you in any other way? b. During your most recent pregnancy were you physically hurt in anyway by your husband or partner?	N/Y for both
Q39	Q39	How would you describe the time during your most recent pregnancy?	Check one answer: -One of the happiest times of my life -A happy time with few problems -A moderately hard time -A very hard time -One of the worst times of my life
Q69	Q75a	Since your new baby was born, how often have you felt down, depressed or hopeless?	-Always -Often -Sometimes

Appendix C. Selected PRAMS Questions and Responses			
2002-2003	**2004-2006**	**Question**	**Response Categories**
			-Rarely -Never
Q70	Q75b	Since your new baby was born, how often have you had little interest or little pleasure in doing things?	-Always -Often -Sometimes -Rarely -Never
	Q76	At any time during your most recent pregnancy or after delivery, did a doctor, nurse, or other health care worker talk with you about "baby blues" or postpartum depression?	N/Y
Medical Care			
Q18	Q18	How many weeks or months pregnant were you when you had your first visit for prenatal care? Do not count a visit that was only for a pregnancy test or only for WIC	__ weeks or __ months __ I didn't go for prenatal care
Q19	Q19	Did you get prenatal care as early in your pregnancy as you wanted?	N/Y __ I didn't want prenatal care
Q20	Q20	Here is a list of problems some women can have getting prenatal care. For each item circle Yes or No a. I couldn't get an appointment when I wanted one b. I didn't have enough money or insurance to pay for my visits c. I had no way to get to the clinic or doctor's office d. I couldn't take time off from work e. The doctor or my health plan would not start care as early as I wanted f. I didn't have my Medicaid, Medical Assistance or MinnesotaCare card g. I had no one to take care of my children h. I had too many other things going on i. I didn't want anyone to know I was pregnant j. Other:	N/Y
Q68	Q64	Since your new baby was born, have you had a postpartum checkup for yourself? (A postpartum checkup is the regular checkup a woman has after she gives birth)	N/Y

Appendix D.

Maternal Methamphetamine Study
Quantitative and Qualitative Instruments

Section 1: Pregnancy and medical care

1. How many weeks or months pregnant were you when you **first found out** you were pregnant? (for example, you took a pregnancy test or a doctor or nurse said you were pregnant)

   [ ][ ] Weeks pregnant **OR**   [ ] Months pregnant **OR**   1 [ ] I don't remember

   1-4

2. When is your baby due?

   [ ][ ]   [ ][ ]   [ ][ ][ ][ ]   **OR**   1 [ ] I don't remember

   Month   Day   Year

   5-13

3. Think back to just before you got pregnant, how did you feel about becoming pregnant? Would you say you:

   1 [ ] Wanted to be pregnant sooner

   2 [ ] Wanted to be pregnant later

   3 [ ] Wanted to be pregnant then

   4 [ ] Didn't want to be pregnant then or at anytime in the future

   14

4. Think back to when you **first got pregnant**. Were you **trying** to get pregnant?

   15

   1 [ ] Yes, I was trying to get pregnant **GO TO QUESTION 6, NEXT PAGE**

   2 [ ] I do not know how I felt about pregnancy or I did not care about pregnancy **GO TO QUESTION 5**

   3 [ ] No, I was trying to avoid getting pregnant **GO TO QUESTION 5**

5. When you became pregnant, what kind of birth control were you using? **CHECK ALL THAT APPLY:**
[ ] No birth control
[ ] Birth Control Pills
[ ] Condoms
[ ] Foam, Jelly, Cream
[ ] Norplant
[ ] Withdrawal
[ ] Tubes tied (sterilization)

   16-24

199

6. Thinking about how you **currently** feel about your pregnancy **most of the time**, do you feel: 25

1 ☐ Very happy

2 ☐ Happy

3 ☐ Unhappy

4 ☐ Very unhappy

5 ☐ Not sure how I feel

7. **At the time you found out you were pregnant**, what was your relationship to the baby's father?   26

1 ☐ Married or engaged to him

2 ☐ Living together, but not engaged or married

3 ☐ Only dating him or going steady

4 ☐ Going out with him once in a while

5 ☐ Just friends

6 ☐ Had just met him

7 ☐ None of the above

8. Have you seen a doctor or nurse at any clinic for prenatal care during this pregnancy?   27

1 ☐ Yes   **GO TO QUESTIONS 9-12**

0 ☐ No   **GO TO QUESTION 13, <u>PAGE 4</u>**

9. How many visits to a clinic have you had for this pregnancy?   28-30

☐☐ Visits   **OR**   1 ☐ I don't remember

200

10. How many weeks or months pregnant were you when you had your **first visit for prenatal care**? Do not count a visit that was only for a pregnancy test or only for WIC.

31-34

| | Weeks pregnant **OR** | | Months pregnant **OR** | ₁ ☐ I don't remember |

11. Did your doctor or nurse have you take any medications during your pregnancy?

35

₁ ☐ Yes
GO TO QUESTION 12

₀ ☐ No **GO TO QUESTION 13, NEXT PAGE**

12. What were the medications for?
   CHECK ALL THAT APPLY:

36-46

☐ Prenatal vitamins

☐ Diabetes

☐ Hypertension

☐ Kidney infection

☐ Back pain

☐ Excess fluid retention

☐ Preterm labor

☐ Depression

☐ Anxiety

☐ Nausea/Constipation

☐ Other, please list:_____

Section 2: Your experiences with drugs

13. Have you smoked cigarettes **even once** in the past year?   47

1 ☐ Yes
GO TO QUESTION 14

0 ☐ No   **GO TO QUESTION 18, NEXT PAGE**

14. Did you smoke **ANY CIGARETTES** within 3 months before you got pregnant?   48

1 ☐ Yes
0 ☐ No

15. Did you smoke **ANY CIGARETTES** during the 1st trimester (months 1,2,3) of this pregnancy?   49

1 ☐ Yes
0 ☐ No

16. Did you smoke **ANY CIGARETTES** during the 2nd trimester (months 4,5,6) of this pregnancy?   50

1 ☐ Yes
2 ☐ No
3 ☐ I have not reached my 2nd trimester of   pregnancy yet. **GO TO QUESTION 18,**
                    NEXT PAGE

17. Did you smoke **ANY CIGARETTES** during the 3rd trimester (months 7,8,9) of this pregnancy?   51

1 ☐ Yes
2 ☐ No
3 ☐ I have not reached my 3rd trimester of   pregnancy yet

18. Did you drink alcohol during the **3 months before** you got pregnant? 52

1 ☐ Yes
GO TO QUESTION 19

> 19. Did you **ever have 4 or more drinks** at one time during the 3 months before you got pregnant? 53
>
> 1 ☐ Yes
>
> 0 ☐ No

0 ☐ No
GO TO QUESTION 20

20. Did you drink alcohol during the **1st trimester** (months 1, 2, 3) of this pregnancy? 54

1 ☐ Yes
GO TO QUESTION 21

> 21. DId you **ever have 4 or more drinks** at one time in your 1st trimester? 55
>
> 1 ☐ Yes
>
> 0 ☐ No

0 ☐ No
GO TO QUESTION 22

22. Did you drink alcohol during **2nd trimester** (months 4, 5, 6) of this pregnancy? 56

1 ☐ Yes
GO TO QUESTION 23

2 ☐ No **GO TO QUESTION 24, BELOW**

3 ☐ I have not reached the 2nd trimester of my pregnancy yet **GO TO QUESTION 26, NEXT PAGE**

> 23. Did you **ever have 4 or more drinks** at one time in your 2nd trimester? 57
>
> 1 ☐ Yes
>
> 0 ☐ No

58

24. Did you drink alcohol during **3rd trimester** (months 7, 8, 9) of this pregnancy?

1 ☐ Yes
GO TO QUESTION 25

2 ☐ No **GO TO QUESTION 26, NEXT PAGE**

> 25. Did you **ever have 4 or more drinks** at one time in your 3rd trimester? 59
>
> 1 ☐ Yes
>
> 0 ☐ No

203

3☐ I have not reached the 3rd trimester of my pregnancy yet. **GO TO QUESTION 26, NEXT PAGE**

60

26. Did you use marijuana or hashish during the **3 months before** you got pregnant?

1☐ Yes
GO TO QUESTION 27

0☐ No
GO TO QUESTION 28

27. How often did you **usually** use marijuana during the 3 months before you got pregnant?

61

1☐ 1 or fewer days per week

2☐ 2-3 days per week

3☐ 4-6 days per week

4☐ Every day

28. Did you use marijuana or hashish during the **1st trimester** (months 1, 2, 3) of this pregnancy?

62

1☐ Yes
GO TO QUESTION 29

0☐ No
GO TO QUESTION 30

29. How often did you **usually** use marijuana in your 1st trimester?

63

1☐ 1 or fewer days per week

2☐ 2-3 days per week

3☐ 4-6 days per week

4☐ Every day

30. Did you use marijuana or hashish during the **2nd trimester** (months 4, 5, 6) of this pregnancy?

64

1☐ Yes
GO TO QUESTION 31

2☐ No **GO TO QUESTION 32, BELOW**

3☐ I have not reached my 2nd trimester of pregnancy yet
GO TO QUESTION 34, NEXT PAGE

31. How often did you **usually** use marijuana in your 2nd trimester?

65

1☐ 1 or fewer days per week

2☐ 2-3 days per week

3☐ 4-6 days per week

4☐ Every day

32. Did you use marijuana or hashish during the **3rd trimester** (months 7, 8, 9) of this pregnancy?

66

1 ☐ Yes **GO TO QUESTION 33**

2 ☐ No **GO TO QUESTION 34, NEXT PAGE**

3 ☐ I have not reached my 3rd trimester of pregnancy yet **GO TO QUESTION 34, NEXT PAGE**

33. How often did you **usually** use marijuana in your 3rd trimester? | 67

1 ☐ 1 or fewer days per week

2 ☐ 2-3 days per week

3 ☐ 4-6 days per week

4 ☐ Every day

34. Did you use methamphetamine (meth) during the **3 months before** you got pregnant? | 68

1 ☐ Yes **GO TO QUESTION 35**

0 ☐ No **GO TO QUESTION 36**

35. How often did you **usually** use meth during the 3 months before you got pregnant? | 69

1 ☐ 1 or fewer days per week

2 ☐ 2-3 days per week

3 ☐ 4-6 days per week

4 ☐ Every day

36. Did you use methamphetamine (meth) during the **1st trimester** (months 1, 2, 3) of this pregnancy? | 70

1 ☐ Yes **GO TO QUESTION 37**

0 ☐ No **GO TO QUESTION 38**

37. How often did you **usually** use meth in your 1st trimester? | 71

1 ☐ 1 or fewer days per week

2 ☐ 2-3 days per week

3 ☐ 4-6 days per week

4 ☐ Every day

38. Did you use methamphetamine (meth) during the **2nd trimester** (months 4,5,6) of this pregnancy? | 72

1 ☐ Yes **GO TO QUESTION 39**

2 ☐ No **GO TO QUESTION 40, BELOW**

3 ☐ I have not reached

39. How often did you **usually** use meth in your 2nd trimester? | 73

1 ☐ 1 or fewer days per week

2 ☐ 2-3 days per week

3 ☐ 4-6 days per week

4 ☐ Every day

my 2nd trimester of
pregnancy yet
**GO TO QUESTION 42,
NEXT PAGE**

40. Did you use methamphetamine (meth) during the **3rd trimester** (months 7, 8, 9) of this pregnancy?

74

1 ☐ Yes ➡
GO TO QUESTION 41

2 ☐ No **GO TO
QUESTION 42, NEXT
PAGE**

3 ☐ I have not reached
my 3rd trimester of
pregnancy yet
**GO TO QUESTION 42,
NEXT PAGE**

41. How often did you **usually** use meth in your 3rd trimester?

75

1 ☐ 1 or fewer days per week

2 ☐ 2-3 days per week

3 ☐ 4-6 days per week

4 ☐ Every day

42. Which of the following drugs did you use **EVEN ONCE <u>during the three months before you got pregnant or during this pregnancy.</u>**

CHECK ALL THAT APPLY:

☐ Inhalants

☐ Ecstasy (MDMA)

☐ Methamphetamine

☐ Amphetamines other than methamphetamine

☐ Bezodiazepines/tranquiizers (Valium, Xanax, Librium)

☐ Cocaine

☐ Crack Cocaine

☐ Heroin or methadone

☐ Other opiates (Oxycodone, Percocet, codeine, morphine, opium, Vicodin)

☐ LSD/hallucinogens (acid, mesc, peyote, shrooms, magic mushrooms)

☐ PCP (angel dust)

☐ Barbituates/sedatives (amytal, Nembutal, Phenobarbital, reds, seconal)

☐ Ketamine (Special K)

☐ GHB (G)

☐ Prescription drugs that were prescribed for someone else

☐ Other: please list _____

☐ I did not use any of the drugs listed above

YOUR METH USE DURING THIS PREGNANCY

43. **During this pregnancy**, did you use meth with other people?

₁ ☐ Yes ➡️
GO TO QUESTION 44-45

₀ ☐ No
**GO TO QUESTION 46,
NEXT PAGE**

⬇️

---

44. Thinking about all of the times you used meth **during this pregnancy,** how often did you do meth with other people?

94

CHECK ONE ANSWER:

₁ ☐ When I used meth, I **almost always used it   alone**

₂ ☐ I sometimes used meth with other people, but I used it alone **more than half of the time**

₃ ☐ I used meth alone about half the time and with people about half of the time

₄ ☐ I sometimes used meth alone, but I used meth with other people **more than half of the time**

₅ ☐ I **always** used meth with other people

45. Who did you use meth with **during this pregnancy**?

95-104

CHECK ALL THAT APPLY:

☐ Friends

☐ Mother/stepmother

☐ Father/stepfather

☐ Brothers or sisters

☐ Other family members (such as cousin, uncle, aunt,

grandparent)

☐ Husband, boyfriend, or partner

☐ Strangers

☐ People I see **only** when I used meth

☐ Co-workers

	Other people not listed above

46. Where did you **usually** use meth **during this pregnancy**?

105-112

   CHECK ALL THAT APPLY:

   ☐ Your home

   ☐ Homes of other people

   ☐ At work

   ☐ Bars or clubs

   ☐ In cars or trucks

   ☐ Outside

   ☐ At school

   ☐ Other, please list: _____

47. Have you ever quit using meth **during this pregnancy**?

113

$_1$☐ Yes
GO TO QUESTIONS 48-49

$_0$☐ No
GO TO QUESTION 50

48. How many times have you quit using meth **during this pregnancy**?

114

$_1$☐ 1 time

$_2$☐ 2 times

$_3$☐ 3 or more times

49. What is the longest time you have been clean (did not use meth) **during this pregnancy?**

115

$_1$☐ 1-7 days

$_2$☐ 8-29 days

$_3$☐ 1-3 months

$_4$☐ 3 or more months

50.   On a scale of 0 -10, where 0 is "not at all sure" and 10 is "extremely sure," how sure are you that **you could stop using meth <u>for the rest of your pregnancy</u>** if you decided to do so?

CIRCLE ONE NUMBER:

0	1	2	3	4	5	6	7	8	9	10

Not at all sure   Kind of sure   Extremely sure

QUESTIONS ABOUT WHEN YOU FIRST TRIED METH

51. How old were you when you first used meth?

☐☐ Years Old

52. **After the first time** you tried meth, how soon did you use it again?

1☐ I used meth again within one week

2☐ I used meth again more than a week but less than a month after I first tried it

3☐ I used meth again more than a month but less than a year after I first tried it

4☐ The second time I used meth was a year or longer after the first time I tried it

53. **The first few times** you tried meth, who did you use it with?
CHECK ALL THAT APPLY:

☐ Friends

☐ Mother or stepmother

☐ Father or stepfather

☐ Foster parent

☐ Brothers or sisters

☐ Other family members (such as a cousin, uncle, aunt, grandparent)

☐ Husband, boyfriend, or partner

☐ Strangers

☐ People I saw **only** when I used meth

☐ Co-workers

☐ Other people not listed above

54. How did you get meth **the first few times** you tried it? CHECK ALL THAT APPLY:

☐ Bought it with cash

☐ Someone gave it to me

☐ I worked for it (such as sold it, distributed it, made it)

☐ I traded something for it (such as jewelry, food stamps)

☐ Other, please list:

_____

211

55. In what situations did you use meth?

137-
154

CHECK ALL THAT APPLY:

☐ When I wanted to fit in with other people

☐ When I wanted to feel confident or good about myself

☐ To celebrate or party

☐ After I had an argument

☐ Because I liked feeling high

☐ Because I liked feeling numb

☐ When I felt depressed

☐ When I got paid

☐ To help me relax or unwind

☐ When I wanted to feel in control

☐ When I felt sad or lonely

☐ When I felt happy

☐ When I felt stressed or anxious

☐ When I needed energy to do things, like housework, errands, etc.

☐ When I felt bored

☐ When I wanted to forget my problems

☐ When wanted to lose weight or control my weight

☐ Other, please list: _____

56. Did you use meth with other people?

₁ ☐ Yes **→**
GO TO QUESTION 57-58

₀ ☐ No **GO TO QUESTION 59, NEXT PAGE**

↓

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57. Thinking about **all of the times** you used meth**,** how often did you **generally** do meth with other people?

CHECK ONE ANSWER:

₁ ☐ When I used meth, I **almost always used it alone**

₂ ☐ I **sometimes** used meth with other people, but I used it **alone more than half the time**

₃ ☐ I used meth alone about half the time and with other people about half of the time

₄ ☐ I sometimes used meth alone, but I used meth **with other people more than half of the time**

₅ ☐ I **always** used it with other people

58. Who did you use meth with?

CHECK ALL THAT APPLY:

☐ Friends

☐ Mother/stepmother

☐ Father/stepfather

☐ Other family members (such as cousin, uncle,
                                                aunt,
grandparent)

☐ Husband, boyfriend, or partner

☐ Strangers

☐ People I saw **only** when I used meth

☐ Co-workers

☐ Other people not listed above

59. Thinking about when you used meth, how many of your friends also used meth? 166

    1 ☐ **All or almost all** of my friends used meth

    2 ☐ **More than half** of my friends used meth

    3 ☐ **About half** of my friends used meth

    4 ☐ **Less than half** of my friends used meth

    5 ☐ **Very few** of my friends used meth

    6 ☐ **None** of my friends used meth

60. Thinking about when you used meth, how many of your **<u>close</u> family members** also used meth? 167

    1 ☐ **Almost all** of my family members used meth

    2 ☐ **About half** of my family members used meth

    3 ☐ **Less than half** of my family members used meth

    4 ☐ **Very few** of my family members used meth

    5 ☐ **None** of my family members used meth

    6 ☐ I did not have close family members

61. Did the people you consider to be <u>close</u> family members know you used meth, **at the time you were using it most frequently?** 168

    1 ☐ Yes

    2 ☐ No

    3 ☐ I don't know

    4 ☐ I did not have close family members

62. How did you usually get meth? **CHECK ALL THAT APPLY:** 169-173

☐ Bought it with cash

☐ Someone else gave it to me

☐ I worked for it (such as sold it, distributed it, made it)

☐ I traded something for it (such as jewelry, food stamps)

☐ Other, please list:

_____

63. Did you ever quit using meth **before you got pregnant**? 174

₁☐ Yes
GO TO QUESTION 64-65

₀☐ No
GO TO QUESTION 66
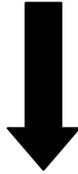
64. How many times did you quit using meth **before you got pregnant?** 175

₁☐ 1 time

₂☐ 2 times

₃☐ 3 or more times

65. What was the longest time you were clean (did not use meth) **before you got pregnant**? 176

₁☐ 1-7 days

₂☐ 8-29 days

₃☐ 1-3 month(s)

₄☐ 3 or more months

215

66.

On a scale of 0-10, where 0 is "not at all sure" and 10 is "extremely sure," how sure are you that you could stop using meth **for the rest of your life** if you decided to do so?

CIRCLE ONE NUMBER:

0   1   2   3   4   5   6   7   8   9   10

Not at all sure   Kind of sure   Extremely sure

67. Thinking about your meth use **in general**, were any of the following true for you during the **last year you used meth**? 179-200

CHECK ALL THAT APPLY:

☐ Thinking about meth most of the time

☐ Feeling more in control because of my meth use

☐ Feeling more sexual because of my meth use

☐ Hiding my meth use from other people

☐ Using more meth than I planned to use

☐ Using meth very quickly, until my supply was gone

☐ Noticing that meth did not affect me as positively as it one did

☐ Using meth for two or more days, continuously (without stopping)

☐ Trying to stop using meth, but being unable to stop

☐ Feeling withdrawal symptoms after stopping meth

☐ Feeling I could connect with people better because of meth

☐ Needing to use meth every day to function

☐ Damaging family relationships because of my meth use

☐ Losing friends because of my meth use

☐ Making new friends because of my meth use

☐ Driving while under the influence of meth

☐ Becoming violent or hurting someone physically because of meth use

☐ Having job or employment problems because of meth use

☐ Had unsafe sex because of meth use

☐ Had sex with someone I did not want to have sex with because of meth use

☐ Arrested because of meth problems

☐ Did not eat regularly or did not eat nutritious meals because of my meth use

68. How many times in your life have you been in treatment for drug or alcohol problems?

201-203

▢▢ Times OR ₁▢ Never

69. Have any of your close relatives such as a brother, sister, parent, grandparent ever been in treatment for drug or alcohol problems?

204

₁▢ Yes

₂▢ No

₃▢ I do not know

Section 3: Your feelings and well-being

70. The following are statements about your teen years.
Think about **how you felt as a teenager (ages 14 to 16) most of the time**.

CHECK THE BOX that best describes if you feel the statement was true: **NONE OF THE TIME, A LITTLE OF THE TIME, SOMETIMES, MOST OF THE TIME**, or **ALL OF THE TIME,** when you were between the ages of 14 and 16.

When you were 14 to 16 years-old, did you:	None of the time	A little of the time	Sometimes	Most of the time	All of the time	
a. Feel good about yourself as a person?	1☐	2☐	3☐	4☐	5☐	205
b. Have a parent to talk to about your problems?	1☐	2☐	3☐	4☐	5☐	206
c. Have a trusted adult other than a parent to talk to about your problems?	1☐	2☐	3☐	4☐	5☐	207
c. Have a boyfriend to talk to about your problems?	1☐	2☐	3☐	4☐	5☐	208
d. Have a female friend to talk to about your problems?	1☐	2☐	3☐	4☐	5☐	209
e. Feel that your family understood you and your feelings?	1☐	2☐	3☐	4☐	5☐	210
f. Feel that teachers cared about you in school?	1☐	2☐	3☐	4☐	5☐	211
g. Feel that you were bullied by people your own age?	1☐	2☐	3☐	4☐	5☐	212
h. Feel good about your ability to perform well in school?	1☐	2☐	3☐	4☐	5☐	213
i. Feel good about the way you looked?	1☐	2☐	3☐	4☐	5☐	214
j. Feel that your home was emotionally stable?	1☐	2☐	3☐	4☐	5☐	215
k. Feel that your home was financially stable?	1☐	2☐	3☐	4☐	5☐	216

71. Below is a list of common sources of stress. **Thinking about the past few months,**

    CHECK THE BOX that best describes if you feel worried about each kind of stress:
     NOT AT ALL, A LITTLE, SOMEWHAT, OR VERY MUCH OF THE TIME.

Source of Stress	Not at all	A little	Somewhat	Very Much	
a. Financial worries	1 ☐	2 ☐	3 ☐	4 ☐	217
b. Unemployment	1 ☐	2 ☐	3 ☐	4 ☐	218
c. Stress from a relationship	1 ☐	2 ☐	3 ☐	4 ☐	219
d. Boredom	1 ☐	2 ☐	3 ☐	4 ☐	220
e. Feeling depressed or hopeless	1 ☐	2 ☐	3 ☐	4 ☐	221
f. Worries about my pregnancy	1 ☐	2 ☐	3 ☐	4 ☐	222
g. Lacking transportation	1 ☐	2 ☐	3 ☐	4 ☐	223
h. Craving alcohol or drugs	1 ☐	2 ☐	3 ☐	4 ☐	224
i. Grief or loss of someone I love	1 ☐	2 ☐	3 ☐	4 ☐	225
j. Job stress	1 ☐	2 ☐	3 ☐	4 ☐	226
k. Unable to think or concentrate	1 ☐	2 ☐	3 ☐	4 ☐	227
l. Finding a place to live	1 ☐	2 ☐	3 ☐	4 ☐	228
m. Difficulty falling asleep or staying asleep	1 ☐	2 ☐	3 ☐	4 ☐	229
n. Thoughts of suicide	1 ☐	2 ☐	3 ☐	4 ☐	230
o. Concerns about my sexuality or sexual orientation	1 ☐	2 ☐	3 ☐	4 ☐	231

72. Below is a list of ways people may support you. **Thinking about the past month,**

CHECK THE BOX that best describes if you feel the statement has been true: **NONE OF THE TIME, A LITTLE OF THE TIME, SOMETIMES, MOST OF THE TIME,** or **ALL OF THE TIME,** in the **PAST MONTH**.

Feeling of support:	None of the time	A little of the time	Sometimes	Most of the time	All of the time	
a. I have someone to confide in or talk to about my problems	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	232
b. I have someone to get together with for relaxation	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	233
c. I have someone to help me with daily chores if I become sick	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	234
d. I have someone to turn to for suggestions about how to handle a personal problem	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	235
e. I have someone to love and make me feel wanted	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	236

73. Below is a list of the ways you may have felt or behaved. **Thinking about the past week,**

CHECK THE BOX that <u>best</u> describes how often these statements have been true for you over the **PAST WEEK**.

Feeling or Behavior	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	A moderate amount of time (3-4 days)	Most or all of the time (5-7 days)	
a. I was bothered by things that usually don't bother me	1 ☐	2 ☐	3 ☐	4 ☐	237
b. I did not feel like eating; my appetite was poor	1 ☐	2 ☐	3 ☐	4 ☐	238
c. I felt that I could not shake off the blues even with help from my family or friends	1 ☐	2 ☐	3 ☐	4 ☐	239
d. I felt I was just as good as other people	1 ☐	2 ☐	3 ☐	4 ☐	240
e. I had trouble keeping my mind on what I was doing	1 ☐	2 ☐	3 ☐	4 ☐	241
f. I felt depressed	1 ☐	2 ☐	3 ☐	4 ☐	242
g. I felt that everything I did was an effort	1 ☐	2 ☐	3 ☐	4 ☐	243
h. I felt hopeful about the future	1 ☐	2 ☐	3 ☐	4 ☐	244
i. I thought my life had been a failure	1 ☐	2 ☐	3 ☐	4 ☐	245
j. I felt fearful	1 ☐	2 ☐	3 ☐	4 ☐	246
k. My sleep was restless	1 ☐	2 ☐	3 ☐	4 ☐	247
l. I was happy	1 ☐	2 ☐	3 ☐	4 ☐	248
m. I talked less than usual	1 ☐	2 ☐	3 ☐	4 ☐	249
n. I felt lonely	1 ☐	2 ☐	3 ☐	4 ☐	250
o. People were unfriendly	1 ☐	2 ☐	3 ☐	4 ☐	251
p. I enjoyed life	1 ☐	2 ☐	3 ☐	4 ☐	252
q. I had crying spells	1 ☐	2 ☐	3 ☐	4 ☐	253
r. I felt sad	1 ☐	2 ☐	3 ☐	4 ☐	254
s. I felt that people dislike me	1 ☐	2 ☐	3 ☐	4 ☐	255
t. I could not get "going"	1 ☐	2 ☐	3 ☐	4 ☐	256

74. Have you ever been treated for any psychological or emotional problems?   257

$_1$☐ Yes

$_0$☐ No

75. Has any close relative such as a parent, grandparent, brother, or sister ever been treated for psychological or emotional problems?   258

$_1$☐ Yes

$_2$☐ No

$_3$☐ I don't know

76. Has your husband, boyfriend, or partner ever abused your emotionally (such as rejected you or made you feel bad through harsh words)?   259

$_1$☐ Yes

$_0$☐ No

77. Has your husband, boyfriend, or partner ever hurt you physically (such as hit you, scratched you, pushed you, or made you afraid because of physical actions)?   260

$_1$☐ Yes

$_0$☐ No

78. Has anyone in your family **ever** hurt you physically (such as hit you, scratched you, pushed you, or made you afraid because of physical actions)?   261-264

CHECK ALL THAT APPLY:

☐ Yes, when I was a child

☐ Yes, when I was a teenager (18 years or younger)

☐ Yes, when I was an adult (older than 18 years)

☐ No, I was never physically harmed by a family member

Section 4: Your neighborhood

79. Which race or ethnic group(s) best describes you?

CHECK ALL THAT APPLY:

☐ White/Non-Hispanic

☐ Hispanic/Latino

☐ Asian

☐ Black

☐ American Indian

☐ Middle Eastern

☐ Other, please list: _____

80. In what country were you born?

1 ☐ USA

0 ☐ Other, please list:

_____

81. What is your marital status?

1 ☐ Married

2 ☐ Living with boyfriend or partner

3 ☐ Separated

4 ☐ Divorced

5 ☐ Widowed

6 ☐ Never married

82. What is your birth date?

☐☐ Month ☐☐ Day ☐☐☐☐ Year

83. Have you had health insurance at any time during your pregnancy? 282

1☐ Yes

2☐ No

3☐ I don't know

84. Who do you live with most of the time? 283-292

CHECK ALL THAT APPLY:

☐ Alone

☐ With my mother or stepmother

☐ With my father or stepfather

☐ With other family member(s)

☐ With the father of the baby I am carrying

☐ With a sexual partner who is not the father of the baby I am carrying

☐ With friends

☐ In a residential program

☐ I have no stable home most of the time

☐ In a shelter

85. Have you been pregnant before?

293

1 ☐ Yes ➡

GO TO QUESTIONS 86-92

0 ☐ No **GO TO QUESTION 93, NEXT PAGE**

Answer these questions only if you have been pregnant before:

86. How many times have you been pregnant (not counting this pregnancy)?

294-295

☐☐ Times

87. How old were you the first time you were pregnant?

296-297

☐☐ Years old

88. How many live births have you had?

298-299

☐☐ Live births

89. Have you ever had an abortion?

1 ☐ Yes ➡ 90. **If yes,** How many?

300

0 ☐ No Abortions

☐☐

301-302

91. Have you ever had a stillbirth or miscarriage?

303

1 ☐ Yes ➡ 92. **If yes,** How many**?**

0 ☐ No Stillbirths

☐☐

304-305

or

miscarriages

93. How many children under age 18 have lived with you most of the time in the **past year**?

☐ ☐ Children

94. Please list your work status now.

CHECK ONE RESPONSE:

1 ☐ Employed for wages

2 ☐ Self- employed

3 ☐ Out of work for **more** than one year

4 ☐ Out of work for **less** than one year

5 ☐ A homemaker

6 ☐ A student

7 ☐ Unable to work because of disability

8 ☐ Unable to work because of my pregnancy

95. Who contributes money to your household now, for food, rent, utilities, transportation, etc.?

CHECK ALL THAT APPLY:

☐ You

☐ The father of the baby I am carrying

☐ A sexual partner who is not the father of the baby I am carrying

☐ Other adult (parent, friend)

☐ Government or welfare

☐ Other source

96. What was the total income in your household over the past year?

   1☐ Less than $10,000

   2☐ $10,000-$14,999

   3☐ $15,000-19,999

   4☐ $20,000-24,999

   5☐ $25,000-34,999

   6☐ $35,000-49,999

   7☐ $50,000 or more

97. What is the highest grade in school you have completed?

   1☐ Less than high school

   2☐ High school graduate or GED

   3☐ Some college

   4☐ Associate's or technical degree

   5☐ BA/BS or graduate degree

98. Did any of the following apply to you the last time you were in school?

   CHECK ALL THAT APPLY:

   ☐ Absent from school often

   ☐ Learning problems (such as attention deficit)

   ☐ Dropped out early because of personal/family problems

   ☐ Other, please list: _____

   ☐ I had no problems in school

99. Thinking about the last time you were in school (high school, technical school, or college), did any of the following exist at your school?

322-332

CHECK ALL THAT APPLY:

☐ Teachers did not care about students

☐ Teachers did not do things that helped students to learn

☐ Students used drugs or alcohol on school property

☐ School was not a physically safe place to be. For example, people were bullied or beaten up on school property

☐ There were many student groups that were hard to be part of

☐ I felt secure and comfortable at school

☐ I enjoyed school most of the time

☐ I disliked school most of the time

☐ I had teachers or other adults at school who I could talk to

☐ I had been bullied or beat up at school by other students

☐ I bulled or beat up other students at school

100. How old were you the first time you had sexual intercourse (vaginal intercourse)?

333-334

☐☐ Years Old

101. Are you currently on probation or parole?

335

1 ☐ Yes

0 ☐ No

102. Has a child ever been removed from your care either temporarily or permanently?

336

1 ☐ Yes

0 ☐ No

103. Have you moved to a different home in the past 2 years?

₁ ☐ Yes ➡
GO TO QUESTION 104

104. How many times have you moved to a different home in the last 2 years?

₁ ☐ I moved once

₂ ☐ I moved twice

₃ ☐ I moved three times

₄ ☐ I moved four times

₅ ☐ I moved five or more times

₀ ☐ No
GO TO QUESTION 105

⬇

105. Below is a list of characteristics that could be a stress in your neighborhood. **CHECK THE BOX** that describes if you feel the following issues in your neighborhood are: **NOT A PROBLEM, SOMEWHAT OF A PROBLEM, OR A BIG PROBLEM.**

Problem in your neighborhood	Not a problem	Somewhat of a problem	A big problem	
a. Unemployment	₁☐	₂☐	₃☐	339
b. Vandalism	₁☐	₂☐	₃☐	340
c. Little respect for laws	₁☐	₂☐	₃☐	341
d. Prostitution	₁☐	₂☐	₃☐	342
e. Abandoned houses	₁☐	₂☐	₃☐	343
f. Sexual assault, rapes, or domestic violence	₁☐	₂☐	₃☐	344
g. Illegal gambling	₁☐	₂☐	₃☐	345
h. Run-down houses	₁☐	₂☐	₃☐	346
i. People not having insurance or enough money for good health care	₁☐	₂☐	₃☐	347
j. Assaults and muggings	₁☐	₂☐	₃☐	348
k. Gangs	₁☐	₂☐	₃☐	349
l. Homelessness	₁☐	₂☐	₃☐	350
m. Drug use or drug dealing	₁☐	₂☐	₃☐	351
n. Police or sheriff's office not caring about your problems	₁☐	₂☐	₃☐	352
o. Unsupervised children	₁☐	₂☐	₃☐	353
p. Teenage mothers	₁☐	₂☐	₃☐	354
q. Teenagers hanging out	₁☐	₂☐	₃☐	355
r. Alcoholism	₁☐	₂☐	₃☐	356
s. Transportation problems	₁☐	₂☐	₃☐	357
t. Bad schools	₁☐	₂☐	₃☐	358

106. Have you ever had a sexually transmitted disease (STD)?

₁☐ Yes ➡️

GO TO QUESTION 107

107. Have you had or been treated for an STD during this pregnancy?

₁☐ Yes

₀☐ No

₂☐ No **GO TO QUESTION**

108

₃☐ I don't know
    GO TO QUESTION
108

⬇️

108. Have you ever done any of the following to lose weight or to control your weight?

CHECK ALL THAT APPLY:

☐ Fasted, went hungry, or skipped meals

☐ Smoked cigarettes (specifically to lose or control weight)

☐ Used meth (specifically to lose or control weight)

☐ Used diet pills or other medications

☐ Vomited on purpose after eating

☐ Used laxatives

109. Do you have access to the internet at home?

₁☐ Yes ₂☐ No ₃☐ I don't know

The questions in this survey can be hard to answer. The last two questions are about how you felt answering the questions on this survey.

110. How comfortable were you answering these questions?

₁☐ Very comfortable

₂☐ Somewhat comfortable

₃☐ Not comfortable or uncomfortable

₄☐ Uncomfortable

₅☐ Very uncomfortable

111. How honest were you when answering these questions?

₁☐ I answered all or almost all of the questions honestly

₂☐ I answered most of the questions honestly

₃☐ I answered less than half the questions honestly

THANK YOU FOR ANSWERING OUR QUESTIONS!
Your answers will help us better understand your needs
and those of your baby.

DATE OF SURVEY   370-377

☐☐   ☐☐   ☐☐☐☐
Month   Day   Year

Thinking about the first few times you used meth:

1. Why did you try meth the first time?

PROBES: Who influenced you to try it? What situations were you in that made you try

it?

2. What did you know about meth the first time you used it?

PROBES: Did you think it was dangerous? Did you think it was addictive? Did you

think using it could become a big part of your life?

3. Were you worried about trying it?

PROBES: Why or why not?

4. How did meth make you feel the first time you used it?

PROBES: Tell me how you felt, good or bad.

5. What was your life like when you first started using meth? For example, how old were you, what was going on for you, how did you feel about yourself?

PROBES: Query for more detail on any comment that could be further explained (e.g., I felt low about myself—probe for "could you tell me more about what you mean by "low"?)

Thinking about all the times you used meth:

6. Tell me about some of the negative experiences you had with meth.

7. Tell me about some of the positive experiences you had with meth.

8. How is your life different—good or bad—since you are not using meth?

Let's talk about this pregnancy

9. When did you first know you were pregnant? Were you surprised or was this planned?

PROBES: What made you think you were pregnant? What were the first signs? <u>Probe closely if women said they didn't think they could get pregnant (ASK why not?), for example</u>

10. When you found out you were pregnant, what did you plan to do?

10a. Did you think about alternatives to having the baby?

PROBES: What were the alternatives? Why did you think about alternatives or why not?

11. Did you tell the father of the baby about your pregnancy?

IF SHE TOLD HIM:

11a. When in the pregnancy did you tell him? Did you tell him right away or did you wait awhile?

11b. Tell me how he responded to the news about your pregnancy. And did he have any ideas about what you should do?

11c. How does he feel now?

11d. Has he been supportive during your pregnancy?

IF HE HAS BEEN SUPPORTIVE, PROBE: In what ways has he been supportive?

11e. What did the baby's father think about your meth use when he first found out you were pregnant?

IF HE KNEW ABOUT HER METH USE:

11f. What does he think about your sobriety?

12. How has the pregnancy affected your relationship with the father of your baby?

PROBES: How has your relationship changed with the baby's father?

If there is no relationship, probe about whether she thinks there will be a future relationship

13. We all learn how to do things through our experiences with other people—whether people in our lives know it or not, they are role models for us. Thinking about the people you have known--relatives, friends, neighbors, teachers--are there people who have taught you about how to be a mother? Or think about people you have observed, in real life or in the media. Who has given you ideas about what to do and what not to do as a mother?

PROBES IF SHE SAYS SHE HAS HAD ROLE MODELS: Who are those people? What have they taught you?

We are very interested in getting ideas that will help women and their children who receive health or social services, so that is what these questions are about:

14. Thinking about <u>women's health</u>, rather than infant's health, do you think there are risks for women <u>themselves</u> who use meth during pregnancy?

PROBES: If she says there are risks, probe for examples. If she says there are no risks, ask why she thinks that.

15. Now thinking about the pregnancy and the baby's health, what do you believe are the risks to the pregnancy and to the babies of women who have used meth during pregnancy?

PROBES: If she says there are risks, probe for examples. If she says there are no risks, ask why she thinks that.

16. **FOLLOW-UP ONLY <u>IF</u> SHE EXPRESSED UNDERSTANDING ANY RISKS TO HERSELF OR HER PREGNANCY:** If women do not stop using meth during their pregnancy, is there anything they can do to reduce the health risks to themselves or their babies?

PROBES: If she says there are things women can do, ask for examples

17. Where have you received information about the risks of meth to women and to their pregnancies? I am interested in all sorts of ways you might have received information—whether it is bogus information or helpful and correct information. It is really helpful to us to know where pregnant women get good and not-so-good information about their health.

18. Thinking about your prenatal care for this pregnancy, did you tell your doctor/nurse that had used meth?

IF SHE TOLD SOMEONE: Tell me about that experience of telling your doctor or nurse.

PROBES TO HELP HER ELABORATE: Why did you tell someone? What did that person say?
Did that person have information that was useful to you? Do you think that person understood your concerns and needs?

IF SHE DID NOT TELL HER DOCTOR OR NURSE: Why didn't you tell anyone?

19. If you ran a clinic for pregnant women, what would you want to tell doctors or nurses who work with pregnant women who use meth? What would help these people do a better job? What would be helpful in getting women to really talk and to really seek help?

PROBES: Should doctors or nurses ask women about their drug use? How should they do it? Think about their manner when they are talking to women. What kind of information should they offer? What kind of referrals?

20. We want to help women in a couple of ways: we want to prevent them from ever trying meth and we want to help women who use to stop using. What are some things you think could help women, either as prevention or treatment—think about anything, ranging from using the media, providing child care, improving schools and education, making sure that women receive more compassion from health care or social services, providing intervention with families, etc. What would you like to see money and effort going into to help women?

PROBES: ASK HER TO THINK ABOUT THINGS THAT COULD PREVENT WOMEN FROM EVER USING METH OR HELP THEM STOP USING METH

21. What is your greatest fear about your own meth use?

Appendix E.

Maternal Methamphetamine Study

Informed Consent Forms

Maternal Methamphetamine Study
Consent Form for Individual Interview

Background Information

This project is being conducted by individuals from the School of Public Health at the University of Minnesota: Wendy Hellerstedt, an Associate Professor and Beth Gyllstrom, a doctoral student. We want to learn more about your experiences with using methamphetamine and your experiences during your pregnancy. We are interested in your feelings about the health care system, as well as any ideas you have to improve how doctors and nurses interact with women during their pregnancies.

You have been invited to participate in this program because you:

- Are currently pregnant and plan to carry this baby to term
- Are 18 years of age or older
- Have ever used methamphetamine during this pregnancy or 3 months before you got pregnant

Procedures

Before you agree to be in this study you should read this form and ask any questions you have. You will be asked to take part in a private interview with one of our researchers. The interview will be audio-taped and it may take up to one hour of your time. The audio-tape will be reviewed by the interviewer, other study researchers, and by a study transcriptionist. There will be no information identifying you on the audio-tape.

Risks and Benefits

Before you agree to be in this study, you should know there are possible risks. If you mention current child abuse or plans to harm yourself or someone else, we must report this and cannot keep it private. All of the study forms are confidential and your name will not be on the forms. We will give you a study ID number that will be on all forms. We will do all we can to protect your privacy.

There are no known direct benefits to you for being in this study.

Compensation

You will get a $20 Target gift card after you finish the interview.

Confidentiality

If you participate in this study we will give you a study identification number. All notes will refer to you only by this number. Your name will not be linked to this number. All study records, tape recordings, and study materials will be stored in a locked file cabinet. The audiotapes will be erased after the project is completed. The study data will be put in a computer file, along with all identification numbers (not names) and stored on a password-protected computer. Only the study staff will have access to this information. In any sort of report we might publish, we will not include any information that will make it possible to identify a study participant.

Voluntary Nature of the Study

It is okay for you to decide you don't want to do this study. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota or the program you are involved with. If you decide to participate, you are free to not answer any question or withdraw at any time with out affecting those relationships. If you do decide to be part of the project, you are free to refuse to answer any question. You can also change your mind or quit at any time during the study. No one will be mad at you if you don't want to be in the study or if you quit partway through.

Contacts or Questions

You may ask any questions you have now. You are encouraged to contact the researchers to get answers to your questions about this project. They are:

Wendy Hellerstedt (helle023@tc.umn.edu) and Beth Gyllstrom (gyll0006@umn.edu) , University of Minnesota School of Public Health, 1300 S. 2nd Street, Suite 300, Minneapolis, MN 55454. Phone: 612-626-2077

If you have any questions or concerns regarding this project and would like to talk to someone other than the researchers, contact the *Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. SE, Minneapolis, Minnesota 55455; (612) 625-1650.*

You will get a copy of this form to keep.

Maternal Methamphetamine Study
Consent Form for Survey

Background Information

This project is being conducted by individuals from the School of Public Health at the University of Minnesota: Wendy Hellerstedt, an Associate Professor and Beth Gyllstrom, a doctoral student. We want to learn more about your experiences with using methamphetamine and your experiences during your pregnancy.   We are interested in your feelings about the health care system, as well as any ideas you have to improve how doctors and nurses interact with women during their pregnancies.

You have been invited to participate in this program because you:

- Are 18 years of age or older
- Are pregnant and intend to carry your baby to term
- Have ever used methamphetamine during this pregnancy or 3 months before pregnancy

Procedures

Before you agree to be in this study you should read this form and ask any questions you have.   You will be asked to complete a written survey. We will give you an identification number, and will put that identification number on the survey. We will not put your name on the survey. The survey will be seen by a study data entry person and, possibly, other study researchers. After the information you provide is entered into a database, the survey will be stored in a locked file and eventually destroyed after the study is complete.

Risks and Benefits

Before you agree to be in this study, you should know there are possible risks.   If you mention current child abuse or plans to harm yourself or someone else, we must report this and cannot keep it private. All of the study forms are confidential and your name will not be on the forms. We will give you a study ID number that will be on all forms. We will do all we can to protect your privacy.

There are no known direct benefits to you for being in this study.

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If you have any questions or concerns regarding this project and would like to talk to someone other than the researchers, contact the *Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. SE, Minneapolis, Minnesota 55455; (612) 625-1650.*

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