Curr Psychiatry Rep (2015) 17: 91
DOI 10.1007/s11920-015-0626-5



# Substance Use in the Perinatal Period

**Ariadna Forray**[1] · **Dawn Foster**[1]

Published online: 19 September 2015


**Abstract** Perinatal substance use remains a major public health problem and is associated with a number of deleterious maternal and fetal effects. Polysubstance use in pregnancy is common and can potentiate adverse maternal and fetal outcomes. Tobacco is the most commonly used substance in pregnancy, followed by alcohol and illicit substances. The treatments for perinatal substance use are limited and consist mostly of behavioral and psychosocial interventions. Of these, contingency management has shown the most efficacy. More recently, novel interventions such as progesterone for postpartum cocaine use have shown promise. The purpose of this review is to examine the recent literature on the use of tobacco, alcohol, cannabis, stimulants, and opioids in the perinatal period, their effects on maternal and fetal health, and current treatments.

**Keywords** Pregnancy · Drug · Tobacco · Smoking · Alcohol · Cannabis · Marijuana · Methamphetamine · Cocaine · Opiates · Opioid · Stimulant · Perinatal · Antenatal · Postpartum

## Introduction

Pregnant women use a range of licit and illicit substances with a common pattern of polysubstance use. According to the 2012 Survey on Drug Use and Health, 5.9 % of pregnant women use illicit drugs, 8.5 % drink alcohol and 15.9 % smoke cigarettes [1], resulting in over 380,000 offspring exposed to illicit substances, over 550,000 exposed to alcohol and over 1 million exposed to tobacco in utero. National data show that in order of frequency of use, nicotine addiction is highest, followed by alcohol, marijuana, and cocaine [2, 3]. However, polysubstance use is as high as 50 % in some studies [2, 4].

Substance use in pregnancy can lead to a number of deleterious effects in the mother and her offspring (see Table 1). The impact of drug use in pregnancy varies, depending upon the drug, point of exposure, and extent of use. The most well-established deleterious consequences are associated with alcohol use during pregnancy and the development of fetal alcohol syndrome and fetal alcohol effects [35]. Smoking during pregnancy exerts direct adverse effects on birth outcomes, including low birth weight, placental abruption, and increased infant mortality [5, 14, 22]. While illicit substances are associated with low birth weight, preterm delivery, placental abruption [36], and cognitive impairment [26, 28]. The adverse effects of perinatal substance use are further complicated by the frequency of concurrent substance use, as noted above, and comorbid psychiatric illness [37, 38]. In addition, women with substance use disorders frequently experience poor nutrition, inadequate prenatal care, poverty, chronic medical problems, and domestic violence [39, 40]. Substance use can also lead to disrupted parental care, and early dysfunctional maternal–infant interactions can compound the negative effects of prenatal drug exposure [41, 42].

Concern for the impact of substances on their baby leads some women to moderate their use of drugs and alcohol during pregnancy [43]. In a recent prospective study on perinatal abstinence and relapse, we found that among women with substance use prior to pregnancy, 96 % of women with heaving drinking, 78 % of women with marijuana use, 73 % of

This article is part of the Topical Collection on *Women's Mental Health*

✉ Ariadna Forray
ariadna.forray@yale.edu

[1] Department of Psychiatry, Yale School of Medicine, 40 Temple Street, Suite 6B, New Haven, CT 06510, USA

**Table 1** Summary of perinatal substance use effects on pregnancy and infant outcomes

| | Tobacco | Alcohol | Cannabis | Stimulants | Opiates |
|---|---|---|---|---|---|
| Pregnancy outcomes | | | | | |
| Preterm birth | ✓ [5, 6] | ✓ [7, 8] | ✓ [9] | ✓ [10–12] | ✓ [12, 13] |
| Small for gestational age | ✓ [5, 12, 14] | ✓ [7, 8] | ✓ [9] | ✓ [10, 11, 15] | ✓ [16] |
| Low birth weight | ✓ [5, 12, 14] | ✓ [8] | ✓ [9] | ✓ [10, 11, 15] | ✓ [17] |
| Miscarriage/spontaneous abortion | ✓ [18] | ✓ [19, 20] | | ✓ [21] | |
| Placental abruption | ✓ [5, 14, 22] | | | ✓ [10, 11] | |
| Premature rupture of membranes | ✓ [5] | | | ✓ [10, 11] | |
| Ectopic pregnancy | ✓ [23] | | | | |
| Infant effects | | | | | |
| Cognitive deficits | ✓ [24] | ✓ [25] | ✓ [26, 27] | ✓ [28] | ✓ [29] |
| Teratogenicity | | ✓ [25] | | | |
| Infant mortality/sudden infant death syndrome | ✓ [5, 14] | | | | ✓ [29] |
| Neonatal withdrawal/abstinence syndrome | | ✓ [30] | | | ✓ [29, 31•] |
| Behavioral problems | ✓ [24] | ✓ [25] | ✓ [32] | ✓ [33] | ✓ [34] |

women with cocaine use, and 32 % of cigarette smokers achieved abstinence in pregnancy [4]. Offsetting the decrease in pregnancy-related use is the precipitous increase in substance use during the 6 months to 1 year after delivery [4]. By 3 months postpartum, 58 % of abstinent smokers, 51 % of abstinent women who used alcohol, 41 % of abstinent women who used marijuana, and 27 % of abstinent women who used cocaine relapsed [4]. Another study found that, even though the majority of women attained some level of abstinence from drug use during the third trimester of pregnancy, the net abstinence rate was only 24 % because of the high likelihood of postpartum relapse [2]. This is unfortunate because maternal relapse occurs at a time when childcare needs are high and maternal bonding is critical to the development of the infant. These data show that perinatal substance use remains a major public health problem.

This review will examine the recent literature on the maternal and neonatal consequences of and available treatments for tobacco, alcohol, cannabis, stimulant, and opioid use in the perinatal period.

## Tobacco

Tobacco use behavior among pregnant women includes cigarette and electronic cigarette smoking [44–46] and smokeless tobacco use [47, 48]. These tobacco-related behaviors, as well as second-hand smoke exposure [49], remain prevalent in the perinatal population, with 16 % of pregnant women reporting smoking [1]. It is important to note that almost half of women who were smokers prior to conception quit smoking during pregnancy [50, 51], particularly those with more education [52]; however, close to 80 % relapse within a year following delivery [53]. In addition, women who smoked pre-pregnancy may cease breastfeeding early in order to restart smoking [54].

Interestingly, compared to other substance use in pregnancy, smokers have the lowest abstinence rates [4]. One potential reason for the lower rates of smoking abstinence might be that women with concurrent substance use substitute smoking for alcohol or illicit substance use while pregnant. Women may perceive illicit substances and alcohol as more harmful and less socially acceptable than cigarettes and thus decide to give up use of the other substances, but not cigarettes [55]. This is supported by the low smoking abstinence rates in women with concurrent substance use. In our prospective study, 77 % of women with concurrent substance use were smokers and only 29 % of them achieved abstinence [4]. This is also in line with previous findings that smoking status is a predictor of illicit substance use in pregnancy [56, 57]. Furthermore, while tobacco, alcohol, and illicit substances all lead to preterm delivery and low birth weight, tobacco has the greatest impact on both outcomes [58].

Tobacco-related fetal and pregnancy outcomes and the severity thereof can vary depending on the timing of exposure, and whether the exposure occurs during the first versus third trimester [59]. Research evaluating the timing of exposure demonstrates links with pregnancy or neonatal outcomes including low birth weight, which has been attributed with smoking throughout the gestational period, as compared quitting smoking by the fifth month of pregnancy, which is not associated with increased risk for low birth weight [60]. Additionally, mothers exhibiting persistent smoking patterns during the second and third trimesters had higher depressive symptomatology and stress relative to non-persistent smokers [61]. Recent research continues to demonstrate that tobacco and nicotine exposure are associated with adverse pregnancy outcomes, including damage to the umbilical cord structure

[62], miscarriage [18], increased risk for ectopic pregnancy [23], and preterm delivery [6, 48]. Smoking in pregnancy is also associated with increased infant morbidity and mortality [14, 63–67], and second-hand smoke is associated deleterious health effects on newborns, which include increased risk for respiratory and ear infections, sudden infant death syndrome, behavioral dysfunction, and cognitive impairment [24]. Further, prenatal exposure to cigarettes is associated with an increase in the probability of tobacco use [68] and experimentation with drugs among adolescents [69]. Smoking in pregnancy is also associated with antenatal depressive symptomatology in the mother [70] and altered maternal–fetal attachment [71].

Behavioral counseling is the mainstay of smoking cessation and relapse prevention in pregnancy; however, psychotherapeutic interventions are only modestly effective [72–75]. The efficacy and safety of pharmacologic treatments for smoking are not yet established in pregnant and postpartum women [72, 76]. More recently, nicotine replacement therapy has been evaluated in several randomized clinical trials [77–80] and has shown limited efficacy in increasing the rates of abstinence. According to a 2013 Cochrane Review on interventions for smoking cessation in pregnant women, the most effective intervention for smoking cessation is contingency management (CM) with financial incentives [81•]. CM for perinatal smoking has also been shown to improve birth outcomes [82]. The promise of CM as a smoking cessation intervention in pregnant women has recently been confirmed by an analytical review focusing specifically on CM [83], and a study that showed prolonged abstinence rates following the intervention, 20 % at delivery and 10 % 6 months postpartum [84•].

More recent interventions for perinatal tobacco use and second-hand smoke exposure range from an indoor smoking ordinance [85], to nurse home visitation [86], a social marketing campaign [87], brief feedback regarding urinary cotinine results [88], and text messaging and smartphone interventions [89]. We are currently conducting a randomized control trial to examine the utility of oral micronized progesterone as an intervention to prevent smoking relapse in postpartum women (NCT01972464, ClinicalTrials.gov). Many of the current efforts appear to be promising for perinatal smoking cessation and relapse prevention. However, ongoing challenges include the need for effectiveness trials and limited dissemination. Thus, researchers will be challenged to understand ways to minimize lost opportunities to reach larger and more diverse populations.

## Alcohol

The majority of pregnant women are able to stop or cut down on drinking, with roughly 87 to 96 % of women with heavy or at risk drinking achieving abstinence [4, 90]. However, 6.4 % of women in one study [90], and over 33 % in another [91], did not reduce their alcohol consumption during pregnancy. The effects of alcohol consumption during pregnancy can range in severity, depending on the timing of exposure, with the first trimester being most sensitive to alcohol-related birth outcomes [92]. Perinatal drinking is associated with many adverse fetal health effects [7, 93, 94], including fetal alcohol spectrum disorders [95, 96], neurodevelopmental outcomes [97], and central nervous system deficits. Additionally, drinking while pregnant is associated with long-term effects such as speech and language outcomes [98], cognitive and behavioral challenges [99, 100] and executive functioning deficits in children [101], and psychosocial consequences in adulthood [102].

Alcohol-related fetal and pregnancy outcomes and the severity thereof can vary depending on the timing of exposure; that is, effects linked with first trimester exposure [103] may be different from those associated with the second [104–106] or third trimester [107, 108], and these in turn may differ from outcomes due to persistent use throughout the duration of pregnancy [109]. For example, alcohol consumption has been associated with oral clefts [103] during the first trimester [103], adverse effects on rat brain weight during the second [104], and disruptions in rat neuroimmune systems [108]. Additional work is needed to further elucidate trimester- or month-specific maternal and fetal effects of perinatal alcohol use.

These effects, although potentially severe, are largely preventable by avoiding alcohol use in pregnancy. Brief interventions [110], particularly those that utilize motivational interviewing [111, 112], can reduce perinatal alcohol use. Other recent interventions to reduce perinatal drinking have included counseling by midwives [113], screening via nonmedical community workers [114], and multimedia and educational efforts aimed to improve knowledge [115]. Additionally, recent work has highlighted the importance of social support in perinatal alcohol prevention, particularly for groups wherein social support has increased significance [116]. A randomized trial suggested that telephone-based brief intervention may have comparable success to in-person interventions in reducing perinatal drinking and, due to its relative cost-effectiveness, might be a viable avenue for additional work [117]. CM has not been well studied for perinatal alcohol use.

Several recommendations have been put forward regarding possible ways to target perinatal alcohol use. One such suggestion is the screening of pregnant women in clinical settings to provide clinicians with an opportunity to review health practices and encourage changes [118]. Surveillance, particularly of fetal alcohol syndrome, has also been suggested as an activity that may reduce alcohol-related consequences associated with perinatal drinking [119], as well as efforts to better identify groups at high risk of drinking during pregnancy

earlier rather than later [120]. For example, one recommendation is to identify non-pregnant women who intend to get pregnant but continue to drink, as these women may unknowingly expose a developing fetus to alcohol for weeks or months [121–123]. However, it is also important to understand how best to intervene against perinatal drinking among women who unintentionally became pregnant, as the relationship between unintended pregnancy and binge drinking has been documented [124]. One study examining college students' knowledge about fetal alcohol spectrum disorder found that undergraduates demonstrated adequate knowledge; however, additional investigation is needed to understand whether this corresponds to a lowered risk of problem drinking [125]. Thus, further research is needed to understand and identify specific mechanisms at play in perinatal alcohol use and best ways to intervene.

## Cannabis

Cannabis is the most commonly used illicit substance during pregnancy and lactation [55, 126]. Prevalence estimates of perinatal cannabis use range from 10 % [127] or less to roughly 43 % [128]. As with tobacco and alcohol use, while many women cease using cannabis during pregnancy [129], rates of past month cannabis use by the third trimester decrease to 1.4 % [130].

Although many pregnant women may view their cannabis as harmless [27], it has been linked with adverse pregnancy outcomes and fetal effects. A recent study confirmed prior findings and found cannabis use in pregnancy was associated with low birth weight (odds ratio (OR)=1.7; 95 % confidence interval (CI): 1.3–2.2), preterm labor (OR=1.5; 95 % CI: 1.1–1.9), small for gestational age (OR=2.2; 95 % CI: 1.8–2.7), and admission to the neonatal intensive care unit (OR=2.0; 95 % CI: 1.7–2.4) [9]. This retrospective cohort study used a large population health registry and controlled for known confounders, such as tobacco smoking, alcohol consumption, and use of other illicit drugs. Cannabis use in pregnancy is also associated with adverse effects on fetal and adolescent brain growth [27], poorer attention and executive functioning skills, lower academic achievement, and increased behavioral problems [32]. Of note, the effects of marijuana are often seen in conjunction with other substances and are most pronounced in heavy users. To our knowledge, no one has yet empirically evaluated whether differences exist with respect to perinatal cannabis outcomes or severity thereof, particularly regarding timing of exposure. Moreover, extant research on perinatal cannabis use is often confounded by multi-substance use [131]. As such, research is needed to examine specific maternal and fetal outcomes related to perinatal cannabis use as they differ by trimester or month.

Recent examinations of national demographic trends in perinatal cannabis use suggest that among pregnant cannabis users, criminal justice referrals, white non-Hispanic women, and those with a psychiatric comorbidity were common [128]. Additionally, recent work has shown that among pregnant treatment seekers enrolled in a community substance abuse program, the prevalence of past psychiatric diagnosis, unemployment, disability, and single relationship status was high [132]. A retrospective cohort study on prenatal patients with positive cannabis screenings showed that cannabis was associated with level of education, employment, other substance use, depressive symptoms, and a history of abuse [127, 129]. It is important to note that findings with respect to perinatal cannabis use have been somewhat mixed [129], and additional work, particularly related to breastfeeding during the postpartum period [27] is needed. Recommendations for reducing perinatal cannabis use include screening pregnant women to promote early identification of cannabis use [27]. CBT [133–137], motivational interviewing [135, 137], and CM therapies have been demonstrated to be effective for reducing marijuana use in women, but they have not been studied specifically with pregnant users. Thus, novel interventions specifically targeting cannabis use are needed, especially given the recent trends in marijuana legalization.

## Stimulants

**Cocaine** While the exact prevalence of cocaine use in pregnancy is not known, it is estimated to be 1.1 % at any point in pregnancy [138]. Cocaine use in pregnancy received much attention in the media in the 1980s and 1990s, with exaggerated claims on the effects of cocaine on infants. While much of the scare of "crack babies" was unfounded, more recent large and rigorous studies have consistently identified several risk factors associated with cocaine use during pregnancy, including premature rupture of membranes, placental abruption, preterm birth, low birth weight, and small for gestational age infants [10]. This was confirmed in a recent meta-analysis that found prenatal cocaine exposure is significantly associated with preterm birth (OR=3.38; 95 % CI: 2.72–4.21), low birth weight (OR=3.66; 95 % CI: 2.90–4.63), and small for gestational age infants (OR=3.23; 95 % CI: 2.43–4.30) [11]. The long-term effects of prenatal cocaine exposure on cognitive, motor, and language development have been inconsistent, with some studies reporting positive findings [139, 140] and some studies finding small or no effects [141]. This inconsistency is likely related to the confounding effects of the postnatal environment, including dysfunctional parenting [41, 42] and unstable and chaotic home environments, and frequent polysubstance use in the mother [142].

Recent examinations of the timing of cocaine exposure with respect to maternal and fetal outcomes suggest that perinatal cocaine effects during the first trimester are associated with decreased head circumference and lower short-term memory

among children [143], child and adolescent delinquent behavior [144, 145], earlier age of sexual initiation [146], and adolescent initiation of other substance use [147]. Examinations of perinatal cocaine use during the second and third trimesters specifically are comparatively rare, possibly due to underreporting [148]. As such, further research in this area is needed.

The current evidence-based treatments for cocaine use in pregnancy are behavioral interventions, including cognitive-behavioral therapy (CBT), motivational interviewing, and CM [149•]. As with smoking, CM is the most promising intervention for cocaine-using pregnant women [142]. In a recent randomized trial comparing CM to community reinforcement approach and 12-step facilitation, CM was associated with significantly greater duration of cocaine abstinence, higher proportion of cocaine-negative urine tests, and higher proportion of documented abstinence across the study period [150]. To date, there are no evidence-based pharmacological treatments for cocaine use in the perinatal period; however, a recent randomized, placebo-controlled trial conducted by our group found promise in the use of oral micronized progesterone for postpartum cocaine use [151]. We found more self-reported cocaine use during the 12 weeks of the trial in women randomized to placebo compared to women receiving micronized progesterone [151]. These findings are preliminary and need to be replicated in a larger clinical trial, but lend support to the use of progesterone for cocaine use in postpartum women.

**Methamphetamine** Methamphetamine, a synthetic stimulant, remains the fastest growing illicit drug worldwide and tends to co-occur with the use of other substances and psychopathology in humans [152] and negative neurodevelopment effects in rats [153]. There are limited data on the prevalence of methamphetamine use in pregnancy, with national estimates varying from 0.7 to 5.2 % [152]. Recent work shows that methamphetamine use is associated with shorter gestational ages, lower birth weight [15], fetal loss [21], developmental and behavioral deficits [33], gestational hypertension, preeclampsia, and intrauterine fetal death [154]. Fetal outcomes may vary based on exposure timing and duration [15]. Infants with a positive toxicology at delivery were smaller on average compared to infants with methamphetamine exposure during the first trimester only, who were in turn smaller than non-exposed infants [15].

A recent study combining reinforcement-based therapy (RBT) with a women-focused intervention among pregnant methamphetamine users showed that the intervention was appealing to participants and methamphetamine use decreased over the course of the study [155]. It is important to note, however, that there were no significant differences between the intervention and control conditions [155], similar to another study utilizing RBT for stimulant use in pregnancy [156]. While RBT appears to be promising intervention for methamphetamine use, further work is needed, particularly to ascertain whether pejorative attitudes towards methamphetamine might influence reporting rates. Interestingly, a recent study showed that treatment with a monoclonal antibody therapy in pregnant rat dams offered maternal and fetal brain protection from adverse drug effects by reducing brain concentrations of methamphetamine [157]. Further work is needed to understand mechanisms underlying risks for methamphetamine use, and individuals for whom interventions might be more effective. Additionally, as pregnant women who use methamphetamine tend to exhibit low rates of antenatal care utilization, recommendations for future efforts may include encouragement of antenatal uptake and adherence [155].

## Opiates

Opioid use has increased dramatically over the last decade, and the incidence of opioid use during pregnancy increased from 1.19 to 5.77 per 1000 hospital live births per year between 2000 and 2009 [31•]. Opioid use in pregnancy includes both heroin and prescription opiates. With this increase in opioid use, there was a corresponding increase in neonatal abstinence syndrome (NAS), the postnatal drug withdrawal syndrome caused by maternal opiate use, from 1.20 to 3.39 per 1000 hospital live births per year [31•], the type of opioid exposure was not specified. NAS affects anywhere from 45 to 94 % of infants exposed opioids in utero; this includes methadone and buprenorphine and results in significant neonatal morbidity and high health-care utilization [29, 31•]. NAS is characterized by numerous signs and symptoms, including increased irritability, hypertonia, tremors, feeding difficulties, emesis, loose stools, seizures, and respiratory distress [30]. In addition to NAS, opioid use in pregnancy is associated with a significantly increased risk of low birth weight, respiratory complications, toxemia, third trimester bleeding, and mortality [29, 31•], as well as postnatal growth deficiency, microcephaly, neurobehavioral problems, and sudden infant death syndrome [29]. Of note, cigarette smoking in pregnant women with opioid use disorder is highly prevalent, 77 to 95 % [158, 159], and can confound the impact of opioid use on adverse pregnancy outcomes. Empirical evidence evaluating exposure timing of opioids during the perinatal period exists [160]; however, to our knowledge, no one has yet evaluated differences in maternal and fetal outcomes or severity based on the timing of exposure.

Methadone maintenance is considered the standard of care for pregnant women with opiate use disorder [161]. Medically monitored conversion from illicit opioid use to opioid maintenance therapy decreases maternal and neonatal morbidity by providing superior relapse prevention with a stable opioid dosing regimen, reduced risk-taking behavior, enhanced compliance with prenatal care, and better neonatal outcomes rates [162]. In contrast, medication-assisted withdrawal is

associated with a high opioid relapse rate, and some evidence suggests increased fetal morbidity and mortality rates [162]. More recently, buprenorphine has emerged as an effective treatment alternative for opioid use in pregnancy. In a randomized controlled trial that compared methadone and buprenorphine in pregnant opioid users, infants born to women treated with buprenorphine had a significantly shorter duration of treatment for NAS, required significantly lower doses of morphine for the treated of NAS symptoms, and had significantly shorter hospital stays than infants born to women treated with methadone [163]. However, methadone is superior to buprenorphine in retaining people in treatment. Compared to methadone, buprenorphine has lower retention rates with flexibly delivered doses and low fixed doses, but when fixed medium or high doses are used, buprenorphine and methadone are equally effective [164•]. While medication-assisted treatment is the standard of care for opiate use disorder in pregnancy, CM has been shown to significantly increase full day treatment attendance and drug abstinence compared to controls [165]. Thus, CM may serve as an important adjunct to methadone or buprenorphine pharmacotherapy in perinatal women. Breastfeeding is another important intervention as it is the only available intervention demonstrated to reduce NAS severity in opioid-exposed newborns is breastfeeding [166, 167].

## Conclusions

**Summary** Perinatal substance use continues to be a significant problem in the United States. Effective treatments for substance use in pregnancy are limited; however, CM appears to have the most potential as an effective treatment across substances and may improve compliance to prenatal care as well. Substance use in pregnancy can lead to a number of deleterious effects in mother and her offspring. The impact of drug use in pregnancy varies, depending on the drug, point of exposure, and extent of use. Several variables are associated with adverse maternal and infant outcomes, in addition to the direct effects of drug exposure in utero. These include psychiatric comorbidity, polysubstance use, environmental stressors, limited prenatal care, and disrupted parental care. All of these factors contribute to adverse pregnancy outcomes and long-term effects. Furthermore, low birth weight, which is an adverse pregnancy outcome associated with all substance use in pregnancy, increases the risk of many neurodevelopmental and functional deficits [168]. Thus, it is difficult to discern the effect of a specific substance in isolation. All of these factors need to be considered in order to effectively address substance use in pregnancy and improve maternal and infant outcomes.

**Future Directions** Many health problems associated with the perinatal period can be prevented with adequate and timely medical care or intervention. Pregnancy is a time during which women tend to become more motivated to reduce substance use [50, 51, 90], but the prevalence of continued substance use remains high [127, 169, 170]. There is a need to elucidate underlying mechanisms and develop empirically driven interventions for postpartum health. Tailored, safe, and convenient treatments are needed to reduce substance-related morbidity and mortality by encouraging and capitalizing on pregnancy-related abstinence [171].

One promising avenue of research is the use of mobile devices as relapse prevention among postpartum women by targeting automatic cues for substance use. Automatic processes play an important role in addictive behaviors [172] and some novel approaches, termed cognitive bias modification, are currently being tested in their efficacy to target the automatic processes that sustain addiction. Initial, unpublished findings from this work suggest that this type of intervention can be administered on a mobile device and can reduce attentional bias to smoking cues in perinatal women (Foster D, Waters A, Forray A, 2015 College on Problems of Drug Dependence meeting, poster presentation). Future research should evaluate the longitudinal outcomes and efficacy of mobile interventions targeting perinatal substance use. Additional work and novel interventions are needed to capitalize on the naturally occurring abstinence and motivation to engage in healthy behaviors experienced by perinatal women.

**Compliance with Ethics Guidelines**

**Conflict of Interest** Ariadna Forray and Dawn Foster declare no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

**Funding Information** Funding for this study was provided in part by grants from the National Institute of Drug Abuse (K12-DA-000167). NIDA had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the manuscript; or in the decision to submit the manuscript for publication.

## References

Papers of particular interest, published recently, have been highlighted as:
- Of importance

1. United States Department of H, Human Services. Substance A, Mental Health Services Administration. Center for Behavioral Health S, Quality. National Survey on Drug Use and Health, 2012. Inter-university Consortium for Political and Social Research (ICPSR) [distributor]. 2013.

2. Ebrahim SH, Gfroerer J. Pregnancy-related substance use in the United States during 1996–1998. Obstet Gynecol. 2003;101:374–9.
3. Howell EM, Heiser N, Harrington M. A review of recent findings on substance abuse treatment for pregnant women. J Subst Abuse Treat. 1999;16:195–219.
4. Forray A, Merry B, Lin H, Ruger JP, Yonkers KA. Perinatal substance use: a prospective evaluation of abstinence and relapse. Drug Alcohol Depend. 2015;150:147–55.
5. Salihu HM, Wilson RE. Epidemiology of prenatal smoking and perinatal outcomes. Early Hum Dev. 2007;83:713–20.
6. Ion R, Bernal AL. Smoking and preterm birth. Reprod Sci. 2015;22:918–26.
7. Srikartika VM, O'Leary CM. Pregnancy outcomes of mothers with an alcohol-related diagnosis: a population-based cohort study for the period 1983–2007. BJOG. 2015;122:795–804.
8. Patra J, Bakker R, Irving H, Jaddoe VW, Malini S, Rehm J. Dose–response relationship between alcohol consumption before and during pregnancy and the risks of low birthweight, preterm birth and small for gestational age (SGA)—a systematic review and meta-analyses. BJOG. 2011;118:1411–21.
9. Mamun AA, Najman JM. Birth outcomes associated with cannabis use before and during pregnancy. Pediatric ReseaRch 2012;71.
10. Addis A, Moretti ME, Ahmed Syed F, Einarson TR, Koren G. Fetal effects of cocaine: an updated meta-analysis. Reprod Toxicol. 2001;15:341–69.
11. Gouin K, Murphy K, Shah PS. Effects of cocaine use during pregnancy on low birthweight and preterm birth: systematic review and metaanalyses. Am J Obstet Gynecol. 2011;204:340.e1–e12.
12. Quesada O, Gotman N, Howell HB, Funai EF, Rounsaville BJ, Yonkers KA. Prenatal hazardous substance use and adverse birth outcomes. J Matern Fetal Neonatal Med. 2012;25:1222–7.
13. Almario CV, Seligman NS, Dysart KC, Berghella V, Baxter JK. Risk factors for preterm birth among opiate-addicted gravid women in a methadone treatment program. Am J Obstet Gynecol. 2009;201:326 e1–6.
14. Cnattingius S. The epidemiology of smoking during pregnancy: smoking prevalence, maternal characteristics, and pregnancy outcomes. Nicotine Tob Res. 2004;6 Suppl 2:S125–40.
15. Wright TE, Schuetter R, Tellei J, Sauvage L. Methamphetamines and pregnancy outcomes. J Addict Med. 2015;9:111–7.
16. Wouldes TA, Woodward LJ. Maternal methadone dose during pregnancy and infant clinical outcome. Neurotoxicol Teratol. 2010;32:406–13.
17. Hulse GK, Milne E, English DR, Holman CDJ. The relationship between maternal use of heroin and methadone and infant birth weight. Addiction. 1997;92:1571–9.
18. Pineles BL, Park E, Samet JM. Systematic review and meta-analysis of miscarriage and maternal exposure to tobacco smoke during pregnancy. Am J Epidemiol. 2014;179:807–23.
19. Henriksen TB, Hjollund NH, Jensen TK, et al. Alcohol consumption at the time of conception and spontaneous abortion. Am J Epidemiol. 2004;160:661–7.
20. Avalos LA, Roberts SCM, Kaskutas LA, Block G, Li D-K. Volume and type of alcohol during early pregnancy and the risk of miscarriage. Subst Use Misuse. 2014;49:1437–45.
21. Brecht ML, Herbeck DM. Pregnancy and fetal loss reported by methamphetamine-using women. Subst Abuse. 2014;8:25–33.
22. Tikkanen M, Nuutila M, Hiilesmaa V, Paavonen J, Ylikorkala O. Prepregnancy risk factors for placental abruption. Acta Obstet Gynecol Scand. 2006;85:40–4.
23. Horne AW, Brown JK, Nio-Kobayashi J, et al. The association between smoking and ectopic pregnancy: why nicotine is BAD for your fallopian tube. PLoS One. 2014;9, e89400.
24. DiFranza JR, Aligne CA, Weitzman M. Prenatal and postnatal environmental tobacco smoke exposure and children's health. Pediatrics. 2004;113:1007–15.
25. Warren KR, Hewitt BG, Thomas JD. Fetal alcohol spectrum disorders: research challenges and opportunities. Alcohol Res Health. 2011;34:4–14.
26. Day NL, Leech SL, Goldschmidt L. The effects of prenatal marijuana exposure on delinquent behaviors are mediated by measures of neurocognitive functioning. Neurotoxicol Teratol. 2011;33:129–36.
27. Jaques SC, Kingsbury A, Henshcke P, et al. Cannabis, the pregnant woman and her child: weeding out the myths. J Perinatol. 2014;34:417–24.
28. Noland JS, Singer LT, Short EJ, et al. Prenatal drug exposure and selective attention in preschoolers. Neurotoxicol Teratol. 2005;27:429–38.
29. Minozzi S, Amato L, Bellisario C, Ferri M, Davoli M. Maintenance agonist treatments for opiate-dependent pregnant women. Cochrane Database Syst Rev. 2013;12, CD006318.
30. Hudak ML, Tan RC. Neonatal drug withdrawal. Pediatrics. 2012;129:e540–60.
31.• Patrick SW, Schumacher RE, Benneyworth BD, Krans EE, McAllister JM, Davis MM. Neonatal abstinence syndrome and associated health care expenditures: United States, 2000–2009. JAMA. 2012;307:1934–40. **Informative study on neonatal abstinence syndrome and the healthcare costs of opioid use in pregnancy**.
32. Warner TD, Roussos-Ross D, Behnke M. It's not your mother's marijuana: effects on maternal-fetal health and the developing child. Clin Perinatol. 2014;41:877–94.
33. Dyk J, Ramanjam V, Church P, Koren G, Donald K. Maternal methamphetamine use in pregnancy and long-term neurodevelopmental and behavioral deficits in children. J Popul Ther Clin Pharmacol. 2014;21:e185–96.
34. Hunt RW, Tzioumi D, Collins E, Jeffery HE. Adverse neurodevelopmental outcome of infants exposed to opiate in-utero. Early Hum Dev. 2008;84:29–35.
35. Hankin JR. Fetal alcohol syndrome prevention research. Alcohol Res Health. 2002;26:58–65.
36. Ludlow JP, Evans SF, Hulse G. Obstetric and perinatal outcomes in pregnancies associated with illicit substance abuse. Aust N Z J Obstet Gynaecol. 2004;44:302–6.
37. Tuten M, Heil SH, O'Grady KE, Fitzsimons H, Chisolm MS, Jones HE. The impact of mood disorders on the delivery and neonatal outcomes of methadone-maintained pregnant patients. Am J Drug Alcohol Abuse. 2009;35:358–63.
38. Benningfield MM, Arria AM, Kaltenbach K, et al. Co-occurring psychiatric symptoms are associated with increased psychological, social, and medical impairment in opioid dependent pregnant women. Am J Addict. 2010;19:416–21.
39. Havens JR, Simmons LA, Shannon LM, Hansen WF. Factors associated with substance use during pregnancy: results from a national sample. Drug Alcohol Depend. 2009;99:89–95.
40. Hutchins E, Dipietro J. Psychosocial risk factors associated with cocaine use during pregnancy: a case–control study. Obstet Gynecol. 1997;90:142–7.
41. Mansoor E, Morrow CE, Accornero VH, et al. Longitudinal effects of prenatal cocaine use on mother-child interactions at ages 3 and 5 years. J Dev Behav Pediatr. 2012;33:32–41.
42. Strathearn L, Mayes LC. Cocaine addiction in mothers: potential effects on maternal care and infant development. Ann N Y Acad Sci. 2010;1187:172–83.
43. Higgins PG, Clough DH, Frank B, Wallerstedt C. Changes in health behaviors made by pregnant substance users. Int J Addict. 1995;30:1323–33.

44. Suter MA, Mastrobattista J, Sachs M, Aagaard K. Is there evidence for potential harm of electronic cigarette use in pregnancy? Birth Defects Res A Clin Mol Teratol. 2015;103:186–95.
45. Farquhar B, Mark K, Terplan M, Chisolm MS. Demystifying electronic cigarette use in pregnancy. J Addict Med. 2015;9: 157–8.
46. Baeza-Loya S, Viswanath H, Carter A, et al. Perceptions about e-cigarette safety may lead to e-smoking during pregnancy. Bull Menninger Clin. 2014;78:243–52.
47. Ratsch A, Bogossian F. Smokeless tobacco use in pregnancy: an integrative review of the literature. Int J Public Health. 2014;59: 599–608.
48. England LJ, Kim SY, Shapiro-Mendoza CK, et al. Effects of maternal smokeless tobacco use on selected pregnancy outcomes in Alaska Native women: a case–control study. Acta Obstet Gynecol Scand. 2013;92:648–55.
49. Vardavas CI, Fthenou E, Patelarou E, et al. Exposure to different sources of second-hand smoke during pregnancy and its effect on urinary cotinine and tobacco-specific nitrosamine (NNAL) concentrations. Tob Control. 2013;22:194–200.
50. Colman GJ, Joyce T. Trends in smoking before, during, and after pregnancy in ten states. Am J Prev Med. 2003;24:29–35.
51. Heil SH, Herrmann ES, Badger GJ, Solomon LJ, Bernstein IM, Higgins ST. Examining the timing of changes in cigarette smoking upon learning of pregnancy. Prev Med. 2014;68:58–61.
52. Vaz LR, Leonardi-Bee J, Aveyard P, et al. Factors associated with smoking cessation in early and late pregnancy in the smoking, nicotine, and pregnancy trial: a trial of nicotine replacement therapy. Nicotine Tob Res. 2014;16:381–9.
53. DiClemente CC, Dolan-Mullen P, Windsor RA. The process of pregnancy smoking cessation: implications for interventions. Tob Control. 2000;9 Suppl 3:III16–21.
54. Ratner PA, Johnson JL, Bottorff JL. Smoking relapse and early weaning among postpartum women: is there an association? Birth. 1999;26:76–82.
55. Moore DG, Turner JD, Parrott AC, et al. During pregnancy, recreational drug-using women stop taking ecstasy (3,4-methylenedioxy-N-methylamphetamine) and reduce alcohol consumption, but continue to smoke tobacco and cannabis: initial findings from the Development and Infancy Study. J Psychopharmacol. 2010;24:1403–10.
56. Goel N, Beasley D, Rajkumar V, Banerjee S. Perinatal outcome of illicit substance use in pregnancy—comparative and contemporary socio-clinical profile in the UK. Eur J Pediatr. 2011;170: 199–205.
57. Yonkers KA, Gotman N, Kershaw T, Forray A, Howell HB, Rounsaville BJ. Screening for prenatal substance use: development of the substance use risk profile-pregnancy scale. Obstet Gynecol. 2010;116:827–33.
58. Janisse JJ, Bailey BA, Ager J, Sokol RJ. Alcohol, tobacco, cocaine, and marijuana use: relative contributions to preterm delivery and fetal growth restriction. Subst Abus. 2013;35:60–7.
59. Alshaarawy O, Anthony JC. Month-wise estimates of tobacco smoking during pregnancy for the United States, 2002–2009. Matern Child Health J. 2015;19:1010–5.
60. Tominey E. Maternal smoking during pregnancy and early child outcomes: Centre for Economic Performance. 2007.
61. Eiden RD, Homish GG, Colder CR, Schuetze P, Gray TR, Huestis MA. Changes in smoking patterns during pregnancy. Subst Use Misuse. 2013;48:513–22.
62. Rua Ede A, Porto ML, Ramos JP, et al. Effects of tobacco smoking during pregnancy on oxidative stress in the umbilical cord and mononuclear blood cells of neonates. J Biomed Sci. 2014;21:105.
63. Centers for Disease Control and Prevention. Tobacco use. In: Healthy People 2010: understanding and improving health and objectives for improving health. Washington, DC: U.S. Department of Health and Human Services. 2000.
64. WHO Recommendations for the Prevention and Management of Tobacco Use and Second-Hand Smoke Exposure in Pregnancy. Geneva. 2013.
65. Inamdar AS, Croucher RE, Chokhandre MK, Mashyakhy MH, Marinho VC. Maternal Smokeless Tobacco Use in Pregnancy and Adverse Health Outcomes in Newborns: A Systematic Review. Nicotine Tob Res. 2014.
66. Li J, Bo L, Zhang P, et al. Exposure to Nicotine During Pregnancy and Altered Learning and Memory in the Rat Offspring. Nicotine Tob Res. 2014.
67. Maritz GS. Perinatal exposure to nicotine and implications for subsequent obstructive lung disease. Paediatr Respir Rev. 2013;14:3–8.
68. Biederman J, Martelon M, Woodworth KY, Spencer TJ, Faraone SV. Is maternal smoking during pregnancy a risk factor for cigarette smoking in offspring? A longitudinal controlled study of ADHD children grown up. J Atten Disord. 2014.
69. Lotfipour S, Ferguson E, Leonard G, et al. Maternal cigarette smoking during pregnancy predicts drug use via externalizing behavior in two community-based samples of adolescents. Addiction. 2014;109:1718–29.
70. Mbah AK, Salihu HM, Dagne G, Wilson RE, Bruder K. Exposure to environmental tobacco smoke and risk of antenatal depression: application of latent variable modeling. Arch Womens Ment Health. 2013;16:293–302.
71. Magee SR, Bublitz MH, Orazine C, et al. The relationship between maternal-fetal attachment and cigarette smoking over pregnancy. Matern Child Health J. 2014;18:1017–22.
72. Agboola S, McNeill A, Coleman T, Leonardi BJ. A systematic review of the effectiveness of smoking relapse prevention interventions for abstinent smokers. Addiction. 2010;105:1362–80.
73. Heckman CJ, Egleston BL, Hofmann MT. Efficacy of motivational interviewing for smoking cessation: a systematic review and meta-analysis. Tob Control. 2010;19:410–6.
74. Levitt C, Shaw E, Wong S, Kaczorowski J. Systematic review of the literature on postpartum care: effectiveness of interventions for smoking relapse prevention, cessation, and reduction in postpartum women. Birth. 2007;34:341–7.
75. Reitzel LR, Vidrine JI, Businelle MS, et al. Preventing postpartum smoking relapse among diverse low-income women: a randomized clinical trial. Nicotine Tob Res. 2010;12:326–35.
76. Oncken CA, Kranzler HR. What do we know about the role of pharmacotherapy for smoking cessation before or during pregnancy? Nicotine Tob Res. 2009;11:1265–73.
77. Essex HN, Parrott S, Wu Q, Li J, Cooper S, Coleman T. Cost-effectiveness of nicotine patches for smoking cessation in pregnancy: a placebo randomized controlled trial (SNAP). Nicotine Tob Res. 2014.
78. El-Mohandes AA, Windsor R, Tan S, Perry DC, Gantz MG, Kiely M. A randomized clinical trial of trans-dermal nicotine replacement in pregnant African-American smokers. Matern Child Health J. 2013;17:897–906.
79. Cooper S, Lewis S, Thornton JG, et al. The SNAP trial: a randomised placebo-controlled trial of nicotine replacement therapy in pregnancy–clinical effectiveness and safety until 2 years after delivery, with economic evaluation. Health Technol Assess. 2014;18:1–128.
80. Coleman T, Cooper S, Thornton JG, et al. A randomized trial of nicotine-replacement therapy patches in pregnancy. N Engl J Med. 2012;366:808–18.
81.• Chamberlain C, O'Mara-Eves A, Oliver S, et al. Psychosocial interventions for supporting women to stop smoking in pregnancy. Cochrane Database Syst Rev. 2013;10, Cd001055. **This is the latest update of the**

**highly influential meta-analysis of interventions for smoking cessation among pregnant women**.

82. Higgins ST, Bernstein IM, Washio Y, et al. Effects of smoking cessation with voucher-based contingency management on birth outcomes. Addiction. 2010;105:2023–30.
83. Higgins ST, Washio Y, Heil SH, et al. Financial incentives for smoking cessation among pregnant and newly postpartum women. Preventive Medicine 2012;55, Supplement:S33-S40.
84.• Ierfino D, Mantzari E, Hirst J, Jones T, Aveyard P, Marteau TM. Financial incentives for smoking cessation in pregnancy: a single-arm intervention study assessing cessation and gaming. Addiction. 2015;110:680–8. **This is an effectiveness trial of contingency management for perinatal smoking with extended postpartum follow-up**.
85. Nguyen KH, Wright RJ, Sorensen G, Subramanian SV. Association between local indoor smoking ordinances in Massachusetts and cigarette smoking during pregnancy: a multilevel analysis. Tob Control. 2013;22:184–9.
86. Mejdoubi J, van den Heijkant SC, van Leerdam FJ, Crone M, Crijnen A, HiraSing RA. Effects of nurse home visitation on cigarette smoking, pregnancy outcomes and breastfeeding: a randomized controlled trial. Midwifery. 2014;30:688–95.
87. Kennedy MG, Genderson MW, Sepulveda AL, et al. Increasing tobacco quitline calls from pregnant African American women: the "one tiny reason to quit" social marketing campaign. J Womens Health. 2013;22:432–8.
88. Higashida Y, Ohashi K. Reduction of tobacco smoke exposure for pregnant passive smokers using feedback of urinary cotinine test results. J Obstet Gynaecol Res. 2014;40:1015–22.
89. Evans WD, Wallace Bihm J, Szekely D, et al. Initial outcomes from a 4-week follow-up study of the Text4baby program in the military women's population: randomized controlled trial. J Med Internet Res. 2014;16, e131.
90. Kitsantas P, Gaffney KF, Wu H, Kastello JC. Determinants of alcohol cessation, reduction and no reduction during pregnancy. Arch Gynecol Obstet. 2014;289:771–9.
91. Anderson AE, Hure AJ, Forder PM, Powers J, Kay-Lambkin FJ, Loxton DJ. Risky drinking patterns are being continued into pregnancy: a prospective cohort study. PLoS One. 2014;9, e86171.
92. Nykjaer C, Alwan NA, Greenwood DC, et al. Maternal alcohol intake prior to and during pregnancy and risk of adverse birth outcomes: evidence from a British cohort. J Epidemiol Community Health. 2014;68:542–9.
93. DeVido J, Bogunovic O, Weiss RD. Alcohol use disorders in pregnancy. Harv Rev Psychiatry. 2015;23:112–21.
94. Waterman EH, Pruett D, Caughey AB. Reducing fetal alcohol exposure in the United States. Obstet Gynecol Surv. 2013;68:367–78.
95. Esper LH, Furtado EF. Identifying maternal risk factors associated with Fetal Alcohol Spectrum Disorders: a systematic review. Eur Child Adolesc Psychiatry. 2014;23:877–89.
96. Fox DJ, Pettygrove S, Cunniff C, et al. Fetal alcohol syndrome among children aged 7–9 years - Arizona, Colorado, and New York, 2010. MMWR Morb Mortal Wkly Rep. 2015;64:54–7.
97. Vall O, Salat-Batlle J, Garcia-Algar O. Alcohol consumption during pregnancy and adverse neurodevelopmental outcomes. J Epidemiol Community Health. 2015.
98. O'Keeffe LM, Greene RA, Kearney PM. The effect of moderate gestational alcohol consumption during pregnancy on speech and language outcomes in children: a systematic review. Syst Rev. 2014;3:1.
99. Green CR, Roane J, Hewitt A, et al. Frequent behavioural challenges in children with fetal alcohol spectrum disorder: a needs-based assessment reported by caregivers and clinicians. J Popul Ther Clin Pharmacol. 2014;21:e405–20.
100. Bakoyiannis I, Gkioka E, Pergialiotis V, et al. Fetal alcohol spectrum disorders and cognitive functions of young children. Rev Neurosci. 2014;25:631–9.
101. Fuglestad AJ, Whitley ML, Carlson SM, et al. Executive functioning deficits in preschool children with Fetal Alcohol Spectrum Disorders. Child Neuropsychol 2014:1–16.
102. Rangmar J, Hjern A, Vinnerljung B, Stromland K, Aronson M, Fahlke C. Psychosocial outcomes of fetal alcohol syndrome in adulthood. Pediatrics. 2015;135:e52–8.
103. Lund AE. First-trimester maternal alcohol consumption may lead to oral clefts. J Am Dent Assoc. 2008;139:1452–3.
104. Qiang M, Wang MW, Elberger AJ. Second trimester prenatal alcohol exposure alters development of rat corpus callosum. Neurotoxicol Teratol. 2002;24:719–32.
105. Simon KE, Mondares RL, Born DE, Gleason CA. The effects of binge alcohol exposure in the 2nd trimester on the estimated density of cerebral microvessels in near-term fetal sheep. Brain Res. 2008;1231:75–80.
106. Li Q, Hankin J, Wilsnack SC, et al. Detection of alcohol use in the second trimester among low-income pregnant women in the prenatal care settings in Jefferson County, Alabama. Alcohol Clin Exp Res. 2012;36:1449–55.
107. Diaz MR, Vollmer CC, Zamudio-Bulcock PA, et al. Repeated intermittent alcohol exposure during the third trimester-equivalent increases expression of the GABA(A) receptor delta subunit in cerebellar granule neurons and delays motor development in rats. Neuropharmacology. 2014;79:262–74.
108. Topper LA, Valenzuela CF. Effect of repeated alcohol exposure during the third trimester-equivalent on messenger RNA levels for interleukin-1beta, chemokine (C-C motif) ligand 2, and interleukin 10 in the developing rat brain after injection of lipopolysaccharide. Alcohol. 2014;48:773–80.
109. Washburn SE, Ramadoss J, Chen WJ, Cudd TA. Effects of all three trimester moderate binge alcohol exposure on the foetal hippocampal formation and olfactory bulb. Brain Inj. 2015;29:104–9.
110. Chang G, McNamara TK, Orav EJ, et al. Brief intervention for prenatal alcohol use: a randomized trial. Obstet Gynecol. 2005;105:991–8.
111. Osterman RL, Carle AC, Ammerman RT, Gates D. Single-session motivational intervention to decrease alcohol use during pregnancy. J Subst Abuse Treat. 2014;47:10–9.
112. Rendall-Mkosi K, Morojele N, London L, Moodley S, Singh C, Girdler-Brown B. A randomized controlled trial of motivational interviewing to prevent risk for an alcohol-exposed pregnancy in the Western Cape, South Africa. Addiction. 2013;108:725–32.
113. van der Wulp NY, Hoving C, Eijmael K, Candel MJ, van Dalen W, De Vries H. Reducing alcohol use during pregnancy via health counseling by midwives and internet-based computer-tailored feedback: a cluster randomized trial. J Med Internet Res. 2014;16, e274.
114. O'Connor MJ, Rotheram-Borus MJ, Tomlinson M, Bill C, LeRoux IM, Stewart J. Screening for fetal alcohol spectrum disorders by nonmedical community workers. J Popul Ther Clin Pharmacol. 2014;21:e442–52.
115. Crawford-Williams F, Fielder A, Mikocka-Walus A, Esterman A. A critical review of public health interventions aimed at reducing alcohol consumption and/or increasing knowledge among pregnant women. Drug Alcohol Rev. 2015;34:154–61.
116. Hanson JD, Jensen J. Importance of social support in preventing alcohol-exposed pregnancies with American Indian communities. J Community Health. 2015;40:138–46.
117. Wilton G, Moberg DP, Van Stelle KR, Dold LL, Obmascher K, Goodrich J. A randomized trial comparing telephone versus in-person brief intervention to reduce the risk of an alcohol-exposed pregnancy. J Subst Abuse Treat. 2013;45:389–94.

118. Chang G. Screening for alcohol and drug use during pregnancy. Obstet Gynecol Clin North Am. 2014;41:205–12.
119. O'Leary LA, Ortiz L, Montgomery A, et al. Methods for surveillance of fetal alcohol syndrome: The fetal alcohol syndrome surveillance network II (FASSNetII) - Arizona, Colorado, New York, 2009–2014. Birth Defects Res A Clin Mol Teratol. 2015;103:196–202.
120. Kitsantas P, Gaffney KF, Wu H. Identifying high-risk subgroups for alcohol consumption among younger and older pregnant women. J Perinat Med. 2015;43:43–52.
121. Cannon MJ, Guo J, Denny CH, et al. Prevalence and characteristics of women at risk for an alcohol-exposed pregnancy (AEP) in the United States: estimates from the National Survey of Family Growth. Matern Child Health J. 2015;19:776–82.
122. Balachova T, Sobell LC, Agrawal S, et al. Using a single binge drinking question to identify Russian women at risk for an alcohol-exposed pregnancy. Addict Behav. 2015;46:53–7.
123. Terplan M, Cheng D, Chisolm MS. The relationship between pregnancy intention and alcohol use behavior: an analysis of PRAMS data. J Subst Abuse Treat. 2014;46:506–10.
124. McDonald SW, Hicks M, Rasmussen C, Nagulesapillai T, Cook J, Tough SC. Characteristics of women who consume alcohol before and after pregnancy recognition in a Canadian sample: a prospective cohort study. Alcohol Clin Exp Res. 2014;38:3008–16.
125. Brems C, Johnson ME, Metzger JS, Dewane SL. College students' knowledge about fetal alcohol spectrum disorder. J Popul Ther Clin Pharmacol. 2014;21:e159–66.
126. Hill M, Reed K. Pregnancy, breast-feeding, and marijuana: a review article. Obstet Gynecol Surv. 2013;68:710–8.
127. Ko JY, Farr SL, Tong VT, Creanga AA, Callaghan WM. Prevalence and patterns of marijuana use among pregnant and nonpregnant women of reproductive age. Am J Obstet Gynecol. 2015.
128. Martin CE, Longinaker N, Mark K, Chisolm MS, Terplan M. Recent trends in treatment admissions for marijuana use during pregnancy. J Addict Med. 2015;9:99–104.
129. Mark K, Desai A, Terplan M. Marijuana use and pregnancy: prevalence, associated characteristics, and birth outcomes. Arch Womens Ment Health. 2015.
130. Administration SAaMHS. The National Survey on Drug Use and Health Report: Substane use among womend urign pregnancy and following childbirth. In: Office of Applied Studies SAaMHSA, ed. Rockville, MD; 2009.
131. Metz TD, Stickrath EH. Marijuana use in pregnancy and lactation: a review of the evidence. Am J Obstet Gynecol. 2015.
132. Tzilos G, Hess L, Kao JC, Zlotnick C. Characteristics of perinatal women seeking treatment for marijuana abuse in a community-based clinic. Arch Womens Ment Health. 2013;16:333–7.
133. Stephens RS, Roffman RA, Simpson EE. Treating adult marijuana dependence: a test of the relapse prevention model. J Consult Clin Psychol. 1994;62:92–9.
134. Carroll KM, Nich C, Lapaglia DM, Peters EN, Easton CJ, Petry NM. Combining cognitive behavioral therapy and contingency management to enhance their effects in treating cannabis dependence: less can be more, more or less. Addiction. 2012;107:1650–9.
135. Hoch E, Noack R, Henker J, et al. Efficacy of a targeted cognitive-behavioral treatment program for cannabis use disorders (CANDIS). Eur Neuropsychopharmacol. 2012;22:267–80.
136. Copeland J, Swift W, Roffman R, Stephens R. A randomized controlled trial of brief cognitive-behavioral interventions for cannabis use disorder. J Subst Abuse Treat. 2001;21:55–64. **discussion 5–6**.
137. Hoch E, Bühringer G, Pixa A, et al. CANDIS treatment program for cannabis use disorders: findings from a randomized multi-site translational trial. Drug Alcohol Depend. 2014;134:185–93.
138. Bhuvaneswar CG, Chang G, Epstein LA, Stern TA. Cocaine and opioid use during pregnancy: prevalence and management. Prim Care Companion J Clin Psychiatry. 2008;10:59–65.
139. Chaplin TM, Freiburger MB, Mayes LC, Sinha R. Prenatal cocaine exposure, gender, and adolescent stress response: a prospective longitudinal study. Neurotoxicol Teratol. 2010;32:595–604.
140. Bandstra ES, Vogel AL, Morrow CE, Xue L, Anthony JC. Severity of prenatal cocaine exposure and child language functioning through age seven years: a longitudinal latent growth curve analysis. Subst Use Misuse. 2004;39:25–59.
141. Frank DA, Augustyn M, Knight WG, Pell T, Zuckerman B. Growth, development, and behavior in early childhood following prenatal cocaine exposure: a systematic review. JAMA. 2001;285:1613–25.
142. Hull L, May J, Farrell-Moore D, Svikis DS. Treatment of cocaine abuse during pregnancy: translating research to clinical practice. Curr Psychiatry Rep. 2010;12:454–61.
143. Richardson GA, Goldschmidt L, Willford J. Continued effects of prenatal cocaine use: preschool development. Neurotoxicol Teratol. 2009;31:325–33.
144. Richardson GA, Goldschmidt L, Larkby C, Day NL. Effects of prenatal cocaine exposure on adolescent development. Neurotoxicol Teratol. 2015;49:41–8.
145. Richardson GA, Goldschmidt L, Larkby C, Day NL. Effects of prenatal cocaine exposure on child behavior and growth at 10 years of age. Neurotoxicol Teratol. 2013;40:1–8.
146. De Genna N, Goldschmidt L, Richardson GA. Prenatal cocaine exposure and age of sexual initiation: direct and indirect effects. Drug Alcohol Depend. 2014;145:194–200.
147. Richardson GA, Larkby C, Goldschmidt L, Day NL. Adolescent initiation of drug use: effects of prenatal cocaine exposure. J Am Acad Child Adolesc Psychiatry. 2013;52:37–46.
148. Bessa MA, Mitsuhiro SS, Chalem E, Barros MM, Guinsburg R, Laranjeira R. Underreporting of use of cocaine and marijuana during the third trimester of gestation among pregnant adolescents. Addict Behav. 2010;35:266–9.
149.• Terplan M, Ramanadhan S, Locke A, Longinaker N, Lui S. Psychosocial interventions for pregnant women in outpatient illicit drug treatment programs compared to other interventions. Cochrane Database Syst Rev. 2015;4, Cd006037. **This is the most recent critical review of available behavioral interventions for illicit substance use**.
150. Schottenfeld RS, Moore B, Pantalon MV. Contingency management with community reinforcement approach or twelve-step facilitation drug counseling for cocaine dependent pregnant women or women with young children. Drug Alcohol Depend. 2011;118:48–55.
151. Yonkers KA, Forray A, Nich C, et al. Progesterone reduces cocaine use in postpartum women with a cocaine use disorder: a randomized, double-blind study. Lancet Psychiatry. 2014;1:360–7.
152. Wouldes TA, LaGasse LL, Derauf C, et al. Co-morbidity of substance use disorder and psychopathology in women who use methamphetamine during pregnancy in the US and New Zealand. Drug Alcohol Depend. 2013;127:101–7.
153. McDonnell-Dowling K, Donlon M, Kelly JP. Methamphetamine exposure during pregnancy at pharmacological doses produces neurodevelopmental and behavioural effects in rat offspring. Int J Dev Neurosci. 2014;35:42–51.
154. Gorman MC, Orme KS, Nguyen NT, Kent EJ, 3rd, Caughey AB. Outcomes in pregnancies complicated by methamphetamine use. Am J Obstet Gynecol 2014;211:429 e1-7.
155. Jones HE, Myers B, O'Grady KE, Gebhardt S, Theron GB, Wechsberg WM. Initial feasibility and acceptability of a comprehensive intervention for methamphetamine-using pregnant women in South Africa. Psychiatry J. 2014;2014:929767.

156. Jones HE, O'Grady KE, Tuten M. Reinforcement-based treatment improves the maternal treatment and neonatal outcomes of pregnant patients enrolled in comprehensive care treatment. Am J Addict. 2011;20:196–204.
157. White SJ, Hendrickson HP, Atchley WT, et al. Treatment with a monoclonal antibody against methamphetamine and amphetamine reduces maternal and fetal rat brain concentrations in late pregnancy. Drug Metab Dispos. 2014;42:1285–91.
158. Jones HE, Heil SH, Tuten M, et al. Cigarette smoking in opioid-dependent pregnant women: neonatal and maternal outcomes. Drug Alcohol Depend. 2013;131:271–7.
159. Chisolm MS, Tuten M, Brigham EC, Strain EC, Jones HE. Relationship between cigarette use and mood/anxiety disorders among pregnant methadone-maintained patients. Am J Addict. 2009;18:422–9.
160. Bateman BT, Hernandez-Diaz S, Rathmell JP, et al. Patterns of opioid utilization in pregnancy in a large cohort of commercial insurance beneficiaries in the United States. Anesthesiology. 2014;120:1216–24.
161. Chapter 13. Medication-Assisted Treatment for Opioid Addiction During Pregnancy. Substance Abuse and Mental Health Services Administration (US), 2005. at http://www.ncbi.nlm.nih.gov/books/NBK64148/.)
162. Jones HE, O'Grady KE, Malfi D, Tuten M. Methadone maintenance vs. methadone taper during pregnancy: maternal and neonatal outcomes. Am J Addict. 2008;17:372–86.
163. Jones HE, Kaltenbach K, Heil SH, et al. Neonatal abstinence syndrome after methadone or buprenorphine exposure. N Engl J Med. 2010;363:2320–31.
164.• Mattick RP, Breen C, Kimber J, Davoli M. Buprenorphine maintenance versus placebo or methadone maintenance for opioid dependence. Cochrane Database Syst Rev. 2014;2:CD002207. **This critical review examines the available data on opiate maintenance therapy in pregnancy**.
165. Jones HE, Haug N, Silverman K, Stitzer M, Svikis D. The effectiveness of incentives in enhancing treatment attendance and drug abstinence in methadone-maintained pregnant women. Drug Alcohol Depend. 2001;61:297–306.
166. O'Connor AB, Collett A, Alto WA, O'Brien LM. Breastfeeding rates and the relationship between breastfeeding and neonatal abstinence syndrome in women maintained on buprenorphine during pregnancy. J Midwifery Womens Health. 2013;58:383–8.
167. Welle-Strand GK, Skurtveit S, Jansson LM, Bakstad B, Bjarko L, Ravndal E. Breastfeeding reduces the need for withdrawal treatment in opioid-exposed infants. Acta Paediatr. 2013;102:1060–6.
168. Mikkola K, Ritari N, Tommiska V, et al. Neurodevelopmental outcome at 5 years of age of a national cohort of extremely low birth weight infants who were born in 1996–1997. Pediatrics. 2005;116:1391–400.
169. Hayatbakhsh MR, Kingsbury AM, Flenady V, Gilshenan KS, Hutchinson DM, Najman JM. Illicit drug use before and during pregnancy at a tertiary maternity hospital 2000–2006. Drug Alcohol Rev. 2011;30:181–7.
170. Akerman SC, Brunette MF, Green AI, Goodman DJ, Blunt HB, Heil SH. Treating tobacco use disorder in pregnant women in medication-assisted treatment for an opioid use disorder: a systematic review. J Subst Abuse Treat. 2015;52:40–7.
171. Bloch M, Parascandola M. Tobacco use in pregnancy: a window of opportunity for prevention. Lancet Glob Health. 2014;2:e489–90.
172. Field M, Cox WM. Attentional bias in addictive behaviors: a review of its development, causes, and consequences. Drug Alcohol Depend. 2008;97:1–20.