



Full length article

Identification of substance use disorders among pregnant women: A comparison of screeners



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ABSTRACT

Background: The purpose of this study is to evaluate five self-report, non-proprietary questionnaires in the identification of substance use disorders [including alcohol, cannabis, opioids, and stimulants] among pregnant women.

Procedures: A total of 1220 pregnant women completed the NIDA Quick Screen, CRAFFT, Substance Use Risk Profile-Pregnancy (SURP-P), Wayne Indirect Drug Use Questionnaire (WIDUS), and the 5 Ps, as well as the MINI diagnostic interview for substance use disorders, which served as the reference standard. Measures of merit calculated for each screener included sensitivity, specificity, accuracy, and area under the receiver operating curve (AUROC).

Main findings: The participants were socioeconomically diverse, with a mean age of 29 years. Over 15% met diagnostic criteria for a substance use disorder. AUROCs for identifying any substance use disorder (including alcohol) ranged from a high of 0.75 for the CRAFFT (95% CI = 0.72–79) and 0.74 for the SURP-P (95% CI = 0.71–.78) to a low of 0.62 for the NIDA Quick Screen (95% CI = 0.59–.65). Overall accuracy of most tested measures was higher for identification of alcohol use disorders than for other substance use disorders (e.g., AUROCs for the CRAFFT and SURP-P for identifying alcohol use disorders were 0.78 and 0.77, respectively).

Principal conclusions: The CRAFFT and SURP-P showed modest ability to identify substance use disorders among pregnant women. Future research is needed to develop an ideal questionnaire set in the complicated societal context which includes increasing rates of use and potential sanction.

1. Introduction

Prenatal exposure to alcohol and other substances is common. The estimated rate of prenatal alcohol use is about 15%, with past month use about 12.6% (Center for Behavioral Statistics and Quality, 2017; Popova et al., 2017). Marijuana is the most commonly used drug during pregnancy; between 2002 and 2017, past month cannabis use increased from 3.4% to 7.0% among pregnant women aged 18 to 44 (Volkow et al., 2019). Higher rates of past month cannabis use (14.6%) are

reported among pregnant adolescents (Salas-Wright et al., 2015). Opioid use among pregnant women increased fourfold between 1999 and 2014 and is present in about 2.5% of pregnancies (Haight et al., 2018; Yazdy et al., 2015).

The consequences of these exposures can be substantial. For example, a recent multi-site study using active case ascertainment methods estimated the prevalence of fetal alcohol spectrum disorders among first graders to range from 1.1 to 5.0% (May et al., 2018). This is concerning because these disorders are associated with life-long

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disabilities. The adverse effects of prenatal marijuana remain unclear (Silverstein et al., 2019). Today, the increased potency of marijuana and the liberalization of laws for its use could result in higher rates of prenatal exposure to stronger cannabis (Crume et al., 2018; Goler et al., 2018). For example, a significantly elevated rate of pre-term birth was recently found among women with self-reported cannabis use (12%) versus nonusers (6%), in a cohort of 661,617 pregnant women in Ontario, Canada, (Corsi et al., 2019). Infants with prenatal opioid exposure are typically born smaller and may have neonatal opioid withdrawal syndrome (NOWS) whereby the infant experiences withdrawal from opioids requiring additional medical care (Ecker et al., 2019). In the United States, a baby was born with opioid withdrawal syndrome every fifteen minutes in 2014 (Honein et al., 2019; Sanlorenzo et al., 2018). Furthermore, mothers of infants with long-term exposure to prenatal opioids may be at elevated risk for mental health conditions (Faherty et al., 2018; Krans and Patrick, 2016).

Early universal screening of pregnant women for alcohol and/or other substance use is recommended by the American College of Obstetricians and Gynecologists [ACOG] since alcohol and substance use is not typically disclosed spontaneously by patients. ACOG has indicated that universal screening can take place through validated questionnaires or conversations with patients but routine urine toxicology testing is not endorsed (American College Committee on Obstetric Practice and American Society of Addiction Medicine, 2017; American College of Obstetrics and Gynecology Committee on Ethics, 2015). Whereas screening instruments for prenatal alcohol use, such as the T-ACE, are well-studied, screening instruments for substances other than alcohol are not (DeVido et al., 2015; Ecker et al., 2019).

The purpose of this study is to evaluate the ability of five self-report, non-proprietary questionnaires, each with some evidence to support its use among pregnant women, to identify substance use disorders, including the alcohol, cannabis, stimulant, and opioid use disorders (American Psychiatric Association, 2013). The opioid use disorders may include both the non-medical use of prescription medications and illicit substances such as heroin. The substance use disorders are distinct from substance use and represent a more significant and persistent pattern of consumption that may increase the risk of adverse infant outcomes, as well as indicating that the pregnant woman may need evaluation and referral for specialty treatment (Edwards et al., 2018).

2. Material and methods

2.1. Sites and participants

Recruitment took place between February of 2016 and April of 2017 at three sites offering outpatient prenatal care (the Yale New Haven Health System in New Haven, CT; Massachusetts General Hospital in Boston, MA; and Henry Ford Health System in Detroit, MI). Women were eligible for participation if they were pregnant, 18 years of age or older, and able to understand written and spoken English. Women were ineligible if they did not provide consent or were considering either termination of the pregnancy or adoption (Lundsberg et al., 2018; Pedersen, 2007; Terplan et al., 2014). Additional details about recruitment are available elsewhere (Ondersma et al., 2019).

2.2. Procedure

Women were either approached directly in the clinical reception area or were told about the study by clinic staff during a regularly scheduled prenatal care visit. Research assistants described the study as having two phases, noting that Phase 2 would be described in detail after conclusion of Phase 1 and that the participant would be free to decline further involvement at that time.

All data for this study were collected anonymously to protect participants' privacy. However, we attempted to address the potential effects of women's privacy concerns and its impact on disclosure by

mimicking usual practice in the following way. Participants at two of the three sites were asked to sign a standard consent form before Phase 1 which implied that information might be available to the health care team. However, at Phase 2 the consent form was returned, and participants were told all information was anonymous. This approach was used at the New Haven and Detroit sites, with approval from the Institutional Review Boards at the Yale University School of Medicine, Wayne State Medical School, and Henry Ford Health System.

At the Boston site, participants were told during the initial consent process before Phase 1 that all data collected were anonymous. This approach was preferred and approved by the Institutional Review Board of Partners Healthcare (Massachusetts General Hospital).

2.3. 2a Study phase 1

Phase 1 was initiated after written, informed consent was obtained. Participants completed five questionnaires on the study iPad which administered them in counterbalanced order (all possible orders of questionnaires equally represented to guard against order effects) at all sites. The five questionnaires were the NIDA Quick Screen (National Institute on Drug Abuse, 2012), CRAFFT (Knight et al., 1999; Chang et al., 2011), Substance Use Risk Profile – Pregnancy (SURP-P, Yonkers et al., 2010), Wayne Indirect Drug Use Screener (WIDUS, Ondersma et al., 2012), and the 5 Ps (Kennedy et al., 2004; Watson et al., 2003) (see Table 1).

These screeners were selected because: 1) The CRAFFT, SURP-P, and WIDUS are non-proprietary screeners with published evidence for identifying substance use (not just alcohol) in pregnancy, 2) the 5 Ps is the non-proprietary version of the 4PsPlus and is widely used among pregnant women but has not heretofore been subject to rigorous evaluation, and 3) the NIDA Quick Screen is a parsimonious screener that

Table 1
Study Screeners.

Substance Use Risk Profile-Pregnancy (SURP-P, Yonkers et al., 2010)
1 Have you ever smoked marijuana?
2 In the month before you knew you were pregnant, how many beers, how much wine, or how much liquor did you drink?
3 Have you ever felt that you needed to cut down on your drug or alcohol use?
Wayne Indirect Drug Use Screener (WIDUS, Ondersma et al., 2012)
1 I am currently married
2 In the past year, I have been bothered by pain in my teeth or mouth.
3 I have smoked at least 100 cigarettes in my entire life.
4 Most of my friends smoke cigarettes
5 There have been times in my life, for at least 2 weeks straight, where I felt like everything was an effort.
6 I get mad easily and feel a need to blow off some steam.
CRAFFT Questionnaire (Knight et al., 1999)
1 Have you ever ridden in a car driven by someone (including yourself) who was “high” or had been using alcohol or drugs?
2 Do you ever use alcohol or drugs to relax, feel better about yourself, or fit in?
3 Do you ever use alcohol/drugs while you are by yourself, alone?
4 Do you ever forget things you did while using alcohol or drugs?
5 Do your family or friends ever tell you that you should cut down on your drinking or drug use?
6 Have you ever gotten into trouble while you were using alcohol or drugs?
5Ps Questionnaire (Watson et al., 2003)
1 Did any of your parents have a problem with using alcohol or drugs?
2 Do any of your friends have a problem with drug or alcohol use?
3 Does your partner have a problem with drug or alcohol use?
4 Before you knew you were pregnant, how often did you drink beer, wine, wine coolers, or liquor?
5 In the past month, how often did you drink beer, wine, wine coolers, or liquor?
NIDA Quick Screen (National Institute on Drug Abuse, 2012)
1 In the past year, how often have you had four or more drinks a day? ^a
2 In the past year, how often have you used tobacco products?
3 In the past year, how often have you used prescription drugs for non-medical reasons?
4 In the past year, how often have you used illegal drugs?

^a The NIDA Quick Screen uses “past year” but this study used “past month” for the 4 questions.

directly measures substance use (Ondersma et al., 2019.) Although the NIDA Quick Screen was included because of the strong performance of its alcohol and drug single items in other adult samples, it had not been tested among pregnant women when this study was designed. Since that time, two published studies have evaluated the NIDA Quick Screen among pregnant samples (Coleman-Cowger et al., 2019; Ondersma et al., 2019), but both focused on identification of substance use rather than of substance use disorders. Because of the tendency for women to reduce substance use during pregnancy, the NIDA Quick Screen's response options were modified to refer to the past month rather than the past year use (Ethen et al., 2009; Lundsberg et al., 2019; Roberts et al., 2014). Notably, the World Health Organization Guidelines for the identification and management of substance use and substance use disorders in pregnancy lists the SURP-P, the proprietary 4PsPlus, and the NIDA Quick Screen -ASSIST as potential screeners in pregnant women (World Health Organization, 2014). Other screeners such as the Hospital Screening Questionnaire, Patient Information Program, and the DAST-10 were not considered for inclusion due to length, lack of validation with pregnant women, or published metrics (Coleman-Cowger et al., 2019; Grekin et al., 2010).

After completion of Phase 1, participants in Detroit and New Haven were told that their responses would in fact not be shared with staff, that no identifying information was being retained, and that this was done to provide as much protection for them as possible while also administering the questionnaires in a realistic way. Participants were then debriefed regarding this minor deception by asking if they had any concerns or negative reactions. As with past studies using this approach, participants expressed neither concern nor distress and did not withdraw from further study participation (Beatty et al., 2014; Ondersma et al., 2012, 2019).

2.4. 2b Study phase 2

All participants who completed Phase 1 were then invited to participate in Phase 2, which included the MINI International Neuropsychiatric Interview (MINI 7.02), a short, structured diagnostic interview for the substance use disorders (including alcohol, cannabis, stimulants such as cocaine or amphetamines, and opioids such as heroin and the non-medical use of prescription drugs, Sheehan et al., 2016). Phase 2 also included a calendar-based recall of alcohol and other substance use for the past 30 days. The MINI and past 30-day use calendar were self-administered via the study iPad. A urine sample was collected and tested for alcohol, amphetamines, barbiturates, benzodiazepines, cannabis, cocaine, and opioids (enzyme immunoassay; Redwood Toxicology Laboratory, Santa Rosa, California). Thus, data gathered from Phase 2 of the study yielded information about participants' recent drug use (based on the 30-day calendar recall and urine toxicology screening results) and the reference standard of the substance use disorders (based on the MINI). Phase 2 participants received a \$30.00 gift card.

2.5. Data analysis

A priori power analysis informed study design so that 400 women with drug or alcohol use were recruited. This would allow a 7.5% difference in sensitivity between two screeners to be detected, with 91% power.

To describe demographic and clinical characteristics of our sample, descriptive statistics were calculated overall and by site, and differences in characteristics between sites were compared using analysis of variance (ANOVA) for continuous variables and Fisher's exact tests or chi-square tests for categorical variables, as appropriate.

Participants were classified as screening positive according to published cut-off scores for each questionnaire. Participants' questionnaire classifications were compared to three different reference standards: 1) presence of an alcohol use disorder, 2) presence of another substance

use disorder (i.e., cannabis, stimulants, and opioids subdivided into heroin and non-medical use of prescription drugs), and 3) presence of either an alcohol or another substance use disorder. Each questionnaire's association with each reference standard was first evaluated using area under the receiver operating characteristic curves (AUROC) with 95% confidence intervals. The area under the curve (AUC) is a derived summary measure of a questionnaire's inherent ability to discriminate between the presence or absence of a condition (e.g., in this study, an alcohol or another substance use disorder diagnosis) without regard to cut-points. The receiver operating characteristic curve plots sensitivity against 1-specificity. Values of AUROC may range from 0.5 (where classification occurs at the level of chance) to 1.0 (where classification is perfect, Hajian-Tilaki, 2013).

Descriptive measures of merit (sensitivity, specificity, and accuracy) along with their 95% confidence intervals, based upon asymptotic standard errors, were also calculated for each screener. Sensitivity is the true positive rate (true positives / (true positives + false negatives)) whereas specificity is the true negative rate (true negatives / (false positives + true negatives)). Accuracy is defined as ((true positives + true negatives) / (true positives + false positives + true negatives + false negatives), Hajian-Taliki, 2013).

Differences in AUC by questionnaires were compared by calculating z-scores $\left(\frac{AUC_1 - AUC_2}{\sqrt{(SE_1)^2 + (SE_2)^2}} \right)$ for each pairwise comparison. Pairwise differences in sensitivity, specificity, and accuracy between questionnaires were tested using generalized estimating equations (GEE) which allowed for correlation in the outcomes within participants and specified a binomial distribution, logit link, and exchangeable correlation structure.

3. Results

3.1. Demographic and clinical characteristics of participants

We approached 3429 women for study participation, 2209 of whom were excluded. Of those excluded, 1101 did not meet eligibility criteria, 941 declined or did not provide consent, 149 did not complete the study, and 18 did not participate for other reasons (e.g. technical difficulties with tablet, ineligibility discovered). Additional details are available elsewhere (Ondersma et al., 2019).

Demographic and clinical characteristics of the study sample are summarized in Table 2. The final sample included 1220 pregnant women with an average age of 29 years, most of whom were either non-Hispanic Black (n = 480, 40.1%) or non-Hispanic White (n = 444, 37.1%). Approximately 10% of participants did not have a high school degree, and 35% had a college degree or higher. About one-half of participants were married or cohabitating (n = 588, 49.1%) and almost half of participants (n = 539, 44.7%) reported receiving public assistance in the past year. Overall, participants were evenly distributed across the three trimesters. Participants from the Boston site were significantly more likely to be white, college educated, and married, and less likely to be receiving some form of public assistance.

3.2. Alcohol and substance use

Recent substance use by the participants is summarized in Table 3. One third of participants (n = 397, 32.5%) had past 30-day substance use, ascertained either by self-report or urine toxicology screening. The most frequently used substances were cannabis and alcohol (see Table 3).

Over 15% of participants satisfied MINI criteria for a substance use disorder, and 3% satisfied criteria for more than one disorder. Nearly 10% were classified as having an alcohol use disorder, and 9.0% were classified as having another substance use disorder. Specifically, cannabis use disorder was the most common substance disorder diagnosis (7.7%). There were considerable variations by site. For example, an

Table 2
Demographic Characteristics Overall and by Site.

Characteristic	Total sample (N = 1220)	New Haven (n = 554)	Detroit (n = 333)	Boston (n = 333)	p-value ^a
Age, mean (SD)	29.0 (5.9)	28.7 (6.1)	26.1 (5.1)	32.6 (4.3)	< .001
Race /ethnicity, n (%)					< .001
Non-Hispanic Black	480 (40.1)	174 (32.2)	283 (86.8)	23 (7.0)	
Non-Hispanic White	444 (37.1)	190 (35.2)	16 (4.9)	238 (71.9)	
Hispanic	190 (15.9)	141 (26.1)	12 (3.7)	37 (11.2)	
Non-Hispanic other/mixed race	83 (6.9)	35 (6.5)	15 (4.6)	33 (10.0)	
Education, n (%)					< .001
Less than high school	124 (10.3)	64 (11.7)	57 (17.5)	3 (0.9)	
High school degree	339 (28.2)	207 (37.9)	115 (35.3)	17 (5.1)	
Some college	320 (26.6)	140 (25.6)	130 (39.9)	50 (15.1)	
College degree or higher	421 (35.0)	135 (24.7)	24 (7.4)	262 (78.9)	
Marital status, n (%)	588 (49.1)	228 (42.3)	57 (17.5)	303 (91.0)	< .001
Married / cohabitating	588 (49.1)	228 (42.3)	57 (17.5)	303 (91.0)	
Other living situation	610 (50.9)	311 (57.7)	269 (82.5)	30 (9.0)	
Received public assistance in past year, n (%)					< .001
Yes	539 (44.7)	261 (47.8)	236 (72.0)	42 (12.6)	
No	668 (55.3)	285 (52.2)	92 (28.1)	291 (87.4)	
Trimester, n (%)					< .001
First	430 (35.3)	183 (33.0)	159 (47.8)	88 (26.4)	
Second	394 (32.3)	187 (33.8)	90 (27.0)	117 (35.1)	
Third	396 (32.5)	184 (33.2)	84 (25.2)	128 (38.4)	

Note: column totals may not add to total due to missing data; percentages based on valid responses and may not add to 100% due to rounding.

^a p-values are based upon ANOVA F-test for continuous variables and chi-square tests for categorical variables.

alcohol use disorder was the most common in Boston (15.4%) but infrequent in New Haven (4.9%). In contrast, the other substance use disorders were the most common in Detroit (16.6%) but less frequent in Boston (3.0%).

Of note, there was little overlap between the women who had past 30-day alcohol or substance use and those who satisfied diagnostic criteria. 67% of the women with alcohol use disorders did not have 30-day past alcohol or substance use (chi-square = 56.6, $df = 2$, $p < .0001$). 31% of the women with another substance use disorder did not have 30-day past alcohol or substance use (chi-square = 205.1, $df = 2$, $p < .0001$). 43% of the women with either alcohol or another substance use disorder did not have 30-day past alcohol or substance use (chi-square = 110.3, $df = 2$, $p < .0001$).

3.3. Evaluation of the screening questionnaires

Measures of merit for the screening questionnaires are summarized in Table 4. For the alcohol use disorder outcome, CRAFFT (AUROC = 0.78, 95% CI = 0.74 to 0.82) and SURP-P (AUROC = 0.77, 95% CI = 0.74 to 0.81) had significantly higher AUROCs compared to the other questionnaires. Sensitivity differed significantly between SURP-P and CRAFFT (0.85 versus 0.75, respectively, $p = 0.03$), and specificity was significantly lower for SURP-P compared to CRAFFT (0.69 versus 0.81, respectively, $p < 0.01$). For the other substance use disorders, the only significant differences in AUROCs was that AUROCs for the WIDUS and SURP-P were significantly greater than that for the Five Ps. Overall WIDUS had the highest AUROC at 0.72 (95% CI = 0.67, 0.76), with a sensitivity of 0.68 (95% CI = 0.59, 0.77) and specificity of 0.75 (95% CI = 0.72, 0.77), followed by the SURP-P (AUROC = 0.71, 95% CI = 0.67, 0.75), sensitivity = 0.75 (95% CI = 0.62, 0.83), and

Table 3
Frequency of Diagnoses Overall and by Site, n (%).

	Total sample (N = 1220)	New Haven (n = 554)	Detroit (n = 333)	Boston (n = 333)	p-value ^a
Substance positive ^b , n (%)					
Alcohol	145 (11.9)	38 (6.9)	63 (18.9)	44 (13.2)	< .001
Cannabis	185 (15.2)	76 (13.7)	98 (29.4)	11 (3.3)	
Opioids ^c	43 (3.5)	18 (3.3)	16 (4.8)	9 (2.7)	0.303
Other illicit drugs ^d	199 (16.3)	87 (15.7)	100 (30.0)	12 (3.6)	< .001
Any substance	397 (32.5)	175 (31.6)	160 (48.1)	62 (18.6)	< .001
Substance Use Disorder					
Alcohol only	117 (9.6)	27 (4.9)	39 (11.7)	51 (15.4)	< 0.001
Substance use excluding EtOh	107 (8.8)	42 (7.6)	55 (16.6)	10 (3.0)	< 0.001
Alcohol and/or substance use	186 (15.3)	57 (10.3)	76 (22.9)	53 (16.1)	< 0.001
Alcohol and substance use	38 (3.1)	12 (2.2)	18 (5.4)	8 (2.4)	0.026
Cannabis	94 (7.7)	35 (6.3)	53 (16.0)	6 (1.8)	< 0.001
Stimulant	13 (1.1)	7 (1.3)	3 (0.9)	3 (0.9)	0.880
Opioids					
Prescription, non-medical use	7 (0.6)	4 (0.7)	1 (0.3)	2 (0.6)	0.890
Illicit, heroin	5 (0.4)	3 (0.5)	1 (0.3)	1 (0.3)	1.000

^a p-values are based upon Fisher's Exact test.

^b defined as positive if either the calendar recall interview (with a past 30-days window) or urine drug screen was positive.

^c including prescription opioid misuse or illicit opioid use.

^d including marijuana, cocaine, heroin, amphetamines, barbiturates, hallucinogens.

Table 4
Questionnaire^a Performance in the Identification of the Substance Use Disorders.

	N (%) positive	AUROC ^c (95% CI)	Sensitivity ^d (95% CI)	Specificity ^d (95% CI)	Accuracy ^d (95% CI)
Alcohol Only	117 (9.6)				
SURP-P	439 (36.4)	0.77 ^x (0.74, 0.81)	0.85 (0.78, 0.91)	0.69 (0.66, 0.72)	0.70 ^x (0.68, 0.73)
WIDUS	349 (28.9)	0.61 (0.56, 0.66)	0.49 (0.39, 0.58)	0.73 (0.70, 0.76)	0.71 ^x (0.68, 0.73)
CRAFFT	300 (24.8)	0.78^x (0.74, 0.82)	0.75 (0.66, 0.83)	0.81 (0.78, 0.83)	0.80 (0.78, 0.82)
5P's	799 (65.7)	0.66 (0.64, 0.69)	0.95 (0.89, 0.98)	0.37 (0.35, 0.40)	0.43 (0.40, 0.46)
NIDA ^b	28 (2.3)	0.52 (0.50, 0.54)	0.06 (0.02, 0.12)	0.98 (0.97, 0.99)	0.89 (0.87, 0.91)
Other Substance Use	107 (8.8)				
SURP-P	439 (36.4)	0.71 ^x (0.67, 0.75)	0.75 ^x (0.65, 0.83)	0.67 (0.65, 0.70)	0.68 (0.65, 0.71)
WIDUS	349 (28.9)	0.72^x (0.67, 0.76)	0.68 ^{x,y} (0.59, 0.77)	0.75 (0.72, 0.77)	0.74 ^x (0.72, 0.77)
CRAFFT	300 (24.8)	0.71 ^{x,y} (0.66, 0.76)	0.63 ^y (0.53, 0.72)	0.79 (0.76, 0.81)	0.78 ^x (0.75, 0.80)
5P's	799 (65.7)	0.67 ^y (0.64, 0.69)	0.96 (0.91, 0.99)	0.37 (0.34, 0.40)	0.42 (0.40, 0.45)
NIDA ^b	79 (6.6)	0.69 ^{x,y} (0.64, 0.73)	0.41 (0.31, 0.51)	0.97 (0.95, 0.98)	0.92 (0.90, 0.93)
Either Alcohol or Other Substance Use	186 (15.3)				
SURP-P	439 (36.4)	0.74 ^x (0.71, 0.78)	0.78 (0.71, 0.84)	0.71 (0.68, 0.74)	0.72 ^x (0.69, 0.75)
WIDUS	349 (28.9)	0.65 ^{y,z} (0.65, 0.69)	0.54 (0.47, 0.62)	0.76 (0.73, 0.78)	0.72 ^x (0.70, 0.75)
CRAFFT	300 (24.8)	0.75^x (0.72, 0.79)	0.68 (0.61, 0.74)	0.83 (0.81, 0.85)	0.81 (0.78, 0.83)
5P's	799 (65.7)	0.68 ^y (0.66, 0.70)	0.96 (0.92, 0.98)	0.40 (0.37, 0.43)	0.48 (0.45, 0.51)
NIDA ^b	98 (8.2)	0.62 ^z (0.59, 0.65)	0.28 (0.22, 0.35)	0.95 (0.94, 0.97)	0.85 (0.83, 0.87)

Note. AUROC = Area under the receiver operating characteristic curve; CI = Confidence Interval; Sensitivity = proportion of people who screen positive among those who were positive for use; Specificity = proportion of people who screen negative among those who were negative for use; Accuracy = proportion correct classifications. Values in bold represent the top score for that performance measure within each substance outcome (but are not necessarily significantly different from the other scores).

^a All questionnaires were evaluated using their recommended published score for each separate outcome.

^b The single alcohol use question was used for identifying alcohol use; the illegal drug use and prescription drug misuse questions were used for identifying substance use.

^c Post-hoc pairwise comparisons of questionnaires for substance use outcomes from z-score tests are shown with superscripts. Performance measures not statistically significantly different at $p < .05$ share a letter; those that are statistically significantly different do not share a letter.

^d Post-hoc pairwise comparisons of questionnaires for substance use outcomes from generalized estimating equation models are shown with superscripts. Performance measures not statistically significantly different at $p < .05$ share a letter; those that are statistically significantly different do not share a letter.

specificity = 0.67 (95% CI = 0.65, 0.70).

When considering screening for any substance use disorder, no single measure emerged as the most effective. Whereas the CRAFFT had the highest AUROC (0.75, 95% CI = 0.72, 0.79), the 5 Ps was the most sensitive (0.96, 95% CI = 0.92, 0.99), and the NIDA Quick Screen was the most specific (0.95, 95% CI = 0.94, 0.97) and accurate (0.85, 95% CI = 0.83, 0.87).

4. Discussion

Universal voluntary self-report screening of pregnant women for alcohol and substance use is recommended to facilitate early identification and modification of a potentially problematic behavior (Ecker et al., 2019). Over 15% of the 1220 women in this study satisfied diagnostic criteria for a substance use disorder, and over 30% had used alcohol or other substances in the past month. Importantly, there was only modest overlap between the women who had substance use disorder and the women who had used alcohol or other substances within the past month. Hence, it is important to identify not only women who are currently using alcohol or substances while pregnant, but also those at risk for using – the women with substance use disorder diagnoses. Indeed, prior research has shown that the best predictor of continued prenatal alcohol and substance use is past use, which is infrequently identified without systematic screening (Chang et al., 2006, 2010; Salas-Wright et al., 2015).

The main findings of this study show that among the five questionnaires tested, only two (the CRAFFT and SURP-P) demonstrated modest overall accuracy. For example, while the NIDA Quick Screen had the highest accuracy for any substance use disorders (0.85), it was the most specific (0.98), the least sensitive (0.28) and had the smallest AUROC (0.62) compared to the other questionnaires. On the other hand, the CRAFFT had the largest AUROC (0.75), with reasonable sensitivity (0.68), specificity (0.83), and accuracy (0.81). The SURP-P had the most comparable sensitivity (0.78) and specificity (0.71), as reflected in its accuracy (0.72) and AUROC (0.74). Among the five

measures evaluated, none had AUROC values that exceed 0.8, the cutoff for “good accuracy” when identifying any substance use disorder, but both the CRAFFT and SURP-P had AUROC values that exceeded the 0.70 cutoff for “fair accuracy” (Hajian-Taliki, 2013)

Potential limitations to the generalizability of study findings are noted. First, despite the large and diverse study sample, the participants were not necessarily representative because they were a sample seeking clinical care and non-English speakers were excluded. Women who were considering pregnancy termination or adoption were not eligible to participate. Second, there was variability in IRB requirements at each site, so that the Boston participants knew that their responses were anonymous from the start of the study. Although the extent to which this influenced participant responding is unknown, measure performance does not appear to differ according to sensitivity analysis that only included the Detroit and New Haven sites (results available upon request). Third, this study compared five screeners but did not include others such as the Drug Abuse Screening Test (DAST-10) or those which focused exclusively on prenatal alcohol use such as the T-ACE. Fourth, we relied on participants' self-reports of alcohol and drug use for the MINI interview and 30-day past use report. While a biological measure of recent use was also obtained, limitations of urine toxicology screening include a short window of detection and limited ability to identify synthetic substances such as fentanyl. Finally, it is not known whether the obstetric teams were aware that over 15% of their patients satisfied diagnostic criteria for current substance use disorders.

Strengths of this research effort include a head to head comparison of five measures in an anonymous, large, and diverse patient sample. Other studies have used smaller samples, fewer screening measures, or exclusive reliance on biological measures of substance use without evaluating for alcohol use. This study complements a companion study that focused on recent alcohol and substance use by also evaluating the presence of the substance use disorders (Ondersma et al., 2019).

Pregnant women with substance use disorders are at increased risk for adverse health and social outcomes, and so their early identification is desirable to optimize pregnancy (Kozhimannil et al., 2019). Since

substance use is substantially under-reported, even among women who participate regularly in urine drug screens (Garg et al., 2016), use of validated questionnaires to identify prenatal alcohol and substance use to facilitate such identification is recommended (Ecker et al., 2019). However, according to a 2010 survey of obstetrician-gynecologists, 58% did not use a validated screening tool to assess alcohol risk (Anderson et al., 2010). It is likely that even fewer will use a screener for prenatal substance use, particularly as such screeners are less well developed (Coleman-Cowger et al., 2019; Ondersma et al., 2019). Future research should consider alternate test construction techniques (e.g., adaptive testing) or methods for addressing under-reporting to increase identification of substance use disorders in pregnancy.

Explanations for the lukewarm uptake of screening for alcohol and drug use among pregnant women by obstetricians and gynecologists may also include concerns about states' punitive approaches to prenatal substance use and the wish to avoid complications for their patients, in addition to reservations about the screening questionnaires themselves (Angelotta and Applebaum, 2017; Guttmacher Institute, 2019; Trocin et al., 2019). Thus, efforts to develop an ideal questionnaire to identify prenatal alcohol and substance use must be set in the complicated societal context which includes increasing rates of use and potential sanction.

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Contributors

All authors had an active role in the design and execution of the study, analysis and interpretation of the data, and manuscript preparation. They have reviewed and approved the final version of the manuscript that has been submitted.

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Dr. Chang discloses royalties from Up-to-Date.

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Declaration of Competing Interest

The authors report no conflicts of interest.

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