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Cigarette Smoking Reduction in Pregnant Women with Opioid Use Disorder

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Abstract

Objectives—Nearly 95% of women with opioid use disorder continue to smoke cigarettes during pregnancy. Despite this prevalence and the well-documented adverse effects of smoking on birth outcomes, cigarette smoking is under-addressed in this population. This study examines factors associated with successful smoking reduction among pregnant women with opioid use disorder and the impact of smoking reduction on maternal and birth outcomes.

Methods—This study is a secondary data analysis of maternal smoking reduction and infant birth outcomes among pregnant women with opioid use disorder (N=118) enrolled in a randomized controlled trial of a contingency management intervention in which escalating monetary vouchers were provided to women who met escalating smoking reduction targets.

Results—Participants' ability to meet higher smoking reduction targets was associated with less cocaine use at baseline ($p=0.022$), higher carbon monoxide levels at baseline ($p=0.039$), fewer prior quit attempts ($p=0.016$), participation in the contingency management intervention, and greater adherence with the parent trial protocol. Some clinically relevant associations were found between smoking reduction and birth outcomes, including birth weight, spontaneous abortions, and neonatal abstinence syndrome treatment, but these differences did not reach statistical significance.

Conclusions—Contingency management promotes smoking reduction, but other factors may be associated with such reduction, including baseline smoking and illicit drug use, prior quit attempts, and willingness to participate in the incentives program. Clinicians caring for pregnant women with opioid use disorder may see greater smoking behavior change if they first encourage smoking reduction before recommending smoking cessation. Future research is needed to determine the level of smoking reduction needed to positively impact birth outcomes.

Keywords

cigarette smoking; pregnancy; opioids; nicotine; tobacco; contingency management

BACKGROUND

Cigarette smoking during pregnancy is the leading preventable cause of pregnancy-related morbidity and mortality in the United States (US) (Bonnie, et al. 2007; Dietz, et al. 2010; Tong, et al. 2013). Smoking during pregnancy has been consistently linked to multiple negative health outcomes for both mother and child, such as placental abruption, ectopic pregnancy, preterm birth, low birth weight, stillbirth, and sudden infant death syndrome (Satcher, et al. 2002; Dietz, et al. 2010; US Department of Health and Human Services. 2014). In particular, data indicate that 5%–8% of preterm deliveries, 13%–19% of full-term infants with growth restriction, 5%–7% of preterm-related deaths, and 23%–34% of SIDS deaths can be attributed to maternal cigarette smoking during pregnancy (Dietz, et al. 2010).

Despite the well-established associations between maternal cigarette smoking and adverse health effects, approximately 12% of women in the US smoke cigarettes during pregnancy (Tong, et al. 2013). Interestingly, the prevalence of cigarette smoking in non-pregnant women between the ages of 15 and 44 has decreased in the past 10 years, while the prevalence of cigarette smoking among pregnant women has remained essentially unchanged (Results from the 2012 National Survey on Drug Use and Health: Summary of National Findings, 2013). Among women who smoke during pregnancy, only 18%–25% are able to quit during pregnancy (US Department of Health and Human Services. 2004).

Cigarette smoking is highly co-morbid among pregnant women with opioid use disorders, with smoking estimates around 95% (Chisolm, et al. 2013; Jones, et al. 2013). The risks associated with cigarette smoking during pregnancy are compounded by the risks from opioid exposure such as preterm birth, low birth weight, and neonatal abstinence syndrome (NAS) (Fajemirokun-Odudeyi, et al. 2006; Greig, et al. 2012). The high prevalence of cigarette smoking among pregnant women with opioid use disorders and the adverse maternal and infant outcomes associated with these co-morbid disorders highlights the need for enhanced intervention in this population. Treatment programs for substance use disorders, particularly those that target opioid use disorders, are in an optimal position to provide important smoking cessation interventions during the patient's treatment episode.

A number of behavioral and pharmacologic interventions are available for treating cigarette smoking. A Cochrane review of 72 randomized and quasi-randomized controlled trials for smoking cessation among pregnant women classified interventions into 5 main categories: 1) cognitive behavior and motivational interviewing; 2) contingency management; 3) interventions based on stages of change; 4) feedback provision to mothers regarding fetal health status or nicotine by-products measurements; and 5) nicotine replacement therapy, bupropion, or other medications. The reviewers concluded that the most effective intervention is contingency management, which helps around 24% of women to quit smoking during pregnancy (Lumley, et al. 2009). It is important to note that, while pharmacotherapy is an effective treatment for smoking cessation in general populations, there is currently insufficient evidence to evaluate its safety or efficacy during pregnancy (U.S. Preventive Services Task Force. 2009).

Although contingency management produces relatively high rates of smoking cessation compared to other interventions (Lemley et al., 2009), it remains insufficient for promoting cessation for the majority of individuals. Novel applications of contingency management, including reinforcement of more attainable target behaviors such as smoking reduction goals (Lamb, et al. 2004; 2005), are promising for encouraging behavior change, particularly among populations without an intention to quit smoking.

Additionally, factors beyond treatment intervention are known to affect the likelihood of success in smoking cessation during pregnancy, including age, socioeconomic status, smoking status of partner, number of children, rate of tobacco consumption, adequacy of prenatal care, maternal stress, and pregnancy intention (Schneider and Schutz. 2008; Schneider, et al. 2010; Hauge, et al. 2012; Chisolm, et al. 2014).

To the authors' knowledge, no studies have examined the predictors of smoking cessation and reduction outcomes among pregnant women with opioid use disorder. Research on factors that affect smoking course in this population can provide information needed to inform clinical interventions.

The present study is a secondary data analysis of a smoking reduction and cessation study of pregnant women with opioid use disorders at the Johns Hopkins Center for Addiction and Pregnancy (CAP). The trial (N=103) examined the relative efficacy of contingent behavioral incentives (CBI), non-contingent behavioral incentives (NCBI), and treatment as usual (TAU) for cigarette smoking reduction and cessation in the sample.

Trial results showed that half of CBI participants met the 75% smoking reduction target and one-third of CBI participants met the abstinence target demand (Tuten, et al. 2012). These outcomes were far superior to the smoking reduction and abstinence outcomes for the NCBI and TAU conditions. Although at lower rates compared to CBI participants, NCBI and TAU participants also met some of the smoking reduction targets, specifically targets with lower smoking reduction demands. For example, more than half of TAU and NCBI participants met the 25% reduction target, while only 2% of TAU and 0% of NCBI participants met the 75% reduction target.

Given the differential outcomes on smoking reduction for the treatment conditions, the authors sought to: 1) further examine the contribution of the trial arm on maternal smoking reduction as well as infant birth outcomes and 2) investigate whether other variables are associated with successful smoking reduction in this population of pregnant women with opioid use disorder, including variables such as demographic characteristics, baseline cigarette smoking and drug use, and adherence with the parent trial protocol. The authors hypothesize that assignment to CBI condition, lower levels of nicotine dependence, and lower levels of poly-substance use will be associated with successful smoking reduction. Prior studies have identified these variables as playing a key role in successful smoking reduction behavior (Berg, et al. 2010; Tuten, et al. 2012; Haug, et al. 2014). However, with the exception of CBI participation, none of these studies specifically focused on women with opioid use disorders. The authors also hypothesize that successful smoking reduction will be associated with improved birth outcomes, as evidenced by one study that examines

the positive effect of maternal smoking reduction on birth weight of term infants (England, et al. 2001).

METHODS

Participants and Setting

Participants for the current study were drawn from a trial conducted at CAP between May 20, 2005 and January 9, 2009. CAP is a comprehensive drug and alcohol treatment program for pregnant women located at the Johns Hopkins Bayview Medical Center (Jansson, et al. 1996). CAP patients were eligible for the parent study if they were: receiving methadone treatment for opioid use disorder, age 18 or older, 30 weeks of gestation, and met Fagerstrom nicotine dependence criteria (Heatherton, et al. 1991), or reported heavy smoking (10 cigarettes daily). Participants were randomized to one of three trial arms: 1) CBI; 2) NCBI; and 3) TAU. The study conditions for the parent trial are described briefly below.

CBI participants were eligible to earn monetary vouchers for percentile reductions in smoking from baseline as follows: any reduction (week 1), 10% reduction for weeks 2–4, 25% reduction for weeks 5–7, 50% reduction for weeks 8–9, 75% reduction for weeks 10–11, and smoking abstinence (carbon monoxide [CO] < 4 parts per million; week 12 or until delivery). No intervention was provided postpartum, however postpartum measurements included maternal CO level at delivery, urine toxicology results for illicit drugs at delivery, and neonatal measurements (e.g. birth weight, gestational age, presence of neonatal abstinence syndrome or spontaneous abortion). The percentile schedule for smoking reduction targets was used based on the work of Lamb et al., 2004; 2005, which shows that contingency management for percentile CO reductions produced greater rates of smoking cessation. CO testing also provides immediate measurement of recent smoking status, and therefore allows for immediate reinforcement of smoking reductions. Vouchers were delivered on an escalating voucher schedule that began at \$7.50 and increased to a maximum of \$42.50 over the course of a 12 week intervention.

NCBI participants were eligible to receive vouchers during the 12 week study independent of their own cigarette smoking status. A prior-generated schedule of voucher earnings was generated from CBI pilot participants (not included in study sample). NCBI participants were “yoked” randomly to these participant earning schedules.

TAU participants received CAP standard care smoking cessation counseling, which includes smoking cessation psycho-education groups and advice from obstetrical staff to quit or substantially reduce smoking during pregnancy. TAU participants were not eligible to earn monetary vouchers.

Participant cigarette smoking for all study conditions was measured three times weekly using urinalysis testing for cotinine, exhaled breath testing for CO level, and participant self-report of number of cigarettes smoked per day (CPD). CO breathalyzer testing was the preferred metric to verify smoking reduction for the contingency management intervention because it represents an objective quantitative measure of recent cigarette smoking (versus

CPD self-report), and because breath testing provides immediate results allowing rapid reinforcement of smoking reduction.

Study Design

This study is a secondary analysis of maternal smoking reduction and infant birth outcomes for participants enrolled in the parent trial (Tuten, et al. 2012). In this secondary analysis, participants from the parent trial were grouped into clinically relevant categories based upon study smoking patterns, and defined below:

1. Successful reducers (SR): participants who met the 50%, 75%, or 100% targets at least once during the 11-week outpatient trial.
2. Non-successful reducers (NSR): participants who failed to meet at least one reduction target of 50% or greater.

Measures

Participants in the SR and NSR groups were compared on pre-treatment characteristics, including demographic variables and baseline cigarette smoking and drug use (Table 1). SR and NSR group participants were also compared on maternal treatment outcomes, including days of treatment attended, urine toxicology results (i.e., total number of urine samples collected, percent of samples positive for illicit drugs), CO reduction from baseline, CO level at delivery, and number of weekly smoking reduction targets attained. Additionally, SR and NSR participants were compared on maternal delivery and infant birth outcomes (Table 2).

Data Analysis

All analyses were conducted using SPSS version 22, with significance value set at $p < 0.05$. Chi-square tests were used to analyze dichotomous variables and T-tests were used to compare means for continuous variables. ANCOVA was used for the measure of mean treatment days (to adjust for estimated gestational age (EGA) at treatment entry. Logistic regression with simultaneous entry was used to develop a model predictive of successful smoking reduction. Smoking reduction was defined as meeting one or more smoking reduction targets of 50% or greater during the trial. Regression variables were entered simultaneously, and included trial arm (i.e., CBI, NCBI, TAU), baseline number of cigarettes smoked, baseline CO measure, baseline Fagerstrom nicotine dependence score, and number of days of baseline cocaine use. Cocaine use was included in the model as use of stimulant drugs is highly associated with cigarette smoking due to additive and potentially synergistic effects (Vansickel, et al. 2007).

RESULTS

Participant Characteristics

A total of 118 women participated in the study. Demographically, SR group participants did not differ significantly from those in the NSR group (Table 1). On average, they were in their early 30s, Caucasian, single, unemployed, and with less than a high school education. The mean ($\pm$ SD) estimated gestational age at treatment entry was 16 weeks (6.8).

Despite their demographic similarity, the two groups differed on several baseline smoking and pre-treatment drug use measures (Table 1). The SR group had higher measured CO levels at baseline, on average, than those in the NSR group ($p=0.039$). In addition, the SR group reported fewer days of cocaine use in the past month at baseline ($p=0.022$). SR group participants also reported fewer smoking quit attempts compared to NSR group participants ($p=0.016$). There were no significant differences in baseline cigarettes smoked per day in the past month or Fagerstrom scores between the two groups.

Treatment Outcomes

Treatment outcomes for the SR and NSR groups are presented in Table 2. Nearly two-thirds of participants in the SR group were in the CBI condition, compared to about one-third of the NSR group; however this difference did not reach significance ($p=0.056$). SR group participants had overall better adherence with treatment: they attended more days of treatment than those in the NSR group ($p=0.027$) and left more urine samples ($p=0.014$). The two groups did not differ on the proportion of urine samples that tested positive for illicit drugs.

On CO measures, the SR group had a significantly larger overall CO reduction across the 11-week trial period than the NSR group ($p=0.001$). Consistent with this finding, the mean CO level at delivery was significantly lower in the SR group than the NSR group ($p<0.001$). In addition, SR participants demonstrated a greater number of successful weeks (i.e., met weekly reduction targets) compared to the NSR group ($p<0.001$).

Table 3 depicts the number of participants who met weekly targets in the SR and NSR groups for each week during the trial. Overall, a greater proportion of SR group participants were able to meet targets compared to NSR group participants. However, in both groups, the proportion of participants meeting weekly CO targets dropped as the reduction targets became increasingly higher. The largest decline in the NSR group occurred between the 10% and 25% reduction targets, while the largest decline in the SR group occurred between the 50% and 75% reduction targets. Only 7 of the total 118 participants met the 100% abstinence target by week 12, all of whom were SR group participants.

Delivery Outcomes: Maternal and Neonatal

Overall, the SR group had more favorable infant birth outcomes compared to the NSR group. Specifically, SR group participants experienced fewer spontaneous abortions, delivered infants with a higher mean birth weight, and had fewer infants treated for NAS. However, differences between the groups on these measures did not reach significance (Table 2).

Logistic Regression to Predict Successful Smoking Reduction

Results of the regression model are presented in Table 4. Multicollinearity tests for the three smoking variables (cigarettes per day, Fagerstrom score, baseline CO) showed acceptable variance inflation factor and tolerance values (Myers, 1990; Menard, 1995), indicating a lack of significant correlation among smoking variables. The regression model was significant ($\chi^2=21.187$, $p=0.002$) for predicting successful smoking reduction. The three

independent significant predictors of successful smoking reduction were CBI condition (OR =5.09, 95% CI= 1.52–17.09), fewer days of baseline cocaine use (OR=0.95, 95% CI= 0.92–0.99), and higher baseline CO levels (OR=1.10, 95% CI= 1.09–1.19).

DISCUSSION

This is the first study to examine factors associated with successful smoking reduction among pregnant women with opioid use disorder.

There are a few noteworthy differences between the SR and NSR groups. First, successful reducers had higher mean CO levels at baseline but lower CO levels at delivery. Although some studies suggest an inverse relationship between smoking reduction and amount of tobacco smoked (Hyland, et al. 2004; Gariti, et al. 2009), others are more consistent with the findings in this study and have found that heavier smokers are more likely to reduce smoking than moderate smokers (Godtfredsen, et al. 2001; Garcia, et al. 2005; Joseph, et al. 2005; Berg, et al. 2010). One explanation for this finding is that participants with a higher CO measure at baseline are more motivated to make reductions than participants with a lower CO measure. Second, the NSR group reported more cocaine use at baseline. This finding is consistent with the literature that suggests cocaine users who smoke concurrently tend to smoke more cigarettes and experience greater cravings for nicotine (Roll, et al. 1996; Brewer, et al. 2013). However, it should be noted that there was no statistically significant between-group difference in percentage of cocaine positive urinalysis tests during treatment. Finally, the SR group reported significantly fewer lifetime smoking quit attempts. It may be that individuals with more failed smoking quit attempts are less motivated to continue efforts to reduce or quit smoking (McDermott, et al. 2013).

On treatment outcome measures, a greater percentage of participants in the SR group were in the CBI arm of the parent trial than in the NSR group. Although this difference was not statistically significant, perhaps due to insufficient power, it trended towards significance ($p=0.056$). This is consistent with the primary findings from the parent trial, which demonstrated that contingent reinforcement was successful in helping pregnant women with opioid use disorder reduce smoking (Tuten, et al. 2012). In addition, the SR group had more mean days of treatment attendance and a greater number of collected urinalysis samples, suggesting that participants who were more actively engaged in treatment were also more likely to be successful at smoking reduction.

Although the majority of participants were able to meet the 10% reduction target, most did not meet the 50% or greater reduction targets, highlighting the difficulty of treating cigarette smoking among individuals with substance use disorders. Only 41 out of 118 participants met at least one 50% reduction or greater target, suggesting that more intensive interventions are needed to achieve more clinically relevant smoking reductions. Patients who fail to significantly reduce or quit cigarette smoking during pregnancy may benefit from more potent behavioral incentives and/or pharmacologic treatments for smoking cessation. The difficulty in achieving smoking reduction targets >50% for this population may also suggest that smoking reduction is a more realistic goal than smoking cessation and that clinicians treating this population should tailor their smoking counseling accordingly.

There were no statistically significant differences between the SR and NSR groups on infant birth outcome measures. It may be that the smoking reduction levels for the SR participants were not sufficient or did not occur early enough in gestation to improve infant outcomes relative to NSR participants. Nonetheless, the SR group had a pattern of more favorable infant birth outcomes. Further study is needed to assess the clinical relevance of smoking reduction versus smoking cessation during pregnancy.

Regression analyses provided additional information on the factors that impact patient efforts to reduce cigarette smoking. The most potent predictor of successful reduction was CBI participation, a finding consistent with efficacy studies of incentive-based interventions for smoking (Lumley, et al. 2009). The finding that less frequent cocaine use was predictive of successful smoking reduction also has clinical relevance. Individuals who use stimulants may indeed consume more nicotine (another stimulant), and these individuals may benefit from more intensive or tailored intervention (Brewer, et al. 2013). In contrast, baseline cigarettes per day and baseline Fagerstrom scores were not significantly associated with being in the SR group, which was inconsistent with the hypothesis that lower levels of tobacco dependence would be associated with successful smoking reduction. One explanation is that there was insufficient variability in tobacco dependency in this population to notice any statistical differences, particularly since nicotine dependence was part of the inclusion criteria for the trial.

This study has several limitations in addition to those described previously (Tuten, et al. 2012). First, birth outcome data were available for a relatively small sub-set of participants whose medical record data were available for extraction. The primary reason for missing medical record data was that participants were no longer engaged in CAP treatment at delivery and delivered at an unknown hospital, prohibiting extraction of maternal and birth outcome data. This attrition is not surprising, as individuals with substance use disorders are challenging to study longitudinally due to transience, homelessness, and other factors that prohibit consistent research contact (Kleschinsky, et al. 2009). It is not known the degree to which small sample size for birth outcome metrics affected power to detect differences in the current study. Post-hoc power analyses are generally not thought to provide adequate evaluation of the risk of type 2 error (Hoenig & Heisey, 2001). Examination of confidence intervals has been suggested as a more informative method for assessing the potential for undetected significant differences (Colgrave & Ruxton, 2003). In this study, confidence intervals for several outcome metrics show limited range, which suggests that lack of outcome differences are not likely the result of insufficient power (Table 2). However, the confidence intervals for other metrics are relatively large, particularly for infant birth weight, indicating that an increase in sample size may improve the potential for detecting existing differences. Research studies evaluating maternal and birth outcomes in pregnant populations with substance use disorders should account for a high level of attrition in a priori sample size calculations. Second, smoking reduction of 50% or greater may not be a clinically meaningful measure of successful smoking reduction during pregnancy in the absence of any associated improvements in maternal and/or birth outcomes. For this reason, absolute reduction goals may be more helpful in future studies than relative reduction goals. Furthermore, for women who are heavy smokers, 50% or greater reductions may still mean significant smoking quantity (i.e., a pack a day reduced to 10 cigarettes a day), and therefore

may not be appropriately termed “successful.” However, in the absence of smoking cessation, reduction of cigarette smoking is preferred to no or minimal change (as evidenced in the TAU and NCBI conditions), and reduces the overall level of chemical exposure to the mother and infant. Additionally, studies show that individuals who reduce smoking are more likely to quit smoking in the future (Hughes & Carpenter, 2006), suggesting that smoking reduction is an important “practice” behavior. Finally, the study population was relatively homogenous in terms of demographic and pre-treatment characteristics, and all participants had an opioid use disorder. Therefore, findings may have limited generalizability to other populations of pregnant women with co-morbid cigarette smoking and substance use disorders.

CONCLUSIONS

This study is the first to examine factors associated with successful smoking reduction in pregnant women with opioid use disorder. It demonstrates that participants’ ability to meet higher smoking reduction targets is associated with receipt of CBI vouchers, less cocaine use at baseline, higher CO level at baseline, fewer past quit attempts, and more active participation in the trial (as measured by treatment attendance and number of urine samples provided). The study also reveals some clinically relevant trends in birth outcomes, including birth weight, spontaneous abortions, and neonatal abstinence syndrome treatment, but these differences are not statistically significant and future studies adequately powered are needed to examine these outcomes more fully.

Results of this study provide valuable insights on smoking reduction in pregnant women with opioid use disorders and can be utilized to tailor smoking counseling in this population. In particular, smoking reduction targets greater than 50% are challenging for this population, with few women achieving smoking abstinence at the completion of the study. However, those women who were successful tended to be from the CBI trial arm. Given the promising results from the CBI shaping schedule on smoking behavior, health care professionals should consider offering incentives to assist this population in meeting escalating smoking reduction targets. In addition, smoking interventions should be implemented at treatment entry to maximize any benefits of smoking reductions on the pregnancy. Presumably those women who attempt to reduce smoking behaviors earlier in their pregnancy will receive more positive reinforcement and smoking counseling than those who attempt later. Additionally, health care professionals may consider more intensive case management (i.e. more frequent follow-up appointments, more potent incentives) for those patients with dual addictions to cocaine and nicotine, as both are stimulants and may have synergistic effects, thus further hindering smoking reduction efforts. For populations who do not intend to quit smoking, smoking reduction goals may produce greater smoking reduction than abstinence goals. More importantly, smoking reduction may be a springboard for future smoking cessation efforts.

Further research is needed on the impact of smoking reduction on later achievement of smoking abstinence and on interventions to help pregnant women with opioid use disorder reduce or quit cigarette smoking, including the use of pharmacotherapy in combination with behavioral treatment. Additionally, future research should investigate the gestational timing

and degree of maternal smoking reduction required to produce improved birth outcomes for this vulnerable population.

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Table 1

Demographic and Pre-treatment Characteristics for SR and NSR Group Participants

Variables	SR Group (n=41)	NSR Group (n=77)	Total (N=118)	P-value
Demographics				
Age, years, mean ($\pm$ SD)	31.5 (6.2)	30.9 (5.9)	31.1 (6.0)	0.621
Race, <i>n</i> (%)				
Caucasian	27 (65.9)	48 (62.3)	75 (63.6)	0.706
African American	14 (34.1)	29 (37.7)	43 (36.4)	
Estimated gestational age at entry, weeks, mean ($\pm$ SD)	16.9 (5.6)	15.6 (7.4)	16.0 (6.8)	0.334
Education, years, mean ($\pm$ SD)	11.1 (1.2)	11.2 (1.7)	11.2 (1.5)	0.805
Currently single, <i>n</i> (%)	34 (82.9)	60 (88.2)	94 (86.2)	0.436
Unemployed, <i>n</i> (%)	38 (92.7)	65 (95.6)	103 (94.5)	0.519
Drug Use				
Days of cigarette use in past 30 days, mean ($\pm$ SD)	28.5 (6.4)	29.5 (3.5)	29.1 (4.8)	0.320
Cigarettes smoked per day in past 30 days, mean ($\pm$ SD)	16.6 (8.1)	18.4 (8.9)	17.7 (8.6)	0.300
Fagerstrom score, mean ($\pm$ SD)	5.4 (1.5)	5.5 (1.4)	5.5 (1.4)	0.607
Lifetime number of quit attempts, mean ($\pm$ SD)	1.9 (0.7)	2.9 (1.9)	2.6 (1.7)	0.016*
CO level at baseline, mean ($\pm$ SD)	13.5 (6.7)	10.5 (7.0)	11.8 (7.0)	0.039*
Methadone, <i>n</i> (%)	41 (100.0)	76 (98.7)	117 (99.2)	0.464
Days of cocaine use in past 30 days, mean ($\pm$ SD)	7.2 (10.6)	12.7 (12.7)	10.6 (12.2)	0.022*

Note. SD= standard deviation;

*
p <0.05

Table 2

Maternal and Neonatal Outcomes for SR and NSR Group Participants

Variables	SR Group (n=41)	NSR Group (n=77)	Total (N=118)	CI	P-value
Maternal					
Voucher Group					
CBI, <i>n</i> (%)	26 (63.4)	31 (40.8)	57 (48.7)	-.349, .168	0.056
NCBI, <i>n</i> (%)	8 (19.5)	20 (26.3)	28 (23.9)		
TAU, <i>n</i> (%)	7 (17.1)	25 (32.9)	32 (27.4)		
Total treatment days attended, mean ($\pm$ SE)	86.0 (6.2)	68.7 (4.5)	74.7 (40.3)	-31.608, -1447	0.027*
Total number of urine toxicology samples collected, mean ($\pm$ SD)	21.9 (12.4)	16.7 (9.9)	18.5 (11.1)	-9.752, -.771	0.014*
Positive for illicit drug(s), mean ($\pm$ SD)	33.0 (0.3)	37.4 (0.3)	35.8 (0.3)	-4.110, 1.733	0.934
Positive for illicit drugs at delivery, <i>n</i> (%)	9 (29.0)	7 (14.6)	16 (20.3)	-2.073, 1.066	0.119
CO reduction, in percent, mean ($\pm$ SD)	42.5 (28.3)	-19.3 (108.8)	8.5 (88.1)	-93.829, -29.711	0.001*
CO level at delivery, mean ($\pm$ SD)	4.3 (4.3)	9.4 (6.9)	7.5 (6.5)	2.903, 7.056	<0.001*
Total number of weeks in which at least one weekly target was met, mean ($\pm$ SD)	7.0 (2.5)	1.1 (1.6)	3.2 (3.4)	-6.675, -4.941	<0.001*
Neonatal					
	SR Group (n=48)	NSR Group (n=30)	Total (N=78)		
Spontaneous abortions, <i>n</i> (%)	3 (7.7)	6 (10.0)	9 (9.1)	-.093, .1389	0.696
Birth weight, grams, mean ($\pm$ SD)	2754.0 (680.0)	2672.0 (672.9)	2703.5 (672.5)	-397.214, 233.173	0.603
Gestational age at delivery, weeks, mean ($\pm$ SD)	37.0 (3.1)	37.4 (3.4)	37.3 (3.2)	-.441, .146	0.615
Treated for NAS, <i>n</i> (%)	22 (75.9)	38 (82.6)	60 (80.0)	-.130, .265	0.477

Note. SD= standard deviation; SE= standard error;

* p <0.05; mean treatment days were adjusted with EGA as a covariate

Table 3

Participants Who Met Weekly Targets in SR vs. NSR Groups

Week (reduction target) n, %	Wk 2 (10%)	Wk 3 (10%)	Wk 4 (10%)	Wk 5 (25%)	Wk 6 (25%)	Wk 7 (25%)	Wk 8 (50%)	Wk 9 (50%)	Wk 10 (75%)	Wk 11 (75%)	Wk 12 (100%)
Successful Reducers	33 (80.5)	34 (82.9)	28 (68.3)	29 (70.7)	33 (80.5)	31 (75.6)	31 (75.6)	30 (73.2)	14 (34.1)	15 (36.6)	7 (17.1)
Non- Successful Reducers	22 (28.6)	21 (27.2)	23 (29.9)	10 (12.9)	8 (10.4)	4 (5.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Note. Week 1= baseline.

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Table 4

Logistic Regression Analysis Predicting Successful Smoking Reduction (n=85)

Predictor	β	Adjusted OR	CI	<i>p</i>
Trial condition				
TAU (ref)				
CBI	1.63	5.09	1.52, 17.09	0.008*
NCBI	0.91	2.49	0.62, 9.89	0.197
Baseline days of cocaine use	-0.047	0.95	0.92, 0.99	0.020*
Baseline mean daily cigarettes	-0.053	0.95	0.89, 1.01	0.107
Baseline carbon monoxide (CO) level	0.091	1.10	1.01, 1.19	0.036*
Fagerstom score	-0.036	0.96	0.66, 1.42	0.854

Note. Successful smoking reduction defined as meeting any smoking reduction goal of 50% or greater during the intervention.

* $p < 0.05$