Original investigation

Financial Incentives for Smoking Cessation Among Depression-Prone Pregnant and Newly Postpartum Women: Effects on Smoking Abstinence and Depression Ratings

Alexa A. Lopez PhD^{1–3}, Joan M. Skelly MS⁴, Stephen T. Higgins PhD^{1–3}

¹Vermont Center on Behavior and Health, University of Vermont, Burlington, VT; ²Department of Psychiatry, University of Vermont, Burlington, VT; ³Department of Psychology, University of Vermont, Burlington, VT; ⁴Department of Medical Biostatistics, University of Vermont, Burlington, VT

Corresponding Author: Stephen T. Higgins, PhD, Vermont Center on Behavior and Health, University of Vermont, UHC Campus, OH3, MS 482, 1 S. Prospect Street, Burlington, VT 05401, USA. Telephone: 802-656-9614; Fax: 802-656-9628; E-mail: stephen.higgins@uvm.edu

Abstract

Introduction: We examined whether pregnant and newly postpartum smokers at risk for postpartum depression respond to an incentive-based smoking-cessation treatment and how the intervention impacts depression ratings.

Methods: This study is a secondary data analysis. Participants ($N = 289$; data collected 2001–2013) were smokers at the start of prenatal care who participated in 4 controlled clinical trials on the efficacy of financial incentives for smoking cessation. Women were assigned either to an intervention wherein they earned vouchers exchangeable for retail items contingent on abstaining from smoking or to a control condition wherein they received vouchers of comparable value independent of smoking status. Treatments were provided antepartum through 12-weeks postpartum. Depression ratings (Beck Depression Inventory [BDI]-1A) were examined across 7 antepartum/postpartum assessments. Women who reported a history of prior depression or who had BDI scores ≥ 17 at the start of prenatal care were categorized as depression-prone (Dep+), while those meeting neither criterion were categorized as depression-negative (Dep-).

Results: The intervention increased smoking abstinence independent of depression status ($p < .001$), and it decreased mean postpartum BDI ratings as well as the proportion of women scoring in the clinical range (≥ 17 and >21) compared with the control treatment ($ps \leq .05$). Treatment effects on depression ratings were attributable to changes in Dep+ women.

Conclusions: These results demonstrate that depression-prone pregnant and newly postpartum women respond well to this incentive-based smoking-cessation intervention in terms of achieving abstinence, and the intervention also reduces the severity of postpartum depression ratings in this at-risk population.

Introduction

Financial incentives delivered in the form of vouchers exchangeable for retail items contingent on objective evidence of recent abstinence is an efficacious smoking-cessation intervention for pregnant

women.¹ Indeed, this approach produced the largest treatment effects in a meta-analysis of smoking cessation interventions for pregnant women.² The treatment also improves birth outcomes³ and increases breastfeeding duration.⁴ While the evidence supporting this

treatment approach is promising, a great deal more remains to be learned about individual differences in treatment response and how this intervention may impact other maternal and neonatal outcomes. The purpose of the present study is to examine whether pregnant women with a history of depression or current depressive symptoms respond to this incentives-based intervention and whether the intervention impacts depressive symptoms, especially postpartum when risk for depression is elevated. To examine these questions, we combined results from a series of four controlled clinical trials that each involved the same vouchers-based incentives intervention and control conditions.

Cigarette smoking is highly associated with depression and other mood disorders in the general population⁵ and an important risk factor for postpartum depression as are a prior history of depression and antepartum depressive symptoms.^{6–11} Postpartum depression is a serious U.S. public health problem that affects up to 10%–15% of women within the year after giving birth and adversely impacts activities important to maternal and infant health (e.g., breastfeeding, maternal-infant bonding, play).⁸ Postpartum depression can occur at any time within the first year after delivery, but usually starts within six weeks postpartum and lasts from a few weeks to months.¹² Importantly, both maternal subclinical and clinical depression are associated with numerous adverse outcomes in infants and children.^{13,14} We know of no prior research on how depressed pregnant smokers respond to smoking-cessation interventions or its impact on postpartum depression risk. Research in non-pregnant smokers suggests equal efficacy in those with and without depression.^{15–17} Whether smoking cessation decreases risk for future depression in those with a history of depression remains unclear in pregnant and non-pregnant smokers. With regard to pregnant smokers, women who continue smoking during pregnancy report more depressive symptoms than those who quit,^{18–20} and those who quit smoking during pregnancy, but relapse back to smoking postpartum, are at increased risk for postpartum depression compared to women who sustain abstinence.²¹ Among non-pregnant smokers, initial case studies suggested that smoking cessation may worsen mood (e.g., Borrelli et al.²²), while subsequent and more detailed studies suggested either a negative association between abstinence and depression risk or no association.^{15,17,23}

Methods

Participants

Participants in the present study were 289 pregnant cigarette smokers who enrolled in one of four controlled clinical trials examining the efficacy of voucher-based financial incentives for smoking cessation.^{24–26} Data were collected from 2001–2013. The local institutional review board approved each trial and all women provided written informed consent. Women were recruited from obstetric practices and the Women, Infants, and Children program in the greater Burlington, VT, area. All women receiving prenatal care at participating clinics completed a brief questionnaire regarding basic sociodemographics and smoking status. Those who endorsed smoking in the past 7 days were invited to complete a detailed study intake assessment evaluating study eligibility. To be eligible, women had to report smoking at entry into prenatal care, reside within the county in which the study clinic was located, plan to remain in the area for 6 months following delivery, and speak English. Trial exclusion criteria included incarceration, previous participation in a trial on incentives for smoking abstinence during pregnancy, or residing currently with someone who participated in a prior trial on this topic.

Assessments

At the intake assessment study, participants completed questionnaires examining sociodemographics, current smoking status/history, completed the Beck Depression Inventory (BDI, version 1A), and provided breath and urine specimens to verify smoking status.²⁷ Modified versions of this battery were completed 1 month after the study intake assessment (mid-pregnancy), at a late-pregnancy assessment (≥ 28 weeks gestation), and at 2-, 4-, 8-, 12-, and 24-weeks postpartum. Smoking status was biochemically verified at each assessment using urine cotinine testing.

Women who endorsed a past history of depression or had current symptoms of depression (i.e., BDI score ≥ 17) at the intake assessment were classified as depression prone (Dep+).²⁷ Women who did not endorse a past history of depression and were without current symptoms of depression (i.e., BDI score < 17) were classified as depression negative (Dep-). To assess the impact of the intervention on depression ratings, we assessed the effects of treatment and smoking status at each assessment on mean BDI total scores, individual BDI items, and the proportion of women meeting either of two cut-offs for possible mild or greater or moderate or greater clinical depression (i.e., BDI score ≥ 17 and BDI score ≥ 21).²⁷

Treatment Interventions

All study participants were assigned to either an intervention condition wherein they received abstinence-contingent incentives or a noncontingent incentives control condition. These methods have been described in detail previously.¹ Briefly, women assigned to contingent incentives earned vouchers exchangeable for retail items contingent on biochemically verified abstinence from recent smoking. Vouchers began at a relatively low value, and escalated per each consecutive negative specimen to a maximum value, where they remained barring positive test results or missed abstinence monitoring visits. Positive test results or missed visits reset the voucher value back to the original low value, but two consecutive negative tests restored the value to the pre-reset level.

Women assigned to noncontingent incentives received vouchers of comparable monetary value but delivered independent of smoking status. The incentives intervention was in place from study initiation through 12-weeks postpartum. Voucher earnings did not differ significantly between treatment conditions and averaged about \$450 (range, \$0–\$1,180) per woman. Additionally, participants in both treatment conditions received usual care for smoking cessation provided through their obstetric clinics.

Statistical Methods

Demographic and smoking characteristics were compared between treatment conditions using *t* tests for continuous measures and chi-square tests for categorical variables. To determine if treatment effects on BDI might be trial dependent the interaction of treatment condition and trial was examined in a two-way analysis of variance at each postpartum assessment. There was no evidence that treatment effects were trial dependent thus data were combined across trials in the analyses described below. Treatment effects on BDI depression scores were analyzed with repeated measures analysis of variance over all three antepartum and five postpartum assessments with treatment condition and baseline depression status as grouping factors. Among the subset of women who were depression prone (Dep+) at baseline, repeated measures analysis was

used to examine the impact of treatment on each of the BDI items individually. Also for this subset of women, treatment differences in the proportion of women with BDI scores in the mild or greater (<17 vs. ≥17) and in the moderate or greater (<21 vs. ≥21) clinical ranges were assessed using repeated measures for categorical data based on generalized estimating equations utilizing a logistic link function (SAS PROC GENMOD). This same procedure was used to assess the impact of treatment on smoking status over the antepartum and postpartum assessments with treatment condition and baseline depression status as grouping factors. Among the subset of Dep+ women, the effect of smoking status on BDI scores and on the individual items across antepartum and postpartum assessments was examined using repeated measures analysis of variance. For all analyses, significant interactions were followed by an assessment of simple effects using contrasts. All analyses were performed using SAS Version 9 statistical software (SAS Institute). Statistical significance was determined based on $\alpha = .05$.

Results

Participant Characteristics

There were no significant differences between treatment conditions observed in baseline characteristics (Table 1). On average, study participants were young and economically disadvantaged. Average BDI scores at the intake assessment were approximately 11 across all study participants, and 13 and 7 among Dep+ and Dep- women, respectively. Among the 289 participants, 120 (42%) met criteria for Dep+ status and 169 (58%) for Dep- status. Within the Dep+ group, 70 (58%) were assigned to the contingent intervention and

50 (42%) to the noncontingent control condition. Within the Dep- group, 97 (57%) were assigned to the contingent intervention and 72 (43%) to the noncontingent control condition.

Treatment Effects on Smoking Abstinence

The contingent intervention significantly increased 7-day, point-prevalence abstinence rates compared to the noncontingent control condition at each assessment through 24-weeks postpartum (Figure 1, panel A), with comparable effects among Dep+ and Dep- participants (Figure 1, panels B and C). That is, there were significant main effects of treatment [$X^2(1) = 20.58, p < .0001$], time [$X^2(6) = 35.98, p < .0001$], and interaction of treatment and time [$X^2(6) = 20.14, p < .01$], but no significant interaction of treatment and depression status [$X^2(1) = .22, p = .64$] or of treatment, depression, and time [$X^2(6) = 4.83, p = .57$].

Treatment Effects on Depression Ratings

Regarding mean BDI scores, there were significant main effects of treatment [$F(1, 285) = 4.78, p < .05$], time [$F(7, 1693) = 25.25, p < .0001$], baseline depression status [$F(1, 285) = 76.60, p < .0001$], and a significant interaction of those three variables (Figure 2; $F(7, 1693) = 4.32, p < .0001$). Among the Dep+ women, BDI scores in the contingent intervention condition began decreasing below levels in the noncontingent control condition by the late-pregnancy assessment, and were significantly below control levels at the 4- [$F(1, 770) = 7.32, p < .01$], 8- [$F(1, 831) = 16.85, p < .0001$], and 12- [$F(1, 789) = 5.20, p < .05$] week postpartum assessments. The two treatment conditions did not differ significantly at the 24-week postpartum assessment.

Table 1. Participant Characteristics

	Contingent ($n = 167$)	Noncontingent ($n = 122$)	p value
Demographics			
Age (years)	24.3 ± 5.2	23.8 ± 4.9	.42
Caucasian (%)	94	93	.84
Education			.84
> 12 years of education (%)	18	18	
= 12 years of education (%)	51	54	
< 12 years of education (%)	31	28	
Weeks pregnant at baseline	10.9 ± 5.4	10.5 ± 4.5	.54
First pregnancy (%)	57	54	.67
Married (%)	17	18	.88
With private insurance (%)	23	16	.18
Working for pay outside of home (%)	49	49	.91
Smoking characteristics			
Age first started smoking cigarettes (years)	14.7 ± 3.0	14.3 ± 2.4	.16
Cigarettes per day pre-pregnancy	19.6 ± 9.2	19.7 ± 8.6	.96
Cigarettes per day at baseline	9.0 ± 6.6	9.5 ± 6.6	.51
Living with another smoker (%)	80	77	.60
With no smoking allowed in home (%)	43	48	.40
With none or few friends/family who smoke (%)	22	20	.83
Attempted to quit pre-pregnancy (%)	68	66	.82
Number of quit attempts during pregnancy	0.9 ± 2.2	0.7 ± 2.0	.44
Minnesota nicotine withdrawal scale score	1.6 ± 0.8	1.5 ± 0.9	.37
Psychiatric symptoms			
Stress rating	5.6 ± 2.7	5.5 ± 2.6	.90
Beck Depression Inventory	10.6 ± 7.1	10.7 ± 7.3	.94
Beck Depression Inventory score ≥ 17 (%)	20	14	.20
Beck Depression Inventory score ≥ 21 (%)	12	9	.42
History of depressive symptoms (%)	39	39	.94

Figure 1. Proportion of women abstinent from smoking by treatment condition at each assessment in the overall sample (panel A), among depression-prone (Dep+) women (panel B), and among depression-negative (Dep-) women (panel C).

Among the Dep- women, no significant differences between treatment conditions were observed at any assessment.

To illustrate the differential magnitude of change in mean BDI scores among Dep+ women in the contingent and noncontingent conditions, Figure 3 shows BDI total scores as a change from baseline. Women in the contingent condition showed average reductions in BDI intake scores as large as 7.5 points at the 4-week assessment compared to only 3 points in those assigned to the noncontingent condition.

We next examined whether treatment impacted the proportion of Dep+ women with scores in the mild or greater (≥ 17) and moderate or greater (≥ 21) clinical ranges (Figure 4). There was a significant interaction of treatment and time for the ≥ 17 (panel A; $X^2(7) = 22.59$, $p < .01$) and ≥ 21 criteria (panel B; $X^2(7) = 16.20$, $p < .05$). Across both criteria, the proportion of women with scores in the clinical range was significantly lower in the contingent intervention compared to the noncontingent control condition at the 4- ($ps < .05$) and 8- ($ps < .01$) week postpartum assessments.

An item analysis was conducted to discern which items were impacted by treatment across the postpartum assessments among Dep+ women (Table 2). The simple effects of treatment at each assessment were examined only if there was a significant treatment or treatment by assessment interaction effect. There were significant effects of treatment on 12 of the 21 (57%) BDI items at one or more assessments and 9 of the 21 (43%) items during peak effects at the 8-week assessment. Four items were significantly impacted at more than one assessment: H-Worse than anyone else; J-Crying; L-Lost interest in people; P-Sleep.

Smoking Status Effects on Depression Outcomes

To examine the influence of smoking status on the changes observed in mean BDI scores among Dep+ women, we compared scores in smokers versus abstainers across antepartum and postpartum assessments. Dep+ women abstainers had significantly lower mean BDI total scores

Figure 2. Effects of the interaction of treatment condition (contingent intervention and noncontingent control), depression status (Dep+ and Dep-), and assessment time on mean BDI total scores. Error bars represent ± 1 SEMs.

Figure 3. Mean change scores from the intake assessment in mean BDI total scores among depression-prone (Dep+) women at each assessment time. Error bars represent ± 1 SEMs. * $p \leq .05$, ** $p \leq .01$, and *** $p \leq .001$.

compared to Dep+ smokers (9.29 ± 1.01 vs. 11.21 ± 0.69 , respectively; $F(1, 32) = 4.24$, $p = .05$), although there was no significant interaction of smoking status with time as there had been for the effect of treatment.

We also examined how smoking status impacted individual items on the BDI among the Dep+ women. There were significant main effects of smoking status on the following eight items: *D-dissatisfied* [$F(1, 32) = 4.07$, $p = .05$], *E-guilty* [$F(1, 32) = 8.04$, $p < .01$], *G-disappointed in self* [$F(1, 32) = 10.08$, $p < .01$], *L-lost interest in people* [$F(1, 32) = 5.07$, $p < .05$], *O-working well* [$F(1, 32) = 5.77$, $p < .05$], *P-sleep* [$F(1, 32) = 4.17$, $p < .05$], and *Q-tired* [$F(1, 32) = 6.52$, $p < .05$] and *S-weight loss* [$F(1, 32) = 4.35$, $p < .05$]. Six of those 8 items were also significantly reduced by treatment (see Table 2), with the exceptions being *D-dissatisfied* and *S-weight loss*. Looked at the other way, smoking status significantly reduced ratings on six of the eleven items significantly reduced by treatment (*E-guilty*, *G-disappointed in self*, *L-lost interest in*

people, *O-working well*, *P-sleep*, *Q-tired*). The five items significantly reduced by treatment but not smoking status were *A-sad*, *C-failure*, *H-worse than anyone else*, *J-crying*, *K-irritated*.

Discussion

The present study was conducted to examine whether depression-prone pregnant or newly postpartum smokers respond to an incentives-based smoking-cessation intervention and if they do whether it impacts the severity of depressive symptoms, especially postpartum when risk for depression is elevated. Regarding the first aim, the incentives-based intervention increased abstinence rates several-fold above control levels among depression-prone and depression-negative women alike through 24-weeks postpartum, 12-weeks after the intervention was discontinued. These results extend to pregnant and newly postpartum women evidence from prior meta-analyses as well

Figure 4. Proportion of depression-prone (Dep+) women meeting criteria for clinically significant BDI scores at all assessments. Results from women with scores suggesting mild or greater (≥ 17) and moderate or greater (≥ 21) depression levels are shown in panels A and B, respectively. * $p \leq .05$; ** $p \leq .01$.

as individual controlled clinical trials demonstrating the efficacy of smoking-cessation interventions in depressed smokers.¹⁵⁻¹⁷

Regarding the second aim, the present findings also demonstrate clearly that providing this incentives-based smoking-cessation intervention to pregnant and newly postpartum women who are at risk for postpartum depression decreases depressive symptoms. Importantly, the magnitude of change was sufficient to reduce by 2–5 fold the proportion of women with BDI total scores in the clinical range during the initial 3-months postpartum using cut-points indicative of mild or greater (≥ 17) and moderate or greater (≥ 21) depression. We did not have sufficient numbers of women scoring in the severe range (≥ 30) to conduct meaningful comparisons at that severity level. The depression-prone women in the intervention condition experienced improvements across a wide swath of depressive symptoms, with a smaller subset of items being impacted across multiple assessments. We did not use diagnostic instruments in the present study and thus cannot determine the extent to which these changes in symptoms represent reductions in postpartum depression per se. That point notwithstanding, the magnitude and

breadth of these changes appear to represent meaningful reductions in the severity of depressive symptoms. Considering the extensive evidence on the adverse impact of subclinical and clinical levels of maternal depression on infant and child health, these effects have the potential to be beneficial to offspring as well.^{13,14} The present results add another important positive outcome achieved with this incentives-based smoking-cessation intervention, which also improves birth outcomes and breastfeeding duration.^{3,4}

The present study used data from the intervention and control conditions in a series of four controlled clinical trials.^{1,26} As such, there are grounds for inferring causation regarding the role of the intervention in producing the increases in smoking abstinence and decreases in the severity of depressive symptoms observed. Regarding potential mechanisms accounting for the changes in depressive symptoms, the design feature of providing comparable monetary vouchers to both treatment conditions controls for the potential impact on mood of receiving extra financial resources. The significant effect of smoking status on mean BDI scores provides evidence that increases in smoking abstinence contributed to the reductions in depressive symptoms.

Table 2. BDI Item Analysis Comparing Dep+ Contingent vs. Noncontingent Conditions

	2 weeks	4 weeks	8 weeks	12 weeks
A. Sad	–	–	+	–
B. Pessimistic	–	–	–	–
C. Failure	–	–	+	–
D. Dissatisfied	–	–	–	–
E. Guilty	–	–	+	–
F. Being punished	–	–	–	–
G. Disappointed in self	–	–	+	–
H. Worse than anyone else	–	–	+	+
I. Harming self	–	–	–	–
J. Crying	+	+	+	–
K. Irritated	–	+	–	–
L. Lost interest in people	–	+	+	+
M. Decision making	–	–	–	–
N. Look worse	–	–	–	–
O. Working well	–	–	+	–
P. Sleep	–	+	+	+
Q. Tired	–	+	–	–
R. Appetite	+	–	–	–
S. Weight loss	–	–	–	–
T. Health concerns	–	–	–	–
U. Sex	–	–	–	–

+ refers to a significant ($<.05$) treatment effect where scores for that item are lower in the contingent compared with the noncontingent conditions.

Treatment and smoking status were each associated with significant reductions in ratings across six symptoms: feelings of guilt, disappointment in self, loss of interest in people, working well, sleep, and tiredness. To the extent that smoking abstinence underpins those changes, then these same effects should be attainable with other smoking-cessation interventions if they can promote the same increases in abstinence. However, treatment had a larger impact reducing a set of items not significantly impacted by smoking status, including feelings of sadness, failure, being worse than anyone else, crying, and irritation. The effect of treatment on this broader array of symptoms suggests that the contingent incentives intervention was engaging the depression-prone women with their surrounding environment in a manner that was therapeutic beyond the benefits of achieving smoking abstinence. With the design used, the only meaningful difference between the two treatment conditions was the contingency on voucher earnings. Those in the contingent condition had to quit smoking in order to earn them while those in the noncontingent condition simply had to participate in the study to receive vouchers. All else other than that contingency was kept constant across experimental conditions. Important to recognize when considering this outcome is that increasing engagement in potentially reinforcing activities is a primary tenet of a highly efficacious treatment for major depression known as behavioral activation therapy,²⁸ which has been previously shown to reduce mild and modest depressive symptoms in illicit drug abusers.²⁹ To the extent that women in the contingent intervention experienced improvements in mood related to interacting with the reinforcement contingencies involved in the contingent intervention, then, of course, the same magnitude of changes would not be expected to occur with other types of smoking-cessation interventions. These are matters that will have to be parsed out in future studies. The most important point about the present results is that this incentives-based intervention significantly increased smoking abstinence rates while also decreasing depressive symptoms in this population of disadvantaged, depression-prone pregnant and newly postpartum women. These are each important

outcomes in their own right. To be obtaining them with a single intervention directed only at smoking status is a promising development about which more remains to be learned, including greater understanding of the mechanisms for the changes in depressive symptoms. The possibility of combining this incentives-based intervention with a depression-focused counseling intervention for pregnant smokers also merits consideration.³⁰

The present study has at least three limitations that merit mention. First, as noted above, we did not include a diagnostic instrument and thus cannot determine what proportion of women met formal criteria for depression. While we demonstrated significant reductions in the proportion of women with BDI scores indicative of possible mild or moderate depression, we cannot confirm that we reduced the proportion meeting diagnostic criteria for depression. Second, we used the BDI rather than the Edinburgh Postnatal Depression Scale (EPDS), an instrument developed specifically for postpartum depression.³¹ A criticism of the BDI is that it assesses general symptoms of pregnancy and early postpartum that are not necessarily related to depression and hence risks inflating depression ratings.³² While that may be a valid criticism, any such inflation of scores would have been expected to occur across both treatment conditions and thus would not undermine the validity of the treatment effects observed. Third, this study represents a secondary analysis of trials conducted with other aims and thus is vulnerable to potential biases associated with such analyses. An ongoing randomized clinical trial in our clinic will examine effects of this intervention in a prospective trial where changes in depressive symptoms is an outcome measure, which will be an important check on the reliability of these effects. These limitations notwithstanding, the present study offers further evidence that providing incentives-based smoking-cessation interventions to socioeconomically disadvantaged pregnant and newly postpartum women results in improvements across a wide range of outcomes of considerable benefit to maternal and infant health.

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Declaration of Interests

None declared.

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