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Examining Maternal Weight Gain During Contingency- Management Treatment for Smoking Cessation Among Pregnant Women

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Abstract

Excessive maternal weight gain during pregnancy can result in serious adverse maternal and neonatal health consequences making it an important outcome to monitor in developing smoking-cessation interventions for pregnant women. Maternal weight gain was investigated in the present study with 154 pregnant participants in controlled trials investigating the efficacy of contingency management (CM) for smoking cessation. Women were assigned to either an abstinence-contingent condition wherein they earned vouchers exchangeable for retail items by abstaining from smoking or to a control condition where they received comparable vouchers independent of smoking status. Mean percent of negative smoking status tests throughout antepartum was greater in the incentive than control condition (45.2 ± 4.6 vs. 15.5 ± 2.4 , $p < .001$) as was late-pregnancy point-prevalence abstinence (36% vs. 8%, $p < .001$) but maternal weight gain did not differ significantly between treatment conditions (15.0 ± 0.8 kg vs. 15.0 ± 0.9 kg, $p = .97$). In a comparison of women classified by smoking status rather than treatment condition, a greater percent of negative smoking status tests predicted significantly more weight gain (0.34 kg per 10% increase in negative tests), an effect that appeared to be attributable to women with greater abstinence having larger infants. This study shows no evidence of excessive maternal weight gain among pregnant women receiving a CM intervention for smoking cessation.

Keywords

Maternal weight gain; smoking cessation; pregnancy; contingency management; vouchers

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1. Introduction

Smoking during pregnancy has serious adverse effects (Cnattingius, 2004; U.S. Department of Health and Human Services, 2001). As such, there is a tremendous need for effective smoking-cessation interventions for pregnant women (Lumley et al., 2009). While quitting smoking has enormous health benefits (Lumley et al., 2009; U.S. Department of Health and Human Services, 2004), one potential complication is excessive maternal weight gain (Adegboye et al., 2009; Favaretto et al., 2007). There is individual variability in whether quitting smoking causes weight gain, but clearly it can (Filozof et al., 2004). Excessive weight gain among pregnant women can increase risk for gestational hypertension, caesarean section, postpartum weight retention, large-for-gestational age and macrosomia (Crane et al., 2009; Oken et al., 2009). Considering the many health benefits of quitting smoking, complications such as excessive weight gain would only suggest the need for steps to manage the complication and not in any way argue against promoting cessation (Lumley et al., 2009; U.S. Department of Health and Human Services, 2004). Results from observational studies indicate that quitting smoking during pregnancy is associated with increased risk for gaining in excess of medical recommendations (Adegboye et al., 2009; Favaretto et al., 2007). The effect of smoking cessation on maternal weight gain has been little examined in controlled trials likely due to the paucity of interventions that produce sufficiently high cessation rates to allow for meaningful investigation (Lumley et al., 2009). To our knowledge, the only report on this topic involving a controlled trial is by Rush et al. (1992) where cessation counseling produced abstinence rates that bordered on but failed to achieve significance in late pregnancy (11.8% vs. 4.3%) and mean maternal weight gain was slightly but not significantly higher in counseling compared to control conditions (0.47 kg/wk vs. 0.44 kg/wk).

The present study was conducted to examine maternal weight gain during pregnancy among women who participated in controlled trials examining the efficacy of contingency management (CM) for smoking cessation (Heil et al., 2008; Higgins et al., 2004). This treatment approach has produced larger treatment effects than typical in pregnant smokers (see Lumley et al., 2009) and of sufficient magnitude to increase the rate of fetal growth and birth weight (Heil et al., 2008; Higgins et al., in press). For those reasons examination of CM treatment effects on maternal weight gain appear warranted.

2. Methods

2.1. Study population

Study participants were enrolled in one of two published (Heil et al., 2008; Higgins et al., 2004) and one unpublished (Higgins, 2010, personal communication) controlled trials. The unpublished trial was conducted for staff-training purposes following unexpected staff turnover between the pilot study (Higgins et al., 2004) and fully randomized trial (Heil et al., 2008). Treatment conditions were the same across trials except that the first 37 participants in the pilot study were assigned to treatment conditions as consecutive admissions to pilot test the interventions while the remaining 13 participants in that trial and all subsequent participants were randomly assigned to treatment conditions. Among the 183 women enrolled in these trials, 29 were excluded from the present study due to abortions (12), multiple births (3), and missing data (14), leaving 154 women who contributed data. Among the 29 exclusions, 13 are from the intervention and 16 from the control conditions described below, with 50 and 70 participants coming from the pilot (Higgins et al., 2004) and fully-randomized (Heil et al., 2008) trials and 34 from the unpublished trial (Higgins, 2010, personal communication). The local Institutional Review Board approved each trial and all participants provided informed consent. Women were recruited from local obstetric practices and a Women Infants and Children (WIC) nutritional program. For inclusion in the

trials, women had to report smoking at entry into prenatal care, reside within the county in which the study clinic is located, plan to remain in the area for 6 months following delivery, and speak English. Trial exclusion criteria included incarceration, previous participation in the study, or residing with someone who participated in the study. All trial participants who delivered a live infant were included in the current study.

2.2. Assessments

Information on maternal height, pre-pregnancy weight, and weight at delivery was obtained from parental worksheets for birth certificates completed by hospital staff at the time of delivery. We obtained these worksheets for 154 of the study sample.

Smoking abstinence was defined as a self-report of no smoking, not even a puff, in the past 7 days confirmed by a urinary cotinine level of 80 ng/ml or less. Breath specimens were analyzed using Micro Smokerlyzer carbon monoxide (CO) monitors (Bedfont Scientific Ltd, Kent, UK). An onsite enzyme immunoassay test (EMIT; Microgenics Corporation, Fremont, CA, USA) run on a Roche Cobas Mira, analyzer (distributed by Dade Behring, Inc., Deerfield, IL, USA) was used to determine urine-cotinine levels. All women also completed the Beck Depression Inventory (BDI) (Beck et al., 1961) and Brief Symptom Inventory (BSI) (Derogatis & Melisaratos, 1983) and answered a yes-no item asking whether they ever felt down, depressed, hopeless, little interest in doing things nearly every day for two or more weeks and a 0-10 Likert scale assessing how stressed they felt over the past four weeks questions (0 = no stress and 10 = extreme stress).

2.3. Treatment intervention

All study participants were assigned to one of two treatments: an abstinence-contingent incentives condition or a control condition. In the incentives condition women earned vouchers exchangeable for retail items contingent on biochemically-verified abstinence. In the control condition women received vouchers of comparable monetary value but they were delivered independent of smoking status. The voucher program was operative from study initiation through 12-weeks postpartum. In both conditions, voucher delivery was daily for the initial 5 days of the cessation effort (Monday through Friday). Beginning with week two, monitoring decreased to twice weekly (Mondays and Thursdays) for the next 7 weeks, then once weekly for 4 weeks (Wednesdays), and then every other Wednesday until delivery. During postpartum, monitoring increased to once weekly for the initial 4 weeks (Wednesdays) and then was every other Wednesday for the next 8 weeks until the end of week 12. Voucher earnings did not differ significantly between treatment conditions and averaged about \$450 (range = \$0-\$1,180) per woman. In addition to the voucher-based incentives, participants in both treatment conditions received usual care for smoking cessation provided through their obstetric clinics, which typically involved provider inquiry regarding smoking status and a discussion of the advantages of quitting during pregnancy.

2.4. Statistical methods

Demographic, smoking characteristics and psychiatric symptoms were compared between treatment conditions using t-tests for continuous measures and chi squares tests for categorical variables. The Breslow Day test, which tests homogeneity of odds ratios, was used to examine whether the treatment effect on abstinence differed across the three trials. Univariately, t-tests were used to compare maternal weight gain between treatment conditions and between smokers and abstainers at the final antepartum assessment. Multiple linear regression was used to examine the effect of treatment condition and final antepartum smoking status on weight gain adjusting for other covariates known to be predictive of maternal weight gain (Institute of Medicine, 2009), including pre-pregnancy body mass index (BMI), primigravida (first child), maternal age, and gestational diabetes. Similarly,

regression analyses were used to examine the relationship between percent of negative smoking-status tests and weight gain adjusting for the covariates specified above with and without birthweight as an additional explanatory variable. All analyses were performed using SAS Version 9 statistical software (SAS Institute, Cary NC). Statistical significance was determined based on $\alpha = .05$.

3. Results

3.1. Participant characteristics

Only two baseline characteristics differed significantly between those assigned to the incentives and control conditions (Table 1): the incentives condition included more women with less than 12 years of education compared to the control condition and more women in the incentives condition reported allowing smoking in their homes. Neither variable was significantly associated with maternal weight gain and thus were not used as predictors in other analyses. On average, women were retained in the incentives and control treatment conditions for 26.4 ± 0.7 weeks vs. 26.3 ± 0.6 weeks respectively ($t_{152} = 0.05$, $p = .96$).

3.2. Treatment effect on smoking status

Seven-day point-prevalence abstinence at the end-of-pregnancy assessment was significantly greater in the incentives compared to the control condition (36% (29/80) vs. 8% (6/74) of women abstinent, Cochran-Mantel-Haenszel $\chi^2_1 = 18.1$, $p < .001$; OR=7.3, 95% CI: 2.7-19.5). The treatment effect did not differ across the three trials (Breslow Day $\chi^2_2 = 0.33$, $p = .85$).

The mean percent of smoking-status tests that were negative was also significantly greater in the incentives compared to the control condition (45.2 ± 4.6 vs. 15.5 ± 2.4 ; $t_{152} = 5.59$, $p < .001$).

3.3. Weight gain during pregnancy

No significant differences in maternal weight gain were observed between the incentives and control conditions (15.0 ± 0.8 kg vs. 15.0 ± 0.9 kg, $t_{152} = .04$, $p = .97$). Results were unchanged when weight gain was examined as kg/week gained antepartum rather than total kg gained. Treatment also remained non-significant when examined in a multivariate analysis ($t_{148} = -0.08$, $p = .94$, where pre-pregnancy BMI ($t_{148} = -3.48$, $p < .001$) and primigravida ($t_{148} = 2.81$, $p = .006$) were the only significant predictors of maternal weight gain, with smaller stature and having a first child being associated with greater weight gain.

A comparison of weight gain among abstainers vs. smokers at the end-of-pregnancy assessment independent of treatment condition revealed an estimated 2.8 kg greater increase in weight gain among abstainers compared to smokers (17.2 ± 1.1 kg vs. 14.4 ± 0.6 kg, $t_{152} = 2.08$, $p = .04$). The percent of negative smoking status tests was positively associated with maternal weight gain ($t_{153} = 2.18$, $p = .03$), with an estimated 0.34 kg increase in weight gain for every 10-percent increase in percent of negative tests. After controlling for the potential confounding influences of pre-pregnancy BMI and primigravida in multivariate analysis, the estimated difference between abstainers and smokers using the end-of-pregnancy assessment was reduced to 2.4 kg and was no longer statistically significant ($t_{148} = -1.89$, $p = .06$, see Table 2a).

Regarding the percent of negative tests, the association between amount of abstinence and weight gain remained significant after controlling for potential confounds ($t_{153} = 2.27$, $p = .03$, see Table 2b). To assess whether the observed increase in weight gain was mediated by increases in fetal growth, birth weight was added to the regression model. With birth weight

included, percent negative tests was no longer a significant predictor ($t_{153} = 1.53$, $p = .13$, see Table 2c).

4. Discussion

This study provides no evidence of excessive maternal weight gain as a complication of CM treatment for smoking during pregnancy. That is an encouraging finding considering that the intervention produced more than a 4-fold increase in late-pregnancy point-prevalence abstinence and significant treatment effects on mean birth weight and percent of low birth weight (< 2500g) deliveries (Higgins et al., in press). However, even with these relatively robust treatment effects, the majority of women in the incentives condition continued smoking during pregnancy, possibly diminishing our ability to discern treatment effects associated with abstinence on weight gain. For that reason the analysis comparing weight gain among women classified by smoking status rather than treatment condition is informative. There was a significant association between the amount of smoking abstinence sustained antepartum and maternal weight gain, suggesting that on average a woman who was completely abstinent throughout the antepartum study period would be expected to gain an additional 3.34 kg. Importantly, that effect appeared to be mediated by increases in fetal size that attend increased smoking abstinence in that the relationship between amount of abstinence and maternal weight gain was no longer significant when birth weight was included in the regression model (Kraemer et al., 2001). We have previously reported that sustained abstinence throughout the antepartum study period in this cohort is associated with an estimated 313 g increase in mean birth weight (Higgins et al., in press). The extra weight gain identified by the difference between maternal weight gain and neonatal birth weight may be accounted for by the weight differences in placental mass and amniotic fluid volume which are closely correlated with birth weight but were not specifically measured in our study.

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Table 1**Participant Baseline Characteristics**

	Incentives (N=80)	Control (N=74)	Test statistic (df)	p-values
Demographics				
Age (years)	24.0(5.6)	23.1(4.7)	1.06 (152)	0.29
% Caucasian	93	96	0.83 (1)	0.36
Education				0.02
% > 12 years of education	16	15		
% = 12 years of education	37	58		
% < 12 years of education	47	27		
Weeks pregnant at baseline	12.7(5.7)	12.0(5.1)	0.18 (151)	0.42
% Primagravida	48	53	0.42 (1)	0.52
% Married	20	18	0.15 (1)	0.70
% With private insurance	19	15	0.41 (1)	0.52
% Working for pay outside of home	43	47	0.36 (1)	0.55
Smoking Characteristics				
Age first started smoking cigarettes	14.1(2.5)	13.9(2.5)	0.37 (152)	0.71
Cigarettes per day pre-pregnancy	20.4(10.4)	20.7(8.4)	-0.19 (152)	0.85
% Living with another smoker	76	78	0.10 (1)	0.75
% With no smoking allowed in home	26	42	4.21 (1)	0.04
% With none or few friends/family who smoke	19	18	0.04 (1)	0.85
% Attempted to quit pre-pregnancy	58	72	0.07 (1)	0.07
Number of quit attempts during pregnancy	1.2(2.7)	0.8(2.4)	0.86 (152)	0.39
Nicotine withdrawal questionnaire total score	1.8(0.9)	1.6(0.8)	1.33 (150)	0.18
Psychiatric Symptoms				
Stress rating	5.6(2.6)	5.6(2.4)	-0.13 (152)	0.90
BDI	10.4(6.9)	10.7(6.6)	-0.34 (151)	0.73
% History of depressive symptoms	39	38	0.01	0.91

Note: Values represent means (SD) unless otherwise indicated.

Significance levels correspond to t-tests for comparisons of means and chi-square tests for comparisons of proportions (percents).

Results of multiple linear regression analyses predicting maternal weight gain (kg) evaluating the effect of smoking status adjusted for covariates.

Table 2

Predictor Variable	Coefficient	Standardized ^a Coefficient	Partial R ²	t	p-Value
A. End-of-pregnancy Point-prevalence Abstinence as predictor (Model R² = 0.17)					
Intercept	23.47	0.00 ^b		6.36	<.001
Pre-pregnancy BMI	-0.26	-0.25	.087	-3.24	.001
Primigravida	3.25	0.23	.055	2.82	.006
Smoking status ^c	2.42	0.14	.017	1.89	.061
Maternal age (per year)	-0.06	-0.04	.005	-0.53	.600
Gestational diabetes	-2.16	-0.06	.002	-0.79	.431
B. Percent of Negative Smoking Status Tests as predictor (Model R² = 0.17)					
Intercept	20.98	0.00 ^b		5.86	<.001
Pre-pregnancy BMI	-0.27	-0.26	.087	-3.40	<.001
Primigravida	3.22	0.23	.055	2.81	.006
% negative samples ^d	0.34	0.17	.025	2.27	.025
Gestational diabetes	-2.19	-0.07	.006	-0.80	.422
Maternal age (per year)	-0.07	-0.05	.002	-0.59	.555
C. Percent of Negative Smoking Status Tests as predictor including birth weight in the model (Model R² = 0.23)					
Intercept	13.37	0.00 ^b		3.24	.002
Pre-pregnancy BMI	-0.33	-0.32	.087	-4.20	<.001
Birthweight (per kg)	3.02	0.26	.071	3.38	.001
Primigravida	3.31	0.24	.060	2.99	.003
% negative samples ^d	0.22	0.12	.010	1.53	.128
Maternal age (per year)	-0.07	-0.05	.004	-0.68	.500
Gestational diabetes	-1.66	-0.05	.002	-0.63	.529

Note:

^aStandardized coefficients represent estimated change in dependent measure (weight gain) expressed in SD units per SD change in each predictor variable.

^bBy definition, intercept of standardized variables equal 0.

^c0= smoker 1 = abstainer

d Coefficient for every 10-percent increase.