Financial Incentives Increase Smoking Cessation and Improve Other Maternal-Infant Outcomes Among Pregnant & Newly Postpartum Women

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Introduction

- Smoking during pregnancy is a leading preventable cause of poor pregnancy outcomes in the U.S. & other developed countries.
- Socioeconomically disadvantaged women are at high risk.
- Efficacious cessation interventions widely available to pregnant women but antepartum quit rates are unacceptably low (<15%).
- Usual care is typically a referral to a quitline; best practices includes follow-up and further referral for continuing smokers.
- There is broad consensus on need for improvements; I'll show evidence that financial incentives represent an innovation that can reliably increase quit rates antepartum and early postpartum.

Methods

- **Current Trial:** RCT comparing best practices (BP) vs. BP + financial incentives (BP+FI) among 169 women still smoking at 1st AP visit and 80 SES-matched never smokers (NS)
- **Primary outcome**: antepartum abstinence
- **Secondary outcomes**: craving/withdrawal, birth outcomes, postpartum abstinence, breastfeeding, infant growth/development, cost-benefit analysis
- **Pooled data set**: to assess the reliability of positive trial outcomes we examined effects in a pooled data set wherein current trial (n=169) data were combined with four prior RCTs examining this FI model versus a non-contingent incentives control condition (n=245) for pooled total n=453 (FI=245; Controls=208)
- **Vermont-wide sample**: to assess external validity of trial results on relationship between maternal smoking status (never-smoked, smoked but quit, continued smoking) to small-for-gestational age (SGA) birth outcomes, and associated healthcare costs (i.e., all singleton deliveries in VT in 2019).

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Participants

- Recruited women still smoking at 1st prenatal visit from ObGyn clinics in Burlington VT and surrounding counties.
- Inclusion criteria: biochemically confirmed self-report smoking in past 7 days, gestational age ≤25 weeks, plans to remain in area for next 12 mos, English speaking.
- Exclusion criteria: incarceration, prior participation in incentives cessation study, residing with current trial participant, regular use of opioids, stimulant, antipsychotic meds
- 584 who reported smoking began screening; 126 failed to complete screening, 282 ineligible, 176 enrolled
- 759 never-smokers initiated screening; 21 failed to complete screening, 657 ineligible, 81 enrolled.
- Only reason for exclusion once enrolled was abortion/fetal demise (3 BP, 4 BP+FI, 1 NS)

Trial Assessments

- At intake, participants completed questionnaires examining sociodemographic, smoking, and psychiatric conditions, provided breath and urine specimens
- Modified version of that battery completed one month after intake (early antepartum assessment), at ≥ 28-weeks gestation (late-pregnancy assessment), 2-, 4-, 8-, 12-, 24-, 48-weeks postpartum. Also assessed breath CO and urine cotinine.
- Birth outcomes obtained from maternal medical record.

Trial Conditions

- All participants assigned to BP encouraged to choose a quit date in next two weeks; once a quit date was selected a signed referral faxed to Vermont quitline.
- Quitline offered perinatal-specific brief phone counseling (National Jewish Health) with quit coach (5 antepartum; 4 postpartum calls) based on stages of change, including motivational interviewing and cognitive-behavioral strategies.
- Quitline offered women $65 in incentives for completing calls.
- Eligible for free nicotine replacement if their providers agreed.
- Women still smoking at scheduled assessments were referred again to the quitline.
- Women assigned to BP+FI encouraged to pick a Monday quit date in next two weeks; received everything above and started on financial incentives on their quit date.

Incentives Model

- Vouchers exchangeable for retail items available antepartum through 12-weeks postpartum
- Voucher delivery contingent on biochemical test results: breath CO $\leq$ 6 ppm initial 5 days of the quit week; urine cotinine (onsite enzyme immunoassay $\leq$ 80 ng/ml) thereafter.
- Daily (M-F) of quit week, 2x weekly next 7 weeks, once weekly for 4 weeks, and then every other week till delivery; following delivery back to weekly through 12-weeks postpartum.
- Voucher value varied by baseline CPD; < 10 CPD: began at $6.25, escalated by $1.25 each consecutive negative test to max $45.00; positive test reset vouchers to initial low value; two negative tests restored vouchers to pre-reset value; $\geq$ 10 CPD: voucher same as above but $ values doubled.
- Total mean earnings: 510.02\pm$76.27 ($467.70$\pm$68.21 and 560.34\pm$146.84 in < 10 CPD and > 10 CPD , respectively).

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Table 1. Participant characteristics.

Characteristics	BP[1] (n=88)	BP+FI[2] (n=81)	NS[3] (n=80)	BP vs BP+FI p-value[a]	All groups p-value[b]
Demographics:					
Age (years)	26.61 ±5.47	25.40 ± 4.96	25.6 ± 5.0	.13	.25
Education				.08	.001
% <12 years	16	28	10[c]		
% 12 years	64	48	80[d]		
% >12 years	20	23	10[c]		
% Non-Latino White	93	91	90	.66	.76
% Married	20	16	42[d]	.46	<.001
% Private insurance	28	27	40	.86	.15
% Work outside of home	50	59	66	.23	.10
% 1st pregnancy	42	53	49	.15	.35
Weeks pregnant at intake	11.14± 4.07	12.37 ± 4.22	15.2 ± 6.4[d]	.05	<.001
Pre-pregnancy BMI	29.60 ±8.45	28.20 ± 7.54	28.4 ± 8.3	.26	.47

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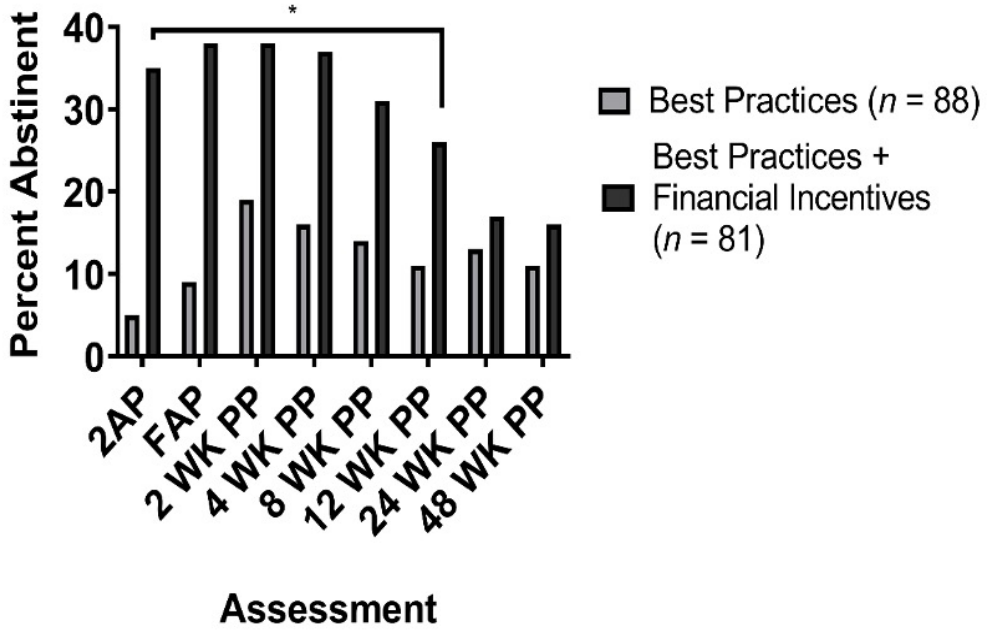
Table 1. Participant characteristics.

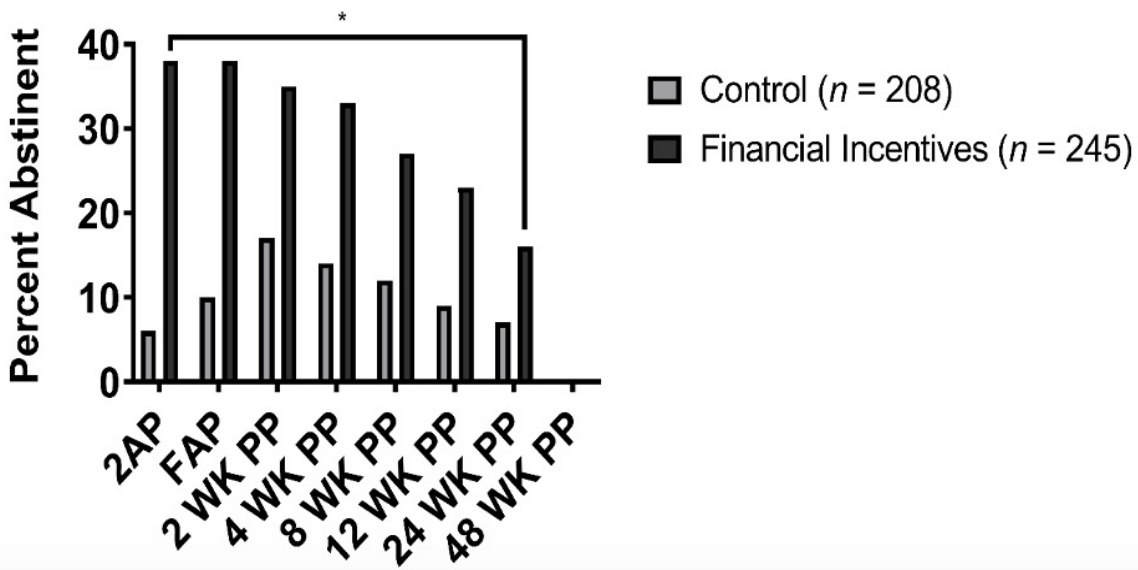
Characteristics	BP[1] (n=88)	BP+FI[2] (n=81)	NS[3] (n=80)	BP vs BP+FI p-value[a]	All groups p-value[b]
Smoking Characteristics:					
Cigs/day pre-pregnancy	18.27± 9.42	19.25 ± 9.87	NA	.51	
Cigs/day at 1st AP	9.92 ± 6.18	8.99 ± 5.21	NA	.29	
Age started smoking (yrs)	15.47± 2.96	15.10 ± 2.92	NA	.41	
% Living with other smoker(s)	77	79	22[d]	.75	<.001
% With no smoking allowed in home	70	68	91[d]	.72	<.001
% With none or few friends/family who smoke	26	25	78[d]	.83	<.001
% Attempted to quit pre-pregnancy	73	70	NA	.73	
Number of quit attempts during pregnancy	0.73 ± 2.35	0.57 ± 0.97	NA	.56	
Nicotine withdrawal questionnaire total scores	1.60 ± 0.75	1.37 ± 0.76	NA	.05	
Fagerström total scores	4.23 ± 2.30	3.98 ± 2.07	NA	.46	

7-Day Point Prevelence Abstinence

Current Trial



Pooled Trials



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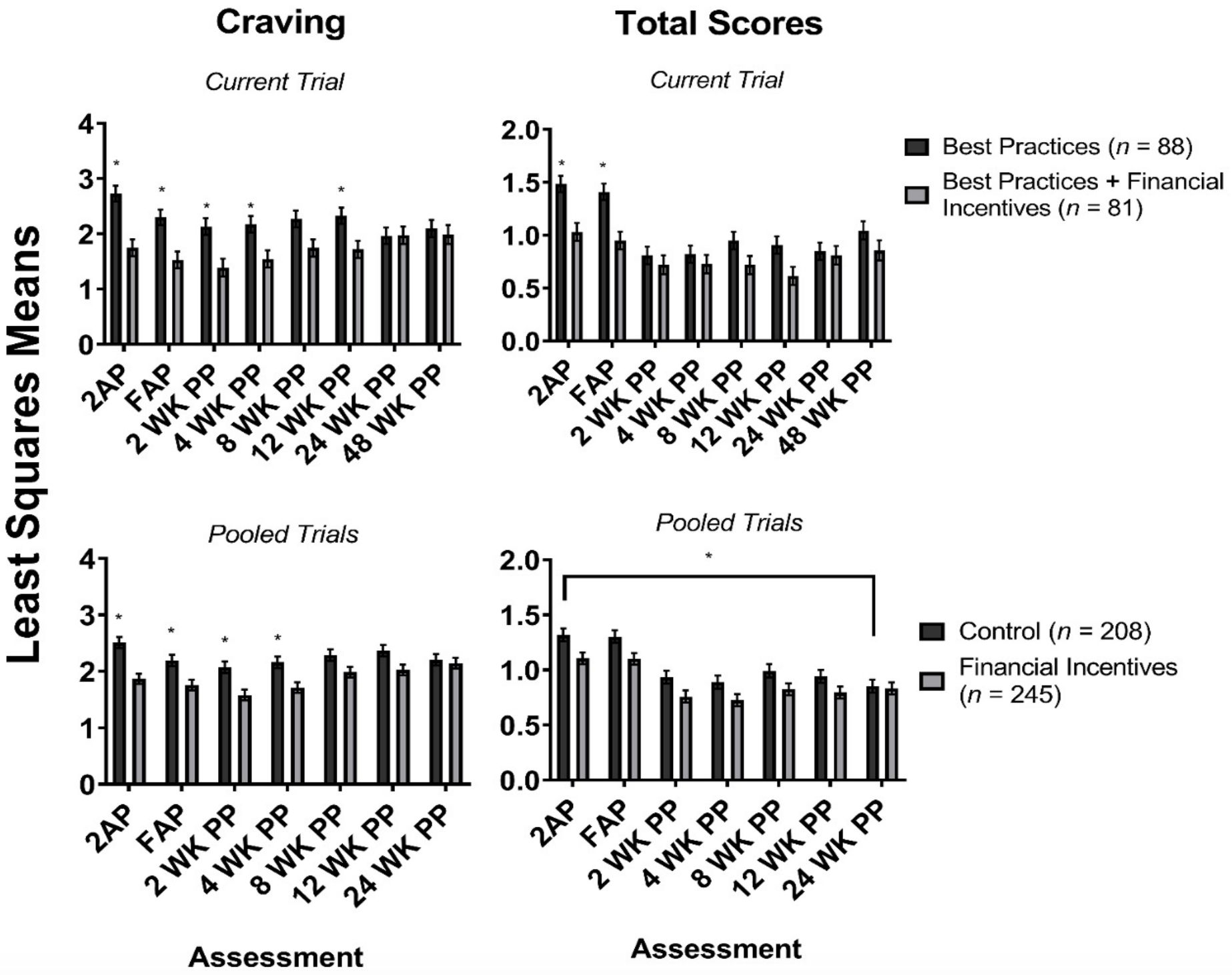
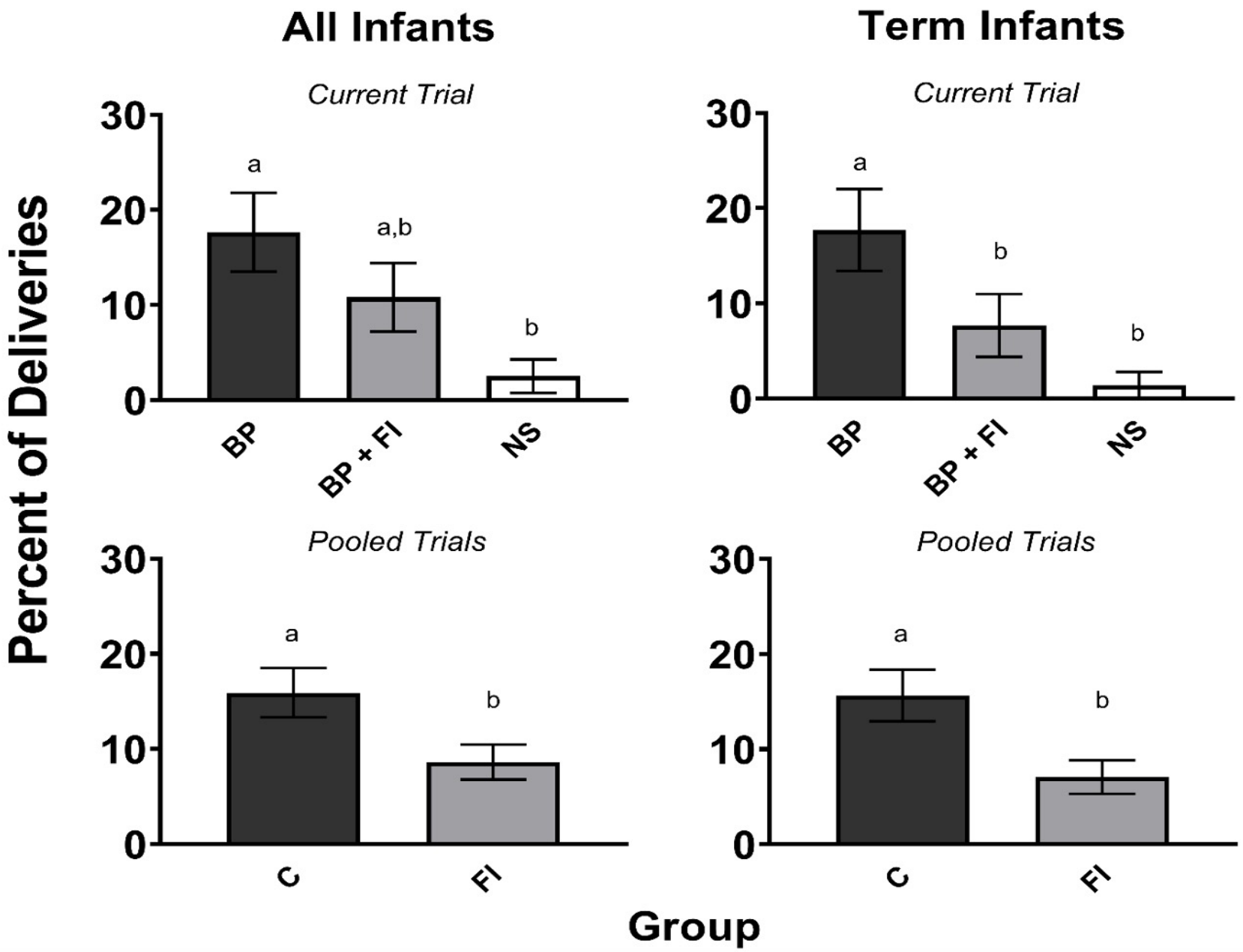
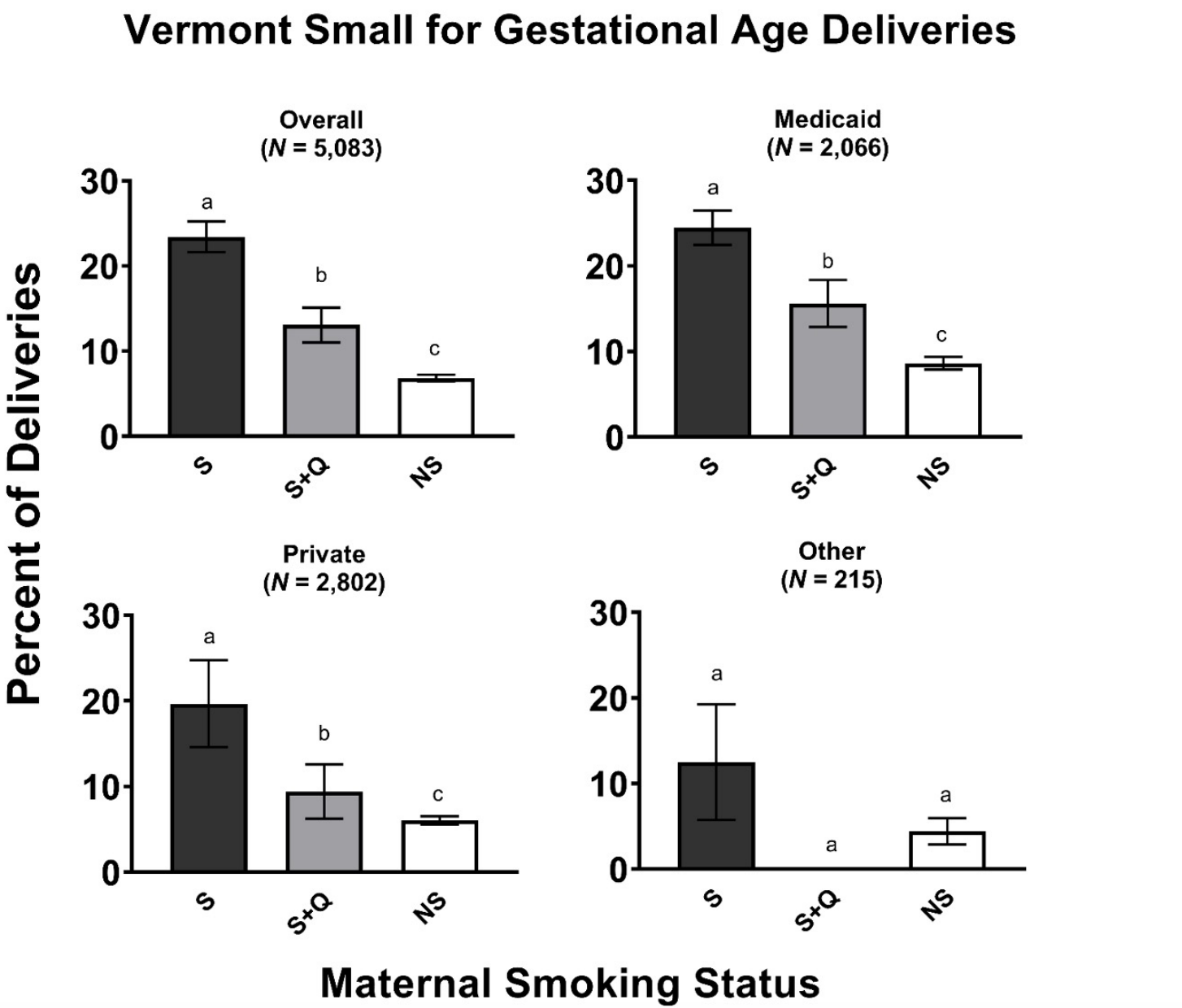

Craving
Total Scores
Current Trial
Current Trial
Least Squares Means
Best Practices (n = 88)
Best Practices + Financial Incentives (n = 81)
Pooled Trials
Pooled Trials
Control (n = 208)
Financial Incentives (n = 245)
2AP
FAP
2 WK PP
4 WK PP
8 WK PP
12 WK PP
24 WK PP
48 WK PP
Assessment
Assessment

Small for Gestational Age Deliveries




Vermont Small for Gestational Age Deliveries
Overall
(N = 5,083)
Medicaid
(N = 2,066)
Private
(N = 2,802)
Other
(N = 215)
Percent of Deliveries
30
20
10
0
a
b
c
S
S+Q
NS
Maternal Smoking Status

Breastfeeding

Assessments	% Breastfeeding* BP[1] (n=88)	BP + FI[2] (n=81)	NS[3] (n=80)
	Percent (n/d)	Percent (n/d)	Percent (n/d)
2 weeks	68.06 (49/72)[a]	78.13 (50/64)[a]	78.67 (59/75)[a]
4 weeks	52.63 (40/76)[a]	60.61 (40/66)[a]	72.73 (56/77)[a]
8 weeks	44.74 (34/76)[a]	49.25 (33/67)[a]	63.16 (48/76)[a]
12 weeks	36.84 (28/76)[a]	47.06 (32/68)[a]	56.58 (43/76)[a]
24 weeks	28.00 (21/54)[a]	35.48 (22/62)[a]	50.00 (36/72)[a]
48 weeks	12.16 (9/74)[a]	15.00 (9/60)[a]	32.86 (23/70)[a]

Assessments	% Breastfeeding and abstinent[#] BP (n=88)	BP + FI (n=81)	NS (n=80)
	Percent (n/d)	Percent (n/d)	Percent (n/d)
2 weeks	17.05 (15/88)[a]	35.80 (29/81)[b]	78.67 (59/75)[c]
4 weeks	12.50 (11/88)[a]	29.63 (24/81)[b]	72.73 (56/77)[c]
8 weeks	10.23 (9/88)[a]	23.46 (19/81)[b]	63.16 (48/76)[c]
12 weeks	7.95 (7/88)[a]	18.52 (15/81)[b]	56.58 (43/76)[c]
24 weeks	7.95 (7/88)[a]	11.11 (9/81)[b]	50.00 (36/72)[c]
48 weeks	3.41 (3/88)[a]	6.12 (5/81)[b]	32.86 (23/70)[c]

Breastfeeding

Assessments	% Breastfeeding# Controls[4] (n=208)	FI[5] (n=245)
	Percent (n/d)	Percent (n/d)
2 wks	61.18 (104/170)[a]	67.31 (140/208)[a]
4 wks	47.73 (84/176)[a]	52.58 (112/213)[a]
8 wks	38.64 (68/176)[a]	43.98 (95/216)[a]
12 wks	29.05 (52/179)[a]	37.79 (82/217)[a]
24 wks	22.78 (41/180)[a]	24.76 (52/210)[a]
48 wks		

Assessments	% Breastfeeding and abstinent* Controls (n=208)	FI (n=245)
	Percent (n/d)	Percent (n/d)
2 wks	12.98 (27/208)[a]	27.76 (68/245)[b]
4 wks	9.62 (20/208)[a]	22.86 (56/245)[b]
8 wks	7.21 (15/208)[a]	18.37 (45/245)[b]
12 wks	4.81 (10/208)[a]	14.69 (36/245)[b]
24 wks	3.37 (7/208)[a]	7.35 (18/245)[b]
48 wks	----------	----------

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Table 4. Estimates of the Economic Costs and Benefits of BP+FI compared to BP ($ in 2020 dollars)

	BP+FI			BP Only			Average Cost Differences: BP+FI versus BP Only		
Costs & Benefits	**Mean Cost Per Visit ($)**	**Mean Cost Per Participant ($)**	**Std. Err.**	**Mean Cost Per Visit ($)**	**Cost Per Participant ($)**	**Std. Err.**	**Mean Cost Difference Per Participant ($)**	**95% CI LL**	**UL**
C. Total Intervention Cost (A+B)	$98.28	$1,486.26	$99.35	$43.48	$124.93	$1.97	$1,361.33	$1,163.65	$1,559.01
D. Medicaid Cost (Delivery and Newborn Care Months 0-12)	$1,426.04	$21,566.68	$1,281.00	$7,742.84	$22,260.67	$1,594.23	-$693.99	-$3,242.77	$1,854.79
E. Medicaid Cost Plus Smoking Intervention Cost (C+D)	$1,524.32	$23,052.94	$1,284.83	$7,786.30	$22,385.60	$1,594.23	$667.34	-$2,111.35	$3,380.87
F. Value of Reduced SUID Mortality from Quitting or Reducing Smoking During Pregnancy	$269.02	$4,068.53	$1,117.13	$894.22	$2,570.89	$121.08	$1,497.64	$1,094.99	$1,952.25
G. Societal Net Benefit of BP+FI vs. BP							$830.30	-$2,285.88	$4,063.60
Societal Return on Investment in BP+FI vs. BP (100% * H / C)							61.0%	-196.4%	260.7%

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Summary and Conclusions

- Overwhelming evidence that financial incentives increase antepartum abstinence (largest effect sizes in RCTS).
- Effects on abstinence remain robust through 12-weeks postpartum; effects after discontinuation of incentives remained above controls across current and pooled trials; only significant in the latter where power was greater.
- Effect of incentives on SGA is consistent across the current and pooled trials with VT-wide study supporting external validity. SGA increases infant and childhood morbidity and mortality risk and later-in-life risk for metabolic-disorder.
- Effects of incentives on continuing to breastfeed while abstinent illustrates the multifaceted ways in which increasing abstinence can foster health improvements.
- Economic analysis supports the cost-benefit of BP+FI over BP alone, but with wide CIs--uncertainlty. Future economic impact studies examining beyond 1st year of infant life and with larger samples are needed.
- We have developed and pilot-tested the efficacy of a smart-phone translation to increase reach (Kurti et al., 2020, *Prev Med*) and have a recently completed RCT on the same that will be submitted in the near future.

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