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Financial Incentives Promote Smoking Cessation Directly, Not by Increasing Use of Cessation Aids

To the Editor:

Evidence-based interventions for smoking cessation include nicotine replacement therapy, pharmacotherapy, behavioral counseling, and financial incentives (1, 2). The provision of several interventions simultaneously (i.e., multicomponent interventions) is commonly believed to be more effective than single interventions alone. However, when brought to scale among large populations, intervention bundles may be inefficient if one or more of the components contributes minimally in the causal pathway to successfully quitting. Thus, using data from a five-arm pragmatic cessation trial of 6,006 smokers (3), we sought to determine whether use of free cessation aids or e-cigarettes mediated the effects of financial incentives for smoking cessation.

Methods

This secondary analysis of the trial was planned *a priori*. The trial was approved by the institutional review board at the University of Pennsylvania. Participants included employees and spouses affiliated with 54 companies that used The Vitality Institute as part of their wellness programs, were 18 years of age or older, and reported being a current smoker on a health-risk assessment within the year preceding enrollment (3). The primary outcome was sustained smoking abstinence for 6 months (4), defined as self-reporting having quit, and then submitting a negative urine or blood test for biochemical confirmation, at 1, 3, and 6 months after the participant's target quit date (3).

Participants in the usual care arm were offered information regarding the health benefits of smoking cessation and the opportunity to enroll in a motivational text-messaging program. Participants assigned to the four intervention arms received usual care plus: 1) free cessation aids, including nicotine replacement therapy, bupropion, and varenicline, and for those who first

reported lack of success with standard cessation aids, free NJOY e-cigarettes (including batteries, a charger, and up to 20 chambers per week in participants' chosen flavors); 2) free e-cigarettes without first requiring standard aids; 3) free cessation aids and a reward incentive worth \$600; or 4) free cessation aids and a redeemable (prefunded) deposit contract worth \$600, designed to leverage participants' loss aversion. Both financial incentive interventions (i.e., interventions 3 and 4 above) had free access to cessation aids and e-cigarettes.

We undertook a multiple mediation analysis (5) among the three preselected, between-arm contrasts that were significant according to a prespecified Holm-adjusted *P*-value threshold (6). We did not adjust for any confounders, as a participant's study arm was randomly allocated. Mediation is a statistical method used to examine the mechanism(s) by which one variable (X = randomized financial incentive) affects another (Y = sustained smoking abstinence) directly ($X \rightarrow Y$) and through intervening (mediating) variable(s) denoted by M ($X \rightarrow M \rightarrow Y$). In our study, the indirect effect (M) of interest provides an estimate of the total effect of the intervention that may be attributable to cessation aid or e-cigarette use. We estimated potential mediation according to both use (e.g., whether or not cessation aids were used at all) and volume (e.g., the total number of orders for cessation aid products) (Table 1). For all analyses, both ever-use and volume of use were included simultaneously as multiple mediators. Estimates and confidence intervals around the indirect and direct effects were calculated using bootstrap methods via the *ldecomp* (7) package in Stata 15 (StataCorp LP). Results are presented on the log-odds scale so that the decomposition into direct and indirect effects can be assessed as additive rather than multiplicative relationships.

Results

The three between-arm 6-month abstinence rate contrasts examined in the mediation analyses were 1) redeemable deposits versus cessation aids (2.9% vs. 0.5%; odds ratio [OR], 5.8; 95% confidence interval [CI], 2.7–12.5; $P < 0.001$), 2) reward incentives versus cessation aids (2.0% vs. 0.5%; OR, 4.0; 95% CI, 1.8–8.8; $P = 0.006$), and 3) redeemable deposits versus e-cigarettes (2.9% vs. 1.0%; OR, 3.0; 95% CI, 1.5–5.7; $P = 0.008$). Among participants who were eligible to use free cessation aids or e-cigarettes, utilization differed across arms, generally being higher in the financial incentive arms than in arms offering only cessation aids and/or e-cigarettes (Table 1). However, mediation analyses indicated that the fractions (i.e., indirect effects) of the total effects attributable to differences in cessation aid or e-cigarette use were small

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Clinical trial registered with www.clinicaltrials.gov (NCT02328794).

Table 1. Participant characteristics, cessation aid use, and e-cigarette use in the four intervention arms

	Free Cessation Aids	Free E-cigarettes	Rewards Plus Free Cessation Aids	Redeemable Deposits Plus Free Cessation Aids
Number randomized	1,588	1,199	1,198	1,208
Participant characteristics at baseline				
Age, yr	43.4 (34.5–52.7)	43.9 (35.0–52.8)	44.0 (34.6–52.6)	44.1 (34.4–54.0)
Female sex	832 (52.4)	597 (49.8)	614 (51.3)	618 (51.2)
Cigarettes per day	10 (5–15)	10 (5–15)	10 (5–15)	10 (5–15)
Years of smoking	18 (10–29)	20 (10–27)	18 (10–28)	18 (10–29)
Cessation aid and e-cigarette use during trial				
Used free patch	56 (3.5)	—	56 (4.7)	64 (5.3)
Used free gum	25 (1.6)	—	34 (2.8)	44 (3.6)
Used free lozenge	20 (1.3)	—	20 (1.7)	17 (1.4)
Used free medication	7 (0.4)	—	7 (0.6)	13 (1.1)
Used any free cessation aids	92 (5.8)	—	94 (7.8)	114 (9.4)
Number of free cessation aids used among users	1 (1–2)	—	1 (1–2)	1 (1–3)
Used free e-cigarettes	101 (6.4)	138 (11.5)	95 (7.9)	133 (11.0)
E-cigarette cartridges used among users	20 (10–70)	20 (10–70)	30 (10–110)	40 (10–100)

Data presented as median (interquartile range) or No. (%) unless otherwise noted.

or absent (Figure 1). Specifically, in the comparison between redeemable deposit contracts and cessation aids, the indirect effect of cessation aid use was 16.6% (95% CI, 4.2–29.1) of the total effect, and the indirect effect of e-cigarette use was 18.6% (95% CI, 5.7–31.5). Differences in cessation aid and e-cigarette use did not significantly mediate the effects of reward incentives versus free cessation aids, and differences in e-cigarette use did not mediate the superiority of redeemable deposits versus free e-cigarettes.

Discussion

This study finds that when incentives are offered as part of multicomponent interventions that include free access to cessation aids and e-cigarettes, incentives primarily promote cessation directly, rather than by increasing use of cessation aids or e-cigarettes. This result aligns with data from earlier randomized controlled trials of incentives for smoking cessation showing that incentives triple quit rates when offered without cessation aids or e-cigarettes (8, 9)—the same effect size as found in the most recent trial. Taken together, these findings suggest that incentives directly modify behavior, and hence the concomitant therapies offered may add cost without greater effectiveness.

A strength of this study is that it represents a planned analysis of the largest trial of financial incentives for smoking cessation to date, which enrolled a diverse population of smokers employed at 54 U.S. companies. In addition, the outcome measure was confirmed biochemically, and the mediators (use of cessation aids or e-cigarettes) were quantified precisely. In contrast, the generalizability of these findings may be limited to workplace settings, rather than applying to clinical populations as well. In addition, because of the pragmatic nature of the trial, many participants did not use their assigned interventions. Although this yields lower absolute quit rates than would be found in an etiologic trial among participants more motivated to quit, it is unlikely to affect the results of mediation analyses because the bias would be nondifferential across arms and would likely affect the direct

and indirect effects proportionately. However, this design and low overall quit rate do restrict the examination of the effects of smoking cessation aids among participant subgroups (10).

In summary, financial incentives effectively promote smoking cessation whether or not free cessation aids and e-cigarettes are made available concomitantly, and the effectiveness of the incentives is mostly attributable to direct effects of the incentives themselves. This suggests that, although considerable cost savings would accrue to employers who offer multicomponent strategies including both incentives and free cessation aids compared with the incremental costs of employing workers who smoke (3), these savings may be even greater without reduced effectiveness if incentives were offered alone.

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Figure 1. Mediation analysis of the effect of free cessation aids and e-cigarettes on intervention efficacy. Indirect, direct, and total effects (reported on the log-odds scale) were estimated using the *ldecomp* package in Stata, with bootstrapped confidence intervals (7). The approach uses two methods to estimate the indirect and direct effect and then averages these into a single ratio (see Reference 7 for additional details). The indirect effect quantifies the portion of each intervention's comparative effectiveness that is mediated by the indicated set of mediators. The direct effect quantifies the portion of each intervention's comparative effectiveness that is not explained by the mediation mode. Cessation aid use was quantified as the number of orders for any form of free cessation aids. E-cigarette use was quantified as the number of e-cigarette cartridges ordered. CI = confidence interval.

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