

**Self-Incentives Uniquely Boost Cessation in Community-based Stop Smoking Programs: Randomized Controlled Trial**

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## Abstract

**Background:** Self-incentives offer a plausible alternative to paying smokers to quit but have not yet been tested in a randomized controlled trial.

**Purpose:** The present study tested whether, compared to a control group, prompting smokers explicitly to self-incentivize if they abstain from smoking for a week or a month encouraged sustained abstinence.

**Method:** One hundred and fifty-nine smokers were recruited from stop smoking clinics and randomized to an active control condition (asked to form a plan to quit,  $N = 65$ ) or one of two intervention conditions in which they were asked to form implementation intentions designed to ensure that they incentivized themselves if they had not smoked at all by the end of: (a) the week ( $N = 44$ ), or (b) the month ( $N = 50$ ). The main outcome measure was self-reported abstinence at 3 and 6-month follow-up, which was biochemically-verified at baseline and in a sub-sample at 3-month follow-up.

**Results:** At 3-month follow-up 34% (15/44;  $p < 0.05$ ,  $d = 0.45$ ) and 36% (18/50;  $p < 0.05$ ,  $d = 0.49$ ) of smokers abstained in the weekly and monthly self-incentivizing conditions respectively, compared with 15% (10/65) in the control. The same pattern of findings was observed at 6-month follow-up: 30% (13/44;  $p < 0.05$ ,  $d = 0.35$ ), 34% (17/50;  $p < 0.05$ ,  $d = 0.45$ ) and 15% (10/65) of smokers remained abstinent in the two intervention groups and control group, respectively.

**Conclusions:** Ensuring that smokers self-incentivized boosted significantly the effectiveness of the stop smoking program. Self-incentivizing implementation intentions could be implemented at low cost with high public health “reach” to change many health behaviors beyond smoking.

**Trial Registration:** ISRCTN11610200

**Keywords:** smoking cessation, self-incentive, implementation intentions, behavior change, intervention

**Self-Incentives Uniquely Boost Cessation in Community Based Stop Smoking**

**Programs: A Randomized Controlled Trial**

Almost 100,000 people die from smoking-attributable deaths in the United Kingdom (UK) each year [1-4] and smokers who are prepared to set a quit date in the next 30-days are given free access to a specialist stop smoking program provided by a National Centre for Smoking Cessation and Training (NCSCT) certified smoking cessation practitioner. The program includes evidence-based behavioral support informed by behavior change theory [5] and smoking cessation medications [6] offered on a weekly basis either in person or over the telephone, lasting 15-30 minutes for a period of 12 weeks. On average, 51% of smokers who set a quit date during their first stop smoking session, committing to this quit date from session two successfully achieve and remain abstinent for at least 28-days [7], but the rate of quitting both in the UK and worldwide is decelerating [8] meaning that new approaches are needed to boost plateauing smoking cessation rates. The aim of the present research was to see whether the new approach of explicitly encouraging smokers to self-incentivize (i.e., “plan to reward one’s self in the future if one is successful in changing one’s behavior”, [p.114, 9]) could boost abstinence rates in a randomized controlled trial.

The UK stop smoking program treatment manual recommends that practitioners “provide rewards contingent on effort or progress” [p.46, 10] in 5 out of 6 sessions and this technique (commonly operationalized as a financial incentive) has been identified as the fifth most effective component of behavioral support for smoking cessation ( $OR = 1.06$ ) in the UK [11]. For example, significantly more pregnant smokers quit when randomized to a financial incentive condition compared to an active control condition (22.5% and 8.6% respectively;  $d = 0.63$ , [12]). Despite these encouraging findings, there is very little evidence that financial incentives are deployed outside of randomized controlled trials [12, 13], which has been attributed to cost [14] and lack of public acceptability for paying smokers to quit [p. 292, 15].

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In fact, financial incentives are considered less acceptable to both UK and US populations than any other equally effective alternative [16]. Therefore, it would be valuable to explore alternatives to financial incentives, for example, by instructing smokers themselves to plan, choose and self-administer incentives (i.e., self-incentivize) contingent on remaining abstinent. Currently, self-incentives do not appear in the UK stop smoking program treatment manual due to a lack of empirical evidence available to assess the effectiveness of this behavior change technique towards smoking cessation.

Notwithstanding the reduced costs and increased acceptability of self-incentivizing, there is evidence outside the domain of smoking cessation that self-incentives can be just as effective [17] as financial incentives [18]. However, evidence suggests that people are reluctant to self-incentivize even when they are entitled to do so (i.e., after the target behavior has been achieved) [17]. For example, in one study, just 11% of participants who were asked to self-incentivize each month actually did so [19]. The question arises as to how to encourage people to self-incentivize [9].

One possible approach might be to ask people to form self-incentivizing implementation intentions [20]. Implementation intentions are “if-then” plans in which people link critical situations (“ifs”) with appropriate responses (“thens”) thereby making critical situations salient and bringing appropriate responses automatically to mind [21] (e.g., “If I reach the end of the week and have not smoked at all, then I will reward myself by...”). Implementation intentions have been shown to be effective in helping smokers to deploy various strategies to help them to quit [22, 23] and in encouraging the implementation of self-incentives contingent on increased fruit consumption [24]. Therefore, implementation intentions may be similarly effective in helping smokers to self-incentivize. In the context of self-incentivizing the critical situation (“if”) is successfully having abstained from smoking and the appropriate response (“then”) is rewarding oneself [adapted from 24].

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One potentially important consideration for self-incentivizing implementation intentions is the time frame in which the incentive should be deployed. Although there is not yet an agreed point at which smokers are considered definitively to have quit (e.g., for at least 28-days in the National Health Service versus at least 6-months in Prochaska & DiClemente's, transtheoretical model [25]), guidance from learning theory suggests that greater behavior change should occur with greater incentive frequency [26]. Therefore, self-incentivizing on a weekly basis (also coinciding with attendance at stop smoking sessions), for example, should therefore be more effective than self-incentivizing on a monthly basis. However, learning theory also suggests that self-incentivizing more frequently (e.g., on a daily basis) raises the possibility of a decrease in responsiveness and thereby reduced behavior change [27], even when the self-incentive is held constant [28]. We will therefore consider the effects of self-incentivizing on a weekly versus a monthly basis to avoid excess repetition undermining any potential effects on behavior change.

The research reviewed above provides the following rationale for the present study. First, new approaches are needed to boost plateauing smoking cessation rates [11] and self-incentivizing may be one means of achieving this. Second, self-incentivizing seems to be an effective means of achieving behavior change, but people regularly fail to deploy their self-incentive [17] thereby undermining its efficacy, and implementation intentions may help to remedy this. Third, incentivizing oneself on a weekly basis is likely to be more effective in bringing about sustained behavior change than incentivizing oneself on a monthly basis [26]. It is hypothesized that, compared to an active control group: (a) implementation intentions will provide an effective means of encouraging people to self-incentivize, (b) self-incentivizing will be effective in encouraging smoking abstinence, and (c) weekly self-incentivizing will be more effective than monthly self-incentivizing.

## Method

### Recruitment and Participants

Participants were recruited from four services that delivered the same stop smoking program within North West England between December 2014 and March 2016. These four services were targeted due to obtaining consistently lower levels of smoking abstinence of at least 28-days compared to the England average during the 12-week program (46% versus 51% respectively, [7]). NCSCT certified practitioners delivered the same stop smoking program in community settings (e.g., primary care clinics), working from treatment manuals developed and provided by the NCSCT.

The stop smoking program runs for a maximum of 12-weeks. Smokers are encouraged to attend the sessions in person on a fortnightly or weekly basis (i.e., attending 6-12 sessions in total), dependent on need. The first stop smoking session lasts approximately 30 minutes, with follow-up sessions lasting approximately 15 minutes. Smokers receive evidence-based behavioral support on a one-to-one basis alongside stop smoking medications (e.g., nicotine patches). The sessions focus on enhancing motivation and boosting self-confidence, and include behavior change techniques such as: “facilitating relapse prevention and coping” (1.2 problem solving, as coded in the Behavior Change Technique Taxonomy v1 [29], and “explaining the purpose of CO monitoring” (2.6 biofeedback, Behavior Change Technique Taxonomy v1) [p.4, 11].

Four hundred and eight participants were approached and assessed for eligibility for inclusion in the study. All potential participants were screened by the stop smoking practitioners or the researcher to ensure that they met the inclusion criteria, namely, that they were: (a) aged 18 years or over, (b) able to understand written English, (c) competent to provide informed consent, (d) attending one of the four stop smoking programs taking part in the trial, and (e) were still smoking tobacco at baseline.

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Following screening, stop smoking practitioners or the researcher asked potential participants if they would consider taking part in a study to evaluate the use of specific plans to increase smoking quit attempts. Participants were also asked if they were willing to provide details about the plans they had implemented at two additional follow-up time points (at 3-months and 6-months). Following recommendations from the Greater Manchester West Research Ethics Committee (14/NW/1262), participants were instructed to take all study materials away with them, allowing sufficient time to consider their decision to take part in the study.

Of the 408 people who were approached to take part, 387 participants (94.85%) met all the inclusion criteria and agreed initially to take part in the study (Figure 1). Of the 387 participants who agreed initially to take part in the study, 228 participants declined to return the baseline questionnaire via mail or at the end of the first stop smoking session, resulting in a final sample of  $N = 159$  (41.09% of the participants who agreed to take part). The sample consisted of 95 women and 64 men aged between 18 and 83 years old ( $M = 50.39$ ,  $SD = 14.74$ ; see Table 1). This gender ratio is representative of the smokers who attended the stop smoking programs across the four services,  $\chi^2(1, N = 159) = 0.49$ ,  $p = 0.48$  (57% and 43%, respectively). Ninety-nine participants (61.64%) provided 3-month follow-up data, and 55 participants (34.59%) also provided 6-month follow-up data (see Figure 1). In initial analyses, all missing data were analyzed on an intention to treat basis (i.e., the last observation being carried forward) to avoid overestimation of the intervention effects [30]. The analyses were repeated using per protocol procedures (i.e., inclusion of only those participants who completed follow-up measures) to ascertain whether the effect remained present, providing an estimate of the true efficacy of the self-incentivizing intervention.

### **Design**

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A mixed design with a between-participants factor of condition and a within-participants factor of time was used. The between-participants factor had three levels: Active control (asked to form a plan to quit smoking), weekly self-incentivizing implementation intention, and monthly self-incentivizing implementation intention. The within-participants factor was time and included baseline, and follow-up time points of 3-months and 6-months after baseline. Three months was chosen as the initial follow-up because it coincided with the end of the stop smoking program; 6-months is commonly regarded as the point at which behavior change is considered “maintained” [25]. The primary outcome measure was smoking abstinence, which was assessed via self-report at baseline, 3-month and 6-month follow-ups. Exhaled carbon monoxide outputs were available from the stop smoking practitioners to verify the self-reported measures at baseline and 3-month follow-up.

### **Procedure**

Participants were randomized individually on a 1:1:1 ratio using a web-based randomizer before anyone was recruited into the study. The researcher ensured that the interventions were placed at the end of otherwise identical looking questionnaires and that the questionnaires were placed in a random order. This procedure ensured that the person randomizing the questionnaire packs, the person administering the questionnaire packs, and the participants were blind to intervention allocation.

Baseline questionnaire packs (including participant information sheets) were then distributed to all participants matching the inclusion criteria and agreeing to take part in this study at their first stop smoking session. Participants were asked to take the questionnaire packs away, and to read all the information regarding the study instructions before making an informed decision to take part in the study. The questionnaire could then be returned in the freepost self-addressed envelope provided, directly to the research team.



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Explicit informed consent was taken through the completion and return of questionnaires. Participants were contacted by their agreed and preferred method of contact (i.e., by phone, post, or email) at 3 and 6-months after baseline to collect follow-up data. Keeping contact information separate from the data ensured anonymity. Baseline and all follow-up questionnaires were matched using identification codes generated by the researcher.

### **Manipulations**

All participants received the standard stop smoking program as outlined above. In addition to the program, all participants were asked to complete the questionnaire measures as described in the following section. Appended to the end of the baseline questionnaires was one of three manipulations that participants completed on their own.

**Active control.** Participants in the active control condition were provided with the following instructions: “We want you to plan to quit smoking. Feel free to use the space below this question if you need more space to write your plan”. Participants were asked to form a simple plan to quit smoking but were not asked to form implementation intentions.

**Weekly self-incentivizing implementation intention.** Participants in the weekly self-incentivizing condition were asked to complete the following stem: “If I reach the end of the week and have not smoked at all, then I will reward myself by...” followed by sufficient space to write down a self-incentive. Participants were asked to choose one self-incentive from a list provided (adapted from the National Health Service Health Trainer Handbook [p. 37, 31]). This list (supplementary material S1) includes 10 self-incentives with monetary costs (e.g., going out for a meal) and 10 self-incentives without monetary costs associated (e.g., going for a walk).

**Monthly self-incentivizing implementation intention.** Participants in the monthly self-incentivizing condition were asked to complete the following stem: “If I reach the end of

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the month and have not smoked at all, then I will reward myself by..." [adapted from 24] followed by sufficient space to write down a self-incentive. Participants were asked to choose one self-incentive from the same list provided to the weekly self-incentive condition.

### Measures

Unless otherwise noted, all measures were taken at baseline, 3-month and 6-month follow-ups, regardless of smoking status.

**Smoking status.** Twenty-eight-day smoking status point prevalence was established by combining participants' responses to the items: "Have you quit smoking? Yes-No", and "How long ago was your last cigarette?" answered in days, minutes, and hours. The use of self-reported smoking status via the dichotomous filter question (e.g., "Have you quit smoking?"), alongside the open contingency question regarding the duration of this smoking status (e.g., "How long ago was your last cigarette?") was used to generate one dichotomized item for this analysis (i.e., participants were categorized as quitters only if they had sustained smoking abstinence for 28 days or more). A 28-day smoking abstinence (or point prevalence) was chosen to reduce memory bias (e.g., remembering a specific date, [32, 33]), and to coincide with the national outcome measure for stop smoking services as specified by Public Health England [34]. Additionally, using objective measures such as exhaled carbon monoxide levels would only provide an accurate representation of smoking status over the last 8 hours [35].

All self-reported measures were taken from a previous study [22] and were verified at baseline, with a sub-sample verified at 3-month follow-up through exhaled carbon monoxide using a Micro<sup>+</sup>™ Smokerlyzer® [36]. A cutoff of 6 parts per million or fewer was established for validating non-smokers at 3-month follow-up, with a value of 7 parts per million or higher validating smoking status at baseline as specified within stop smoking programs. Additionally, this value has been found to provide the highest sensitivity and

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selectivity between smokers and non-smokers [37]. Biochemical verification (i.e., exhaled carbon monoxide) was provided by 98.74% (157/159) of the sample at baseline and this correlated perfectly with self-reported smoking abstinence,  $r(157) = 1.00, p < 0.01$ .

Biochemical verification was also provided from a sub-sample of participants at 3-month follow-up (41.41%; 41/99) and also correlated strongly with self-reported smoking status,  $r(41) = 0.75, p < 0.01$ .

**Self-incentive administration.** Self-incentive administration was measured at 3-month and 6-months only using a single item [adapted from 24]. Participants were asked “If you successfully stopped smoking during the stop smoking support, how many times did you reward yourself?”. The distribution of self-incentive scores deviated significantly from normal,  $D(95) = 0.42, p < 0.05$  across all conditions, due to extreme variations in the rates at which incentives were self-administered, regardless of the weekly or monthly instruction to self-incentivize ( $M = 3.31, SD = 15.41$ , ranging from 0-133). Thus, self-incentive administration was dichotomized (i.e., 0 assigned to participants that had not incentivized at all; 1 assigned for participants that had incentivized at least once between baseline and 3-month or 6-month follow-up, regardless of condition allocation) to tap whether participants had administered an incentive at least once versus not incentivizing at all.

### Data Analysis

A power calculation was undertaken to predict the sample size required for this study using self-reported measures of smoking status at follow-up, analyzed by chi-square. Based on previous research assessing the effects of single behavior change techniques [9, 12, 21, 38, 39] in order to detect a medium sized effect ( $d = 0.50$ , [40]) at a power of 80% and a significance level of 0.05, 108 participants were required across all three conditions at follow-up.

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Success of the randomization procedures was checked using MANOVA to verify equivalence of age, validated carbon monoxide outputs and nicotine dependence across conditions at baseline. Chi-square was used to assess randomization for gender, ethnicity, occupation and educational attainment. Participants who completed at least one follow-up measure were compared to participants who dropped out after baseline measures using MANOVA and chi-square.

Chi-square was used to assess whether participants actually administered self-incentives at both 3-month and 6-month follow-ups. Chi-square was also used to assess the primary outcome measure of self-reported smoking status between baseline and both 3-month, and 6-month follow-ups for all three conditions.

Mediation analysis [see 41] was used to test whether self-incentive administration mediated the relationship between condition and abstinence outcome. Logistic regression was used to calculate the beta and standard error values for the four paths to calculate mediation (i.e., path a, condition to mediator; path b, mediator to outcome controlling for condition; path c, condition to outcome, and path c', condition to outcome controlling for the mediator) as proposed by Baron and Kenny [42], and MacKinnon and Dwyer [41]. Sobel test values [43] were created by multiplying the beta values of path a and path b and dividing by the standard error for the indirect effect ( $S_{ab}$ ).

## Results

### Randomization and Attrition Checks

Success of the randomization procedures was checked for all variables at baseline for all participants who supplied these data. There were no significant differences across the three conditions for age,  $F(2, 150) = 0.27, p = 0.76, \eta_p^2 = 0.01$ , carbon monoxide validation,  $F(2, 150) = 0.28, p = 0.76, \eta_p^2 = 0.01$ , nicotine dependence,  $F(2, 150) = 1.19, p = 0.83, \eta_p^2 = 0.01$ , gender,  $\chi^2(2, N = 159) = 0.09, p = 0.95$ , ethnicity,  $\chi^2(2, N = 157) = 2.59, p = 0.28$ ,

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occupation,  $\chi^2(2, N = 143) = 0.88, p = 0.64$ , or educational attainment,  $\chi^2(6, N = 137) = 2.02, p = 0.92$  (Table 1).

For participants who completed at least one follow-up questionnaire (i.e., at 3-months or 6-months,  $N = 99$ ) compared to those participants who dropped out after baseline measures were completed (i.e., no questionnaires completed and returned at 3-months or 6-months), no significant differences were found across conditions for age,  $F(1, 152) = 1.44, p = 0.23, \eta_p^2 = 0.01$ , carbon monoxide validation,  $F(1, 153) = 1.01, p = 0.37, \eta_p^2 = 0.02$ , nicotine dependence,  $F(1, 153) = 1.15, p = 0.29, \eta_p^2 = 0.01$ , gender,  $\chi^2(1, N = 159) = 1.65, p = 0.19$ , ethnicity,  $\chi^2(1, N = 157) = 0.61, p = 0.45$ , occupation,  $\chi^2(1, N = 143) = 2.15, p = 0.14$ , or educational attainment,  $\chi^2(3, N = 137) = 0.40, p = 0.94$ .

### Effect of the Interventions on the Use of Self-Incentives

**Intention to treat.** Assuming that those participants not responding at 3 and 6-month follow-up had not administered self-incentives, chi-square showed statistically significant differences between conditions on self-incentive administration at 3-month follow-up,  $\chi^2(2, N = 159) = 11.07, p < 0.05, d = 0.55$ . Significantly more participants administered self-incentives at least once in the weekly (14/44; 31.82%),  $\chi^2(1, N = 109) = 10.61, p < 0.05, d = 0.67$ , and monthly (13/50; 26.00%),  $\chi^2(1, N = 115) = 7.18, p < 0.05, d = 0.52$ , self-incentivizing conditions than in the active control condition (5/65; 7.69%). However, no statistically significant differences were found for self-incentive administration between the weekly and monthly self-incentivizing conditions,  $\chi^2(1, N = 94) = 0.39, p = 0.53, d = 0.13$ .

Differences between conditions on self-incentive administration at 6-month follow-up did not achieve conventional levels of statistical significance,  $\chi^2(2, N = 159) = 6.12, p = 0.05, d = 0.51$ , although significantly more participants administered self-incentives at least once in the monthly self-incentivizing condition (14/50; 28.00%) compared with the active control condition (7/65; 10.77%),  $\chi^2(1, N = 115) = 5.62, p < 0.05, d = 0.45$ .

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**Per protocol analysis.** Including only participants who had provided follow-up data at 3-months ( $N = 99$ ) and 6-months ( $N = 55$ ), similar results to the intention to treat-based analyses were found between conditions on self-incentive administration at 3-month follow-up,  $\chi^2(2, N = 99) = 10.76, p < 0.05, d = 0.70$ , for the weekly (14/29; 48.28%),  $\chi^2(1, N = 67) = 9.98, p < 0.05, d = 0.84$ , and monthly (13/32; 40.63%),  $\chi^2(1, N = 70) = 6.86, p < 0.05, d = 0.66$ , self-incentivizing conditions compared to the active control condition (5/38; 13.16%) with no statistically significant differences found between the weekly and monthly self-incentivizing conditions,  $\chi^2(1, N = 61) = 0.36, p = 0.55, d = 0.15$ .

Comparable with the intention to treat-based analyses, differences between conditions at 6-month follow-up did not achieve conventional levels of statistical significance,  $\chi^2(2, N = 55) = 4.81, p = 0.09, d = 0.46$ , although significant differences were found in the monthly self-incentivizing condition (10/20; 50.00%) compared to the active control condition (4/22; 18.18%),  $\chi^2(1, N = 42) = 4.77, p < 0.05, d = 0.72$ .

### Effect of the Interventions on Smoking

**Intention to treat.** Assuming those participants not responding at 3 and 6-month follow-up had not abstained from smoking, chi-square showed statistically significant differences between conditions on smoking status at 3-month follow-up,  $\chi^2(2, N = 159) = 7.62, p < 0.05, d = 0.46$ . Significantly more participants abstained from smoking for at least 28-days in the weekly (15/44; 34.09%),  $\chi^2(1, N = 109) = 5.20, p < 0.05, d = 0.45$ , and monthly (18/50; 36.00%),  $\chi^2(1, N = 115) = 6.52, p < 0.05, d = 0.49$ , self-incentivizing conditions than in the active control condition (10/65; 15.38%), producing small to medium sized effects. Consistent with the analysis reported above, self-incentivizing worked equally well towards smoking abstinence, regardless of whether participants incentivized themselves on a weekly or monthly basis,  $\chi^2(1, N = 94) = 0.04, p = 0.85, d = 0.04$  (see Table 2).

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Statistically significant differences were also found between conditions for smoking abstinence at 6-month follow-up,  $\chi^2(2, N = 159) = 5.82, p < 0.05, d = 0.35$ . Significant differences were found for smoking abstinence at 6-month follow-up in the weekly (13/44; 29.55%),  $\chi^2(1, N = 109) = 3.16, p < 0.05, d = 0.35$ , and monthly (17/50; 34.00%),  $\chi^2(1, N = 115) = 5.45, p < 0.05, d = 0.45$ , self-incentivizing conditions compared to the active control condition (10/65; 15.38%). In contrast, no significant differences were found between the weekly self-incentivizing condition, and the monthly self-incentivizing condition on smoking abstinence,  $\chi^2(1, N = 94) = 0.21, p = 0.64, d = 0.09$ .

**Per protocol analysis.** Including only participants who had provided follow-up data at 3-months ( $N = 99$ ) and 6-months ( $N = 55$ ), similar results to the intention to treat-based analyses were found between conditions on smoking status at 3-month follow-up,  $\chi^2(2, N = 99) = 7.48, p < 0.05, d = 0.59$ , for the weekly (15/29; 51.72%),  $\chi^2(1, N = 67) = 4.54, p < 0.05, d = 0.54$ , and monthly (18/32; 56.25%),  $\chi^2(1, N = 70) = 6.49, p < 0.05, d = 0.64$ , self-incentivizing conditions compared to the active control condition (10/38; 26.32%), with no statistically significant difference between the weekly and monthly self-incentivizing conditions,  $\chi^2(1, N = 61) = 0.13, p = 0.72, d = 0.09$ . In contrast with the intention to treat-based analyses, however, differences in smoking abstinence between conditions at 6-month follow-up did not achieve conventional levels of statistical significance,  $\chi^2(2, N = 55) = 1.18, p = 0.56, d = 0.29$  when data were analyzed per protocol.

### Potential Mediating Effects

The lack of differences between the two intervention conditions on smoking status at both follow-up time points meant that the “weekly” and “monthly” conditions were combined to focus the analyses on comparing self-incentivizing versus the active control condition.

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**Intention to Treat.** Analyses were conducted to test whether the effects of condition on successful abstinence reported at both 3-month, and 6-month follow-up, was mediated by successful self-incentive administration. Condition significantly predicted the abstinence outcome,  $B = 1.09$ ,  $SE = 0.41$ ,  $p < 0.05$  and the potential mediator of self-incentive administration,  $B = 1.58$ ,  $SE = 0.52$ ,  $p < 0.05$ . Including the mediator in the regression equation significantly reduced the effect of condition on abstinence,  $B = 0.53$ ,  $SE = 0.47$ ,  $p = 0.26$ , and self-incentive administration predicted the abstinence outcome,  $B = 2.94$ ,  $SE = 0.51$ ,  $p < 0.05$  meaning that self-incentive administration significantly mediated the effect of self-incentivizing on abstinence ( $z = 2.69$ ,  $p < 0.05$ ,  $d = 0.44$ ) at 3-month follow-up.

For the 6-month follow-up, mediation analysis was conducted for the active control and the monthly self-incentivizing condition (as the weekly self-incentivizing condition was not significantly different from the active control for self-incentive administration). Condition did not achieve conventional levels of significance to predict the abstinence outcome,  $B = 0.66$ ,  $SE = 0.38$ ,  $p = 0.08$  or the potential mediator of self-incentive administration,  $B = 0.67$ ,  $SE = 0.41$ ,  $p = 0.10$ . Including the mediator in the regression equation reduced the effect of condition on abstinence,  $B = 0.44$ ,  $SE = 0.47$ ,  $p = 0.35$ , and self-incentive administration predicted the abstinence outcome,  $B = 3.00$ ,  $SE = 0.49$ ,  $p < 0.05$  meaning that self-incentive administration mediated the effect of self-incentivizing on abstinence ( $z = 1.60$ ,  $p = 0.05$ ,  $d = 0.26$ ) at 6-month follow-up, though not to conventional levels of significance.

**Per Protocol.** Including only participants who had provided follow-up data at 3-months ( $N = 99$ ) and 6-months ( $N = 55$ ), condition significantly predicted the abstinence outcome,  $B = 1.09$ ,  $SE = 0.41$ ,  $p < 0.05$  and the potential mediator of self-incentive administration,  $B = 1.66$ ,  $SE = 0.55$ ,  $p < 0.05$ . Including the mediator in the regression equation significantly reduced the effect of condition on abstinence,  $B = 0.69$ ,  $SE = 0.50$ ,  $p = 0.17$ , and self-incentive administration predicted the abstinence outcome,  $B = 2.09$ ,  $SE = 0.52$ ,  $p < 0.05$



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meaning that self-incentive administration significantly mediated the effect of self-incentivizing on abstinence ( $z = 2.41, p < 0.05, d = 0.50$ ) at 3-month follow-up.

For the 6-month follow-up, mediation analysis was conducted for the active control and the monthly self-incentivizing condition (due to no significant difference between the weekly self-incentivizing condition and the active control). Again, condition significantly predicted abstinence outcome,  $B = 1.00, SE = 0.43, p < 0.05$  and the potential mediator of self-incentive administration,  $B = 1.24, SE = 0.55, p < 0.05$ . Including the mediator in the regression equation significantly reduced the effect of condition on abstinence,  $B = 0.74, SE = 0.62, p = 0.23$ , and self-incentive administration predicted the abstinence outcome,  $B = 3.24, SE = 0.82, p < 0.05$  meaning that self-incentive administration significantly mediated the effect of self-incentivizing on abstinence ( $z = 1.96, p < 0.05, d = 0.55$ ) at 6-month follow-up.

### Discussion

This is the first study to use a self-incentivizing implementation intention to boost smoking abstinence in a UK stop smoking program. The principal findings were: (a) implementation intentions appear to encourage use and administration of self-incentives contingent on achieved smoking abstinence, (b) self-incentivizing is an effective behavior change technique for smoking abstinence, and (c) few participants followed instructions to self-incentivize on a weekly or monthly basis which limited the identification of the most optimal schedule of self-incentivizing. The following discussion considers the conceptual and clinical impact of the present findings.

Prior research had suggested that if self-incentives could be administered successfully, then self-incentivizing could provide an effective and cost-effective strategy to change behavior, but not yet in the field of smoking cessation [17]. The fact that the self-incentivizing implementation intentions produced up to 2.4 times more abstainers than the active control condition is comparable with studies showing that financial incentives produce

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up to 2.2 times more abstainers than active control conditions [12, 13, 44]. Additionally, the mediational analyses provide evidence that self-incentive administration is crucial for successful behaviour change meaning that self-incentivizing implementation intentions could be augmented by other approaches to optimising the administration of self-incentives.

Contrary to predictions, there was no difference in smoking abstinence between self-incentivizing on a weekly versus a monthly basis, implying that self-incentivizing on a monthly basis is sufficient to change people's behavior. Indeed, it could be the case that self-incentivizing less frequently than monthly might be sufficient to promote smoking abstinence. Given that self-incentivizing implementation intentions could be deployed to change other behaviors, it would be valuable in further research to identify the optimal schedules of self-incentivizing among other populations and behaviors.

### **Future Research**

The lower costs, greater acceptability, and self-selection (e.g., practical, realistic, appropriate rewarding value [45]) of self-incentives compared with financial incentives has the potential to: a) increase intrinsic motivation by placing the individual in control of self-selecting and administering thus increasing autonomy and the likelihood of initiating and maintaining the behavior [46], and b) make the present approach more attractive to health care professionals and policy makers. Additionally, the advantages of self-incentivizing outlined above mean that self-incentives could be easily incorporated in to future treatment manuals, as this is a quick, easy to explain technique that is self-completed by the smoker. It would therefore be valuable to explore the use and effectiveness of self-incentives within other stop smoking programs, in other countries, and by other means (e.g., digitally delivered interventions).

Furthermore, in principle, self-incentivizing is a technique that could also be applied to change other behaviors. For example, whilst prior research has shown that externally

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administered incentives are effective in changing a range of behaviors such as increasing physical activity ( $d = 0.29$  [47]) and attendance at vaccination or screening ( $d = 0.36$  [48]), self-incentivizing implementation intentions could be just as effective and potentially more acceptable. Moreover, self-incentivizing implementation intentions could be deployed to change multiple health related behaviors simultaneously (e.g., “If I reach the end of the week and have not drunk alcohol or smoked at all, then I will reward myself by...”). This is potentially important because 68% of adults in England engage in two or more unhealthy behaviors, of which hazardous alcohol use and smoking are the most commonly clustered behaviors [49].

Moreover, it is plausible that encouraging people to use implementation intentions to self-incentivize may contribute to future use of implementation intentions to deploy other behavior change techniques (e.g., self-affirmation, “If I feel threatened or anxious, then I will think about the things that are important to me” [50]) or to change other behaviors. Although beyond the scope of the present research, ongoing research is testing the effectiveness of teaching parents and children how to use implementation intentions to improve oral health [51]. Future research should monitor the use of spontaneous implementation intentions following training and the effect this may have on behavior change.

Although the present findings support the use and effectiveness of self-incentives to boost successful abstinence outcomes within UK stop smoking programs, it is important to acknowledge the potential limitations that should be addressed in future research. First, as the smokers included in the present study were recruited from community-based stop smoking programs and were prepared to quit smoking within the next 30-days, it is likely that these smokers were more motivated to quit smoking than smokers in the general population. Although, it has been reported that 72.8% of smokers in England want to quit smoking at

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some point [52], further research is required to establish if the present findings can be generalized to all smoking populations.

Second, although the study was adequately powered to detect a significant effect of the self-incentivizing implementation intentions on smoking abstinence at 3-month and 6-month follow-up using an intention to treat analysis, the sample size at both follow-up time points and the data used in per protocol analyses was lower than the initial power calculation had predicted. Therefore, there is the possibility that the high rates of attrition obtained in this study, and the variation of this attrition between conditions reduced the effect of the intervention, introducing bias. However, studies that aim for a wide inclusion of participants and are focused on lifestyle interventions such as smoking cessation rarely achieve the desired attrition rates of <20% at follow-up [53].

Third, the primary outcome measure of smoking status was assessed through completed self-report measures at 3-month, and 6-month follow-up due to a lack of availability of the biochemical measures from all participants. Regardless of this, the sub-sample of validated carbon monoxide outputs provided at 3-month follow-up correlated very strongly with the self-report measures, supporting previous evidence that self-report measures are highly accurate for smokers who are not adolescents, high risk smokers, or medical patients [54]. Nevertheless, further research should consider the collection of anabasine levels of participants as this provides a longer period of assessment coverage (i.e., 16 hours) than both exhaled carbon monoxide (i.e., 8 hours), and self-reported data (i.e., memory and response bias) can reliably conclude [55].

Additionally, it is notable that the 28-day smoking abstinence reported in the present study is lower than the average rates reported by the stop smoking services taking part in this trial (27% compared to 46%, respectively). Although the 12-week program takes possible lapses back to smoking in to consideration meaning that additional quit dates may be

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required, as long as an abstinence outcome of at least 28-days is still feasible [10], there is reason to suspect some leniency in what is considered and reported as a 28-day abstinence outcome by the stop smoking services [56] in comparison to the Public Health England definition (i.e., “not a puff” rule for 28-days, [p. 11, 34]) with these discrepancies also noted within previous smoking cessation research (26% compared to 48% respectively [57]).

In conclusion, the present study shows that implementation intentions encourage the administration of self-incentives, and that self-incentives thus prompted smoking abstinence. Importantly, self-incentivizing implementation intentions significantly boosted the effectiveness of the standard stop smoking program as evidenced through comparison with an active control condition. The findings of the present study have the potential to inform researchers and practitioners within smoking cessation fields, but also has the potential to be implemented at low cost with high public health “reach” to change many health behaviors beyond smoking and populations beyond smokers.

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Table 1: Baseline characteristics of the sample

Variables	Active control (N=65)		Weekly self-incentivizing implementation intention (N=44)		Monthly self-incentivizing implementation intention (N=50)		<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Age	50.53	14.04	48.83	16.44	16.44	14.37	0.76
Carbon monoxide output	17.22	11.13	17.57	11.84	11.84	11.60	0.67
Nicotine dependence	4.50	2.16	4.67	1.96	4.38	2.39	0.83
	<i>N</i>	% per variable	<i>N</i>	% per variable	<i>N</i>	% per variable	<i>p</i>
Gender							0.95
Men	27	41.54	17	38.64	20	40.00	
Women	38	58.46	27	61.36	30	60.00	
Ethnicity							0.28
Black	0	0	1	2.27	0	0	
White	65	100.00	43	97.73	48	100.00	

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Occupation							0.64
Unemployed/sick/retired/full time student	31	55.36	21	50.00	27	60.00	
Employed	25	44.64	21	50.00	18	40.00	
Education							0.92
No formal education	15	27.78	8	21.05	11	24.44	
Completed secondary education	27	50.00	23	60.53	22	48.89	
Completed post-secondary education	7	12.96	5	13.16	7	15.56	
Completed degree-level education	5	9.26	2	5.26	5	11.11	

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Table 2: Percentages and sample sizes for the primary outcome of self-reported smoking abstinence (Intention to treat)

3-month follow-up						
Abstinence status	Active control ( <i>N</i> =65)	Weekly self-incentivizing implementation intention ( <i>N</i> =44)	Effect size ( <sup>a+b</sup> )	Monthly self-incentivizing implementation intention ( <i>N</i> =50)	Effect size ( <sup>a+b*</sup> )	Effect size ( <sup>b+b*</sup> )
	<i>N</i> (%)	<i>N</i> (%)		<i>N</i> (%)		
Abstained	10 (15.38) <sup>a</sup>	15 (34.09) <sup>b</sup>	<i>d</i> = 0.45	18 (36.00) <sup>b*</sup>	<i>d</i> = 0.49	<i>d</i> = 0.04
Not abstained	55 (84.60)	29 (65.91)		32 (64.00)		
6-month follow-up						
	<i>N</i> (%)	<i>N</i> (%)		<i>N</i> (%)		
Abstained	10 (15.38) <sup>a</sup>	13 (29.55) <sup>b</sup>	<i>d</i> = 0.35	17 (34.00) <sup>b*</sup>	<i>d</i> = 0.45	<i>d</i> = 0.09
Not abstained	55 (84.60)	31 (70.45)		33 (66.00)		

Note: Different subscripts between conditions indicate that the frequencies differ significantly.

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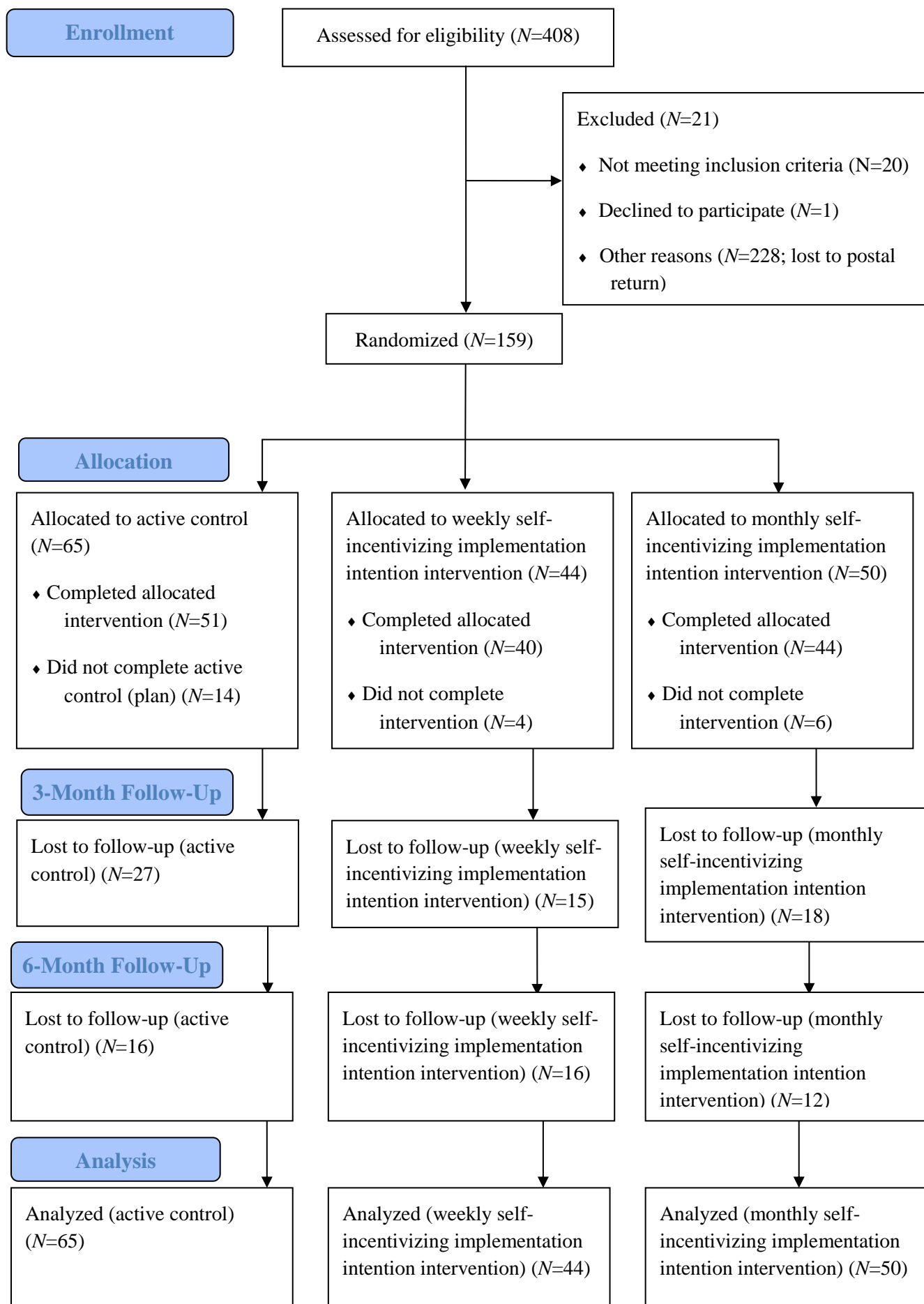


Figure 1. Flow of participants through the study