Original Investigation

Predicting Successful 24-Hr Quit Attempt in a Smoking Cessation Intervention

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Abstract

Introduction: The factors that influence the initial phase of quitting smoking have been understudied. Although maintenance of change is the ultimate test of the efficacy of treatment, maintenance is a nonissue for those who fail to manage even brief periods of abstinence. We examined factors associated with smokers' ability to achieve a targeted 24-hr quit during a smoking cessation program. As a comparison, we also examine whether predictors of an initial quit are different from factors that predict smoking abstinence at 52-week follow-up.

Methods: Using baseline data from a randomized clinical trial to examine the efficacy of selegiline for cigarette smoking cessation ($n = 280$), we conducted univariate analyses (analysis of variance or chi-square) to determine statistically significant predictors of a successful quit attempt (SQA) versus unsuccessful quit attempt. Multiple logistic regression was performed with significant predictors from the univariate analyses to determine main effects and interactions in a multivariate model. The same factors and analyses were used to examine predictors of 52-week point prevalence abstinence.

Results: Lower nicotine dependence (modified Fagerström Tolerance Questionnaire [mFTQ]), higher Behavioral Inhibition System score, and lower baseline heart rate were predictive of SQA in both the univariate and the multivariate models. Gender was the only predictor of 52-week smoking abstinence.

Conclusions: Predictors of initial induction of change were not predictors of abstinence at the 1-year follow-up, suggesting that different factors mediate the different subprocesses of behavior change. Knowledge of these pretreatment factors that moderate a SQA could help clinicians target smokers who need more intensive therapy during the initial induction of cessation.

research, most reports have examined factors that influence mid- to longer term maintenance with far less attention paid to variables that may control the initial treatment induction. The limited research that exists appears consistent with Bandura's formulation. For example, [Powell, Dawkins, West, Powell, and Pickering \(2010\)](#) found that three measures of salience attribution and two measures of inhibitory control predicted early smoking abstinence (1 week) but that only two of the five measures predicted abstinence at 3 months.

Although maintenance of change is the ultimate test of the efficacy of treatment, maintenance is a nonissue for those who fail to manage even brief periods of abstinence. We must understand the factors that influence the initial phase of quitting precisely because so many smokers have great difficulty achieving a successful quit attempt (SQA, i.e., 24-hr abstinence; [Killen, Fortmann, Newman, & Varady, 1990](#)). Furthermore, quit date abstinence and early treatment success have been found to improve the likelihood of longer term smoking abstinence ([Kenford et al., 1994](#); [Westman, Behm, Simel, & Rose, 1997](#)). For example, [Westman et al. \(1997\)](#) reported that achieving abstinence for 24 hr on the targeted quit date increased the odds of 6-month abstinence 10-fold. Thus, knowledge of pretreatment factors that moderate a SQA during treatment could help clinicians target smokers who need more intensive therapy during the initial induction of cessation.

The goal of this study is to examine factors associated with smokers' ability to achieve a targeted 24-hr quit during the course of an 8-week smoking cessation program. As a comparison, we also examine whether baseline predictors of an initial quit are different from factors that predict smoking abstinence at 52-week follow-up. The variables selected for analysis were chosen because of both empirical and theoretical support for their relationship to smoking treatment outcome.

Introduction

[Bandura \(1976\)](#) argued that separate subprocesses (induction, generalization, and maintenance) characterize the course of behavior change and that different factors mediate the different subprocesses. In the field of cigarette smoking cessation

Methods

Randomized Clinical Trial

Data for this study was collected during a double-blind randomized clinical trial designed to assess the effectiveness of transdermal selegiline for producing cigarette smoking abstinence ([Killen et al., 2010](#)).

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Selegiline is a selective inhibitor of monoamine oxidase B and is used clinically in combination with levodopa to treat late-stage Parkinsonism and, in transdermal form, to treat depression. Selegiline permits the stabilization of dopamine levels in the brain by preventing the rapid degradation of dopamine via monoamine oxidase B. The study consisted of 8 weeks of cognitive behavioral therapy and either transdermal selegiline or placebo. Smoking status follow-up assessments were conducted at 8, 25, and 52 weeks.

Participants

Participants were recruited through advertisements on the radio, local newspapers, on a community website, and by notices distributed throughout local organizations. In order to be eligible to participate in the study, participants had to be between 18 and 65 years of age and smoking at least 10 cigarettes/day. Individuals were excluded for pregnancy, lactation, intent to become pregnant within six months, bipolar disorder, schizophrenia, current liver or kidney disease, uncontrolled diabetes, Parkinson's disease, Alzheimer's disease, unstable thyroid disorder, active treatment for or reporting current depression or substance abuse, history of heart problems in the previous six months, uncontrolled hypertension, orthostatic hypotension, current use of medications intended to assist in smoking cessation, or use of medications contraindicated for use with selegiline.

Baseline Measures

Participants completed baseline measures prior to the initial quit week. No additional data were collected until the participant achieved 24 hr of abstinence and attended the Quit Week appointment.

Demographic Variables and Smoking Quantity

Age, gender, ethnicity, marital status, years of education, and number of cigarettes smoked on a typical day were assessed during the screening telephone call prior to entry into the study.

Body Mass Index

Height was measured on a wall-mounted stadiometer. Weight was recorded on a Scale-Tronix 5600 electronic scale. Body Mass Index (BMI) was calculated as kilograms per square meter.

Heart Rate

Heart rate was measured at baseline using an automated blood pressure device (DINAMAP Procare 120, www.gehealthcare.com; last accessed 12 July 2011).

Craving and Withdrawal Symptoms

Craving was measured at baseline with the following two questions, "Have you felt cravings for a cigarette?" and "Have you felt strong urges to smoke?" Participants rated how upsetting cravings and urges had been in the past 24 hr on a scale of 0 = *none* to 6 = *extremely upsetting*. A craving score was calculated by averaging the two items. Withdrawal symptoms were assessed by asking how much they had experienced each symptom over the past 24 hr (0 = *none* to 4 = *severe*).

Modified Fagerström Tolerance Questionnaire

This questionnaire (modified Fagerström Tolerance Questionnaire [mFTQ]) was administered at baseline and consists of five questions designed to assess tobacco dependence (Killen, Fortmann, Telch, & Newman, 1988). The mFTQ is a modified

version of the instrument first developed by Fagerström (1978) as a self-report assessment of level of nicotine dependence. The modified questionnaire consists of the following five questions: "When you are in a place where smoking is forbidden, is it difficult for you not to smoke?" "Do you smoke more in the morning than during the rest of the day?" "Do you smoke even when you are so ill that you have to stay in bed most of the day?" "How deeply do you inhale?" and "How soon after you wake up in the morning do you smoke your first cigarette?" Scores on the mFTQ range from a minimum of 5 to a maximum total of 25.

Depression Symptoms

Depression symptoms were measured with the 20-item Center of Epidemiological Studies depression instrument (Center for Epidemiological Studies Depression Scale [CES-D]; Radloff, 1977). Participants were asked to indicate the number of days (0–7) they felt or behaved in particular ways (i.e., did not feel like eating or had a poor appetite; feel life had been a failure) during the past week.

History of Major Depressive Disorder

A screen for current Major Depressive Disorder (MDD) and past history of MDD was administered at the baseline visit using the mood disorders portion of the Structured Clinical Interview for the "Diagnostic and Statistical Manual of Mental Disorders" (SCID), fourth edition (DSM-IV; First, Spitzer, Gibbon, & Williams, 1996). Those with current MDD were excluded from the study.

Behavioral Inhibition System/Behavioral Activation System Scales

This measure is designed to assess the behavioral activation system (BAS) and the behavioral inhibition system (BIS) based on Gray's theory of personality (Carver & White, 1994). The BAS activates behavior and positive mood in response to rewarding stimuli, whereas the BIS serves to inhibit behavior when negative or aversive stimuli are present and is responsible for anxiety-related characteristics. The BIS/BAS is a 20-item measure with four subscales, BIS, BAS-Reward Responsiveness, BAS-Drive, and BAS-Fun Seeking. The items were measured on a 4-point Likert scale with 1 indicating *strong agreement* and 4 indicating *strong disagreement*. All but two items were reverse scored so that a higher score is indicative of higher sensitivity of each system.

Treatment Group

Participants were randomly assigned to receive either active transdermal selegiline patches or placebo patches.

Dependent Variable

Successful Quit Attempt

Participants in the study were asked to set a quit date and to be successfully quit for 24 hr before coming to their Quit Week appointment. If the quit attempt was unsuccessful, participants were asked to set a new quit date. Participants were considered to have a SQA if they were able to successfully complete a 24-hr quit within the 8-week treatment program. Successful 24-hr quit was based on self-report of no smoking and biologically verified by an expired-air carbon monoxide reading of less than 10 parts per million.

Fifty-Two-Week Follow-up Point Prevalence Abstinence

Participants were considered to be abstinent at the 52-week follow-up if they reported not smoking for seven consecutive

days prior to staff contact and a CO level below 10 parts per million. Those who could not be reached at the follow-up were coded as not abstinent.

Statistical Analysis

Analysis of variance was used to compare continuous baseline characteristics (age, BMI, years of education, number of cigarettes smoked, mFTQ, cravings, withdrawal symptoms, BIS, BAS-Reward, BAS-Drive, and BAS-Fun) between those who had a SQA and those who had no successful quit. Chi-squared analysis was employed for dichotomous variables (gender, race [Caucasian vs. not], marital status [married vs. not married], history of depression, and treatment group [active selegiline vs. placebo]). Because this is an initial study with the goal of identifying potential predictors for future study, we chose to not correct for multiple testing in order to maximize the power to detect such predictors (Feise, 2002; Rothman, 1990). Multiple logistic regression was performed with significant predictors from the univariate analyses to determine main effects and interactions in a multivariate model. Effects sizes were reported using Cohen's delta (continuous measures) and odds ratio (binary data). These analyses were repeated using 52-week point prevalence abstinence as the dependent measure as a way of comparing the characteristics of those who successfully quit during the treatment phase with those who were abstinent at the long-term follow-up.

Results

Participants

A total of 240 of the original 243 participants in the randomized clinical trial were included in the analyses. Three were excluded

because they could not actively participate in the trial (one pregnancy prior to initial quit attempt and two moved out of area prior to initial quit attempt). The sample consisted of 167 males and 73 females; 39% of the sample was married, and the majority was Caucasian (78%). Approximately 10% of the sample reported a history of depression. Of the 240 participants, 42 (17.5%) were not able to make a successful 24-hr quit attempt within the 8 weeks of active treatment. Twenty-one (50%) of those unable to make a quit attempt received active treatment (selegiline). The majority (85%) of those in the SQA group achieved 24-hr abstinence at their initial quit date of the treatment study.

Randomized Clinical Trial

There were no statistically significant differences between those who received active medication and those who received placebo at either the 8-, 25-, or 52-week follow-ups.

Predictors of SQA

Table 1 shows the percentage and/or means and SDs for each of the predictor variables measured at baseline and effect sizes for the univariate analyses. In the univariate analyses, mFTQ, $F(1, 238) = 4.15, p = .04; \delta = 0.35, 95\% CI: 0.01-0.68$, the BIS score, $F(1, 238) = 8.72, p = .004; \delta = 0.50, 95\% CI: 0.16-0.84$, and heart rate, $F(1, 238) = 6.31, p = .01; \delta = 0.43, 95\% CI: 0.09-0.76$, were significant predictors of SQA. In the logistic regression model, participants who were successful in their quit attempt had lower mFTQ scores, $W(1) = 4.9, p = .03; OR = 0.85, 95\% CI: 0.74-0.98$, higher BIS scores, $W(1) = 9.8, p = .002; OR = 1.20, 95\% CI: 1.07-1.35$, and lower baseline heart rates, $W(1) = 5.1, p = .02; OR = 0.96, 95\% CI: 0.93-0.99$, than those unable to quit for at least 24 hr. There were no significant interactions. See Table 2.

Table 1. Percentages and/or Means (SDs in parentheses) of Baseline Variables and Effect Sizes for the Univariate Analyses by Successful Versus No SQA

	SQA (N = 198)	NSQA (N = 42)	Effect size (CI)
Gender (% female)	30.81	28.57	OR = 1.11 (0.53-2.32)
% Minority (non-Caucasian)	22.45	21.43	OR = 1.06 (0.47-2.39)
Age	44.34 (10.64)	43.29 (11.15)	$\delta = 0.10 (-0.24 \text{ to } 0.43)$
BMI	28.52 (5.84)	27.97 (4.03)	$\delta = 0.10 (-0.23 \text{ to } 0.43)$
Marital status (% married)	39.90	33.33	OR = 1.33 (0.66-2.68)
History of depression (%)	10.10	11.90	OR = 0.83 (0.29-2.36)
Years of education	13.98 (1.95)	14.02 (2.30)	$\delta = 0.02 (-0.31 \text{ to } 0.35)$
Number of cigarettes smoked per day	19.38 (6.86)	21.00 (7.82)	$\delta = 0.23 (-0.10 \text{ to } 0.56)$
mFTQ	15.27 (2.89)	16.29 (3.11)	$\delta = 0.35^* (0.01-0.68)$
Cravings and urges in past 24 hr	2.95 (1.58)	2.70 (1.85)	$\delta = 0.15 (-0.18 \text{ to } 0.49)$
Withdrawal symptoms	0.84 (0.55)	0.93 (0.59)	$\delta = 0.16 (-0.17 \text{ to } 0.49)$
CES-D	7.89 (8.07)	7.00 (6.40)	$\delta = 0.14 (-0.19 \text{ to } 0.48)$
BIS	17.62 (3.83)	15.74 (3.39)	$\delta = 0.50^{**} (0.16-0.83)$
BAS-Reward Responsiveness	17.02 (3.03)	16.93 (2.85)	$\delta = 0.03 (-0.30 \text{ to } 0.36)$
BAS-Drive	10.87 (2.69)	11.26 (2.80)	$\delta = 0.14 (-0.19 \text{ to } 0.48)$
BAS-Fun Seeking	11.43 (2.72)	11.52 (2.65)	$\delta = 0.03 (-0.30 \text{ to } 0.37)$
Heart rate	77.29 (10.65)	81.90 (11.64)	$\delta = 0.43^* (0.09-0.76)$
Treatment (% in active selegiline group)	50	50	OR = 1.00 (0.51-1.95)

Note. BAS = Behavioral Activation System Scale; BIS = Behavioral Inhibition System Scale; BMI = body mass index; CES-D = Center for Epidemiological Studies Depression Scale; mFTQ = modified Fagerström Tolerance Questionnaire; NSQA = no successful quit attempt; OR = odds ratio; SQA = successful quit attempt; δ = Cohen's delta.

* $p < .05$. ** $p < .01$.

Predictors of 52-Week Abstinence

Table 3 shows the percentage and/or means and SDs for each of the predictor variables measured at baseline and effect sizes for the univariate analyses. Gender was the only predictor of abstinence at 1 year with females more likely to be abstinent at the 52-week follow-up than males, $\chi^2(1) = 4.5$, $p = .03$; $OR = 2.00$, 95% CI : 1.05–3.84. No other factors were significant.

Discussion

Although many studies have examined factors associated with treatment outcome, this is the first to examine predictors of the ability to refrain from smoking for 24 hr in a smoking cessation trial. Knowledge of pretreatment characteristics that weaken a smoker's resolve to successfully refrain from smoking during the initial induction phase of the behavior change process could allow for specialized treatment to increase quit day success.

Those with higher mFTQ scores were less able to quit smoking successfully for 24 hr. Similarly, Lamb, Kirby, Morral, Galbicka, and Iguchi (2010) found that nicotine dependence (assessed with the Fagerström Test for Nicotine Dependence [FTND]) was higher in those who were not able to successfully quit for at least one day; however, smokers in that study did not receive any intervention except for contingency management. Future treatment could focus on the triggers that are specifically referenced in the mFTQ/FTND to increase the likelihood of a SQA. For example, if a patient has difficulty refraining from smoking in the morning, a treatment plan could be formulated to help him/her cope on the first morning without a cigarette. Furthermore, more intensive treatment could be planned for the first 24 hr of a quit attempt for those with high levels of nicotine dependence.

The BIS subscale also predicted the success of a 24-hr quit attempt. This finding is consistent with other investigations of the BIS as a predictor of drug use (Pardo, Aguilar, Molinuevo, & Torrubia, 2007; Powell et al., 2010) but contrasts with studies that show the BAS to be associated with increased drug use (Franken, Muris, & Georgieva, 2006; Johnson, Turner, & Iwata, 2003; Pardo et al., 2007).

Table 2. Logistic Regression Model of Independent Predictors of Successful Quit Attempt and Interactions

	Estimate	Significance test	OR (CI)
mFTQ	−0.16	$W(1) = 4.9$	0.85* (0.74–0.98)
BIS	0.18	$W(1) = 9.8$	1.20** (1.07–1.35)
Heart rate	−0.04	$W(1) = 5.1$	0.96* (0.93–0.99)
BIS × mFTQ	0.003	$W(1) = 0.03$	1.00 (0.97–1.04)
BIS × Heart Rate	−0.01	$W(1) = 3.5$	0.99 (0.98–1.00)
mFTQ × Heart Rate	−0.002	$W(1) = 0.1$	1.00 (0.99–1.01)
BIS × mFTQ × Heart Rate	0.002	$W(1) = 1.1$	1.00 (0.998–1.01)

Note. BIS = Behavioral Inhibition System Scale; mFTQ = modified Fagerström Tolerance Questionnaire; OR = odds ratio.

* $p < .05$. ** $p < .01$.

The BAS is related to risk taking and, therefore, may be more linked to initiation of drug use than ability to quit per se. The BIS is thought to mediate responses to conditioned stimuli for punishment and extinction, and undercontrolled behavior is seen as a failure to inhibit behavior in response to cues for impending punishment. The BIS may be more predictive of a quit attempt as anxiety over health effects could result in inhibition of an undesirable behavior. In one study assessing anxious temperament and progression of diabetes, higher BIS scores were related to lower disease progression across all age groups, suggesting that high levels of temperamental anxiety might facilitate early diagnosis, particularly among younger individuals (Hall, Coons, & Vallis, 2008). Similar to the patients in Hall's study, the smokers in our study who had higher BIS scores might have been more worried about health effects (temperamental anxiety) and hence more likely to have inhibited the undesirable behavior, at least in the short term. In the current study, if smokers with low BIS scores are less likely to initiate change due to low levels of anxiety associated with the negative consequences of smoking, evoking anxiety regarding health concerns associated with smoking might increase motivation to quit.

The findings that unsuccessful quit attempts were associated with both low BIS scores (representing lower anxiety) and higher heart rate (often associated with high anxiety) might seem paradoxical. Furthermore, the BIS result could seem counterintuitive since nicotine dependence and anxiety disorders are often comorbid (Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007). However, those who are temperamentally anxious may be more motivated to quit smoking to avoid negative long-term effects of diseases (Hall et al., 2008), while those suffering from clinically significant anxiety may be less likely to initiate change due to avoidance behaviors. The finding of higher heart rate among those who failed to quit successfully is consistent with this hypothesis. Those who were unable to quit might have a higher propensity to clinically significant anxiety or trait anxiety as indicated by a higher baseline heart rate but might have a lower dispositional variety of anxious temperament that results in a weaker inhibition system, thus being less likely to quit smoking. It should be noted that although higher heart rate is associated with higher levels of anxiety, we did not assess for clinically significant anxiety or trait anxiety. The higher heart rate could have been due to a variety of factors, including underlying physical or psychological conditions, use of other substances (including caffeine), or more recent nicotine intake. Future studies are warranted to understand the role of the BIS in initiating behavior change.

Consistent with Bandura's theory that the subprocesses of change might be mediated by different factors (Bandura, 1976), we found that the predictors of initial induction of change were not predictors of abstinence at the 1-year follow-up. In fact, gender was the only factor that was predictive of 52-week abstinence. There is some evidence that factors measured during treatment, as opposed to baseline, are more predictive of long-term abstinence (Bailey, Hammer, Bryson, Schatzberg, & Killen, 2010). In the current study, we assessed pretreatment factors while participants were still smoking to determine what factors could be targeted during the initial induction phase to increase a SQA. To increase successful behavior change, treatment could be adapted from the onset to target those who are

Table 3. Percentages and/or Means (SDs in parentheses) of Baseline Variables and Effect Sizes for the Univariate Analyses by Abstinent Versus Not Abstinent at 52-Week Follow-up Assessment

	Abstinent (<i>N</i> = 49)	Not abstinent (<i>N</i> = 191)	Effect size (<i>CI</i>)
Gender (% female)	42.86	27.23	<i>OR</i> = 2.00* (1.05–3.84)
% Minority (non-Caucasian)	16.67	23.68	<i>OR</i> = 0.64 (0.28–1.48)
Age	45.92 (10.42)	43.71 (10.77)	δ = 0.21 (–0.11–0.52)
BMI	28.71 (6.35)	28.34 (5.35)	δ = 0.06 (–0.25 to 0.38)
Marital status (% married)	46.94	36.65	<i>OR</i> = 1.53 (0.81–2.88)
History of depression (%)	12.24	9.95	<i>OR</i> = 1.26 (0.48–3.35)
Years of education	14.08 (1.87)	13.96 (2.05)	δ = 0.06 (–0.25 to 0.37)
Number of cigarettes smoked per day	18.12 (6.90)	20.06 (7.05)	δ = 0.28 (–0.04 to 0.59)
mFTQ	15.29 (3.35)	15.49 (2.84)	δ = 0.07 (–0.25 to 0.38)
Cravings and urges in past 24 hr	3.07 (1.43)	2.87 (1.68)	δ = 0.12 (–0.19 to 0.44)
Withdrawal symptoms	0.86 (0.55)	0.86 (0.56)	δ = 0.00 (–0.31 to 0.31)
CES-D	7.65 (7.62)	7.76 (7.86)	δ = 0.01 (–0.30 to 0.33)
BIS	16.90 (3.99)	17.39 (3.77)	δ = 0.13 (–0.19 to 0.44)
BAS-Reward Responsiveness	16.82 (2.71)	17.06 (3.07)	δ = 0.08 (–0.23 to 0.39)
BAS-Drive	10.88 (2.96)	10.96 (2.65)	δ = 0.03 (–0.28 to 0.34)
BAS-Fun Seeking	11.12 (2.67)	11.53 (2.71)	δ = 0.15 (–0.16 to 0.47)
Heart rate	76.67 (10.92)	78.46 (10.95)	δ = 0.16 (–0.15 to 0.48)
Treatment (% in active selegiline group)	49	50	<i>OR</i> = 1.05 (0.56–1.97)

Note. BAS = Behavioral Activation System Scale; BIS = Behavioral Inhibition System Scale; BMI = body mass index; CES-D = Center for Epidemiological Studies Depression Scale; mFTQ = modified Fagerström Tolerance Questionnaire; NSQA = no successful quit attempt; *OR* = odds ratio; SQA = successful quit attempt; δ = Cohen's delta.

**p* < .05.

likely to have difficulty with the induction phase of change, while treatment factors could be targeted over the course of treatment for longer term abstinence.

Although a main strength of this study is that it is the first to examine predictors of an SQA during a smoking cessation treatment study, there are some limitations of the study that should be noted. One limitation is that our sample was primarily Caucasian. Future studies should examine whether these results are replicated in other races/ethnicities. We also did not have the necessary data or statistical power to conduct more in-depth analyses of the SQA group to determine if predictors of success vary across the number of attempts before achieving 24-hr abstinence. Determining if smokers who are able to successfully abstain from smoking on their initial quit attempt are distinctly different from those who require more attempts is beyond the scope of this study but could be a focus of future research.

In conclusion, three significant factors were found to be predictive of successfully completing a 24-hr quit attempt over the course of treatment. Furthermore, we found that those three predictors were not associated with long-term smoking abstinence, suggesting that different factors mediate the subprocesses of behavior change. If these results are replicated in future studies, treatments could be tailored early on to increase one's ability to successfully initiate behavior change.

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Declaration of Interests

None Declared.

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