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Associations of Mindfulness with Nicotine Dependence, Withdrawal, and Agency

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Abstract

Quitting smoking is a major life stressor that results in numerous aversive consequences, including persistently increased level of post-cessation negative affect and relapse. The identification of factors that may enhance behavioral and emotional regulation after quitting may be useful in enhancing quit rates and preventing relapse. One factor broadly linked with behavioral and emotional regulation is mindfulness. This study examined baseline associations of mindfulness with demographic variables, smoking history, dependence, withdrawal severity, and agency among 158 smokers enrolled in a cessation trial. Results indicated that mindfulness was negatively associated with level of nicotine dependence and withdrawal severity, and positively associated with a sense of agency regarding cessation. Moreover, mindfulness remained significantly associated with these measures even after controlling for key demographic variables. Results suggest that low level of mindfulness may be an important predictor of vulnerability to relapse among adult smokers preparing to quit; thus, mindfulness-based interventions may enhance cessation.

Keywords

mindfulness; nicotine dependence; withdrawal; agency; self-efficacy

Introduction

Tobacco use is the leading cause of preventable morbidity and mortality in the United States. (1) Unfortunately, long-term quit rates are low. This is not surprising given that quitting smoking is a major life stressor resulting in numerous aversive consequences such as mood and sleep disturbance, and cognitive and psychomotor deficits. (2) These consequences can be generally characterized as behavioral or emotional. One factor broadly and consistently linked with behavioral and emotion regulation is degree of mindfulness. (3) Mindfulness reflects an intentional awareness of internal and external stimuli occurring in the present moment. A key characteristic of mindfulness is that by simply noticing emotions, cognitions, perceptions, and sensations, as they are happening, in a nonjudgmental manner, individuals learn over time that these phenomena are transient and that they are not compelled to impulsively react. (4)

Although the evidence is limited, several pilot studies have provided preliminary support for the efficacy of mindfulness-based treatments for smoking cessation. (5-7) In addition, degree of mindfulness was found to be negatively associated with the frequency of heavy drinking. (8) The focus of the current study is on potential associations of degree of trait mindfulness with nicotine dependence, withdrawal severity, and a sense of agency regarding cessation. These outcomes are of interest because they were found to be predictive of smoking cessation and relapse.

Nicotine dependence has been established as the primary factor responsible for the maintenance of smoking, and dependence severity strongly predicts withdrawal severity and relapse. (9) Recent conceptualizations have emphasized the multidimensional nature of dependence which encompasses factors such as negative (e.g., smoking to alleviate negative affect) and positive (e.g., smoking to enhance mood) reinforcement, and automaticity (e.g., automatically reaching for a cigarette after quitting and disposing of cigarettes). Degree of mindfulness and level of nicotine dependence are hypothesized to be related because mindfulness reduces both self-report and objective indices of negative affect and stress, (10) and is associated with enhanced positive affect. (11) That is, greater mindfulness is hypothesized to attenuate levels of dependence via its influence on reducing negative affect. Given that affect-related constructs are consistently and very powerfully related to relapse, (12) mindfulness may impact cessation outcomes through its effects on enhancing emotional regulation. This hypothesis is modeled after Baker and colleagues' reformulation of the negative reinforcement model of drug addiction, which proposes that negative affect is the most important motivational factor driving continued addictive drug use. (13)

Mindfulness is also hypothesized to impact dependence through its effects on enhancing attentional control and reducing automaticity. This is consistent with theory and empirical data indicating that mindfulness increases the ability to disengage attention from problematic stimuli. (14) Tiffany's cognitive processing model of drug craving posits that drug use behavior becomes largely automatized over time and relapse occurs when individuals are not able to effectively impede automatized smoking routines. (15) Smokers governed largely by automaticity may have greater difficulty interrupting smoking patterns and, thus, be more dependent. This has direct implications for cessation because greater

automaticity of smoking predicts relapse.(16) Thus, more mindful smokers may be able to respond to difficult situations in more flexible and adaptive (“mindful”) ways rather than by relying on automatic responses that are more likely to lead to relapse.

Nicotine withdrawal severity is an important outcome because it is a critical hallmark of dependence and predicts relapse.(17) It includes both affective (e.g., anxiety, sadness) and physiological (e.g., craving, hunger, concentration difficulty) components, and the current focus was on the affective aspects of withdrawal. Greater mindfulness was hypothesized to be associated with less withdrawal severity via its influence on reducing negative affect.

Mindfulness was also hypothesized to enhance cessation outcomes by increasing one's sense of agency about their ability to successfully quit smoking. Self-efficacy, a critical component of agency, predicted relapse to smoking in numerous studies.(18-20) In addition, affect regulation expectancies (another component of agency) for both smoking and non-smoking coping predict smoking motivation, self-administration, and longitudinal changes in smoking behavior.(21, 22) Degree of mindfulness may enhance agency through its effects on increasing awareness of internal and external stimuli occurring in the present moment, and through increasing acceptance of distressing cognitions, emotions, perceptions, and sensations that occupy awareness.(4) Thus, mindfulness may enhance flexibility in responding and ultimately expand perceived options for handling high-risk situations.

This study examined cross-sectional associations of mindfulness with demographic and smoking history variables, dependence, withdrawal severity, and agency in 158 adult smokers enrolled in a pilot smoking cessation clinical trial.

Methods

Procedures

Current manuscript presents findings based on analysis of baseline data of 158 participants who were adult smokers, recruited from the Houston metropolitan area via local print media and enrolled in a randomized controlled pilot study (N=158) to evaluate a mindfulness-based group therapy for nicotine dependence. In this pilot trial, participants were randomly assigned to either mindfulness intervention or “standard of care” treatment. The mindfulness intervention included 8 weekly group therapy sessions that integrated Mindfulness-Based Stress Reduction(23) with a cognitive-behavioral relapse prevention based on and consistent with a standard coping skills training approach.(24) In this trial, after participants provided informed consent, an exhaled carbon monoxide (CO) sample was obtained and the baseline assessments were completed. Then, they were randomized. The study was approved by the Institutional Review Board of The University of Texas M. D. Anderson Cancer Center.

Participants

Participants (N=158), per eligibility criteria, were tobacco cigarette smokers who had smoked at least 5 cigarettes per day for the past year, motivated to quit within next 30 days, were fluent in English, and had a home address and telephone number. Exclusion criteria included contraindication of nicotine patch use, regular use of non-cigarette tobacco products, use of nicotine replacement therapies or smoking cessation pharmacotherapy other

than study-provided, enrollment in another cessation program, self-reported pregnancy or lactation, psychotropic medication use, and other household members enrolled in the study. The primary reasons for exclusion from the study included a lack of motivation to quit within 30 days, regular use of tobacco products other than cigarettes, current use of nicotine replacement, and smoking < 5 cigarettes per day (see Figure 1).

Measures

Demographics assessed included age, race/ethnicity, gender, marital status, educational attainment (years completed), employment status, and annual household income. Several of demographic variables were categorized. Race/ethnicity was categorized as a four-group variable (non-Latino White, non-Latino Black, Latino, and Other). Marital status, employment status and household income level were dichotomized (married/living with partner versus not married/not living with partner; employed versus not employed; income < \$20,000 versus ≥ \$20,000 per year).

Nicotine dependence severity was evaluated using the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) (16) and the Heaviness of Smoking Index (HSI).(25). The WISDM-68 is a multidimensional measure that yields an overall score and 13 subscale scores for critical dimensions of dependence. These scores have high internal consistency and reliability; and high predictive validity regarding predicting relapse.(16) The WISDM-68 subscales were combined to compute Primary and Secondary Dependence Scores, with higher scores reflecting greater dependence severity. (26) The HSI (25) is comprised of two items from the Fagerström Test for Nicotine Dependence (27): cigarettes per day (CPD) and time to the first cigarette after waking (TTFC). The HSI has fair internal consistency ($\alpha=.63$) (28) and the TTFC item predicts relapse (the shorter TTFC, the higher risk for relapse to smoking).(29)

Nicotine withdrawal severity was assessed prior to quitting with the Wisconsin Smoking Withdrawal Scale (WSWS).(30) The scale yields a total score and 7 subscale scores (i.e., anger, anxiety, concentration difficulty, craving, hunger, sadness, and sleep problems). All scales have excellent internal consistency and demonstrate clear increases as a function of withdrawal severity, with higher scores reflecting greater withdrawal severity.(31) Because withdrawal was assessed before the quit day, smokers were not likely in physiological withdrawal at the time of the assessment; however, they were all anticipating quitting in a near future as a part of the study. Thus, the focus of the current study was on the more affective, anticipatory (e.g., anxiety, sadness) rather than physiological (e.g., craving, hunger, concentration difficulty) aspects of withdrawal.

Agency or confidence in one's ability to cope with high-risk situations without relapsing was assessed using 2 questionnaires: one evaluating self-efficacy (Self-Efficacy Scale (20)) and one evaluating affect regulation expectancies (Affective Information Processing Questionnaire (AIPQ) (22)). The Self-Efficacy Scale is a 9-item measure; its total score and three subscale scores reflect situational categories that characterize high-risk situations: positive affect/social situations, negative affect situations, and habitual/craving situations. Higher scores reflect greater confidence in one's ability to cope in high-risk situations.(20)

The Self-Efficacy Scale was completed by only 116 of the 158 participants because it was inadvertently excluded from the assessment battery for the first 42 participants.

The AIPQ evaluated affect regulation expectancies by assessing responses to vignettes relating to negative affect. Participants provided ratings of the controllability of their affect in that situation (described by a vignette) by a) smoking, and b) means other than smoking. The AIPQ internal consistency is excellent, with both subscales predicting smoking motivation and use in laboratory settings,(22) and change over time among young adults. (32)

The degree of mindfulness was measured with the Kentucky Inventory of Mindfulness Skills (KIMS) and the Mindfulness Attention Awareness Scale (MAAS).(33, 34) Higher scores on both measures indicate greater degree of mindfulness. The KIMS is a 39-item multidimensional measure comprising of four subscales: Observing, Describing, Acting with Awareness, and Accepting without Judgment. The KIMS outcome measure is a score calculated as an average of the four subscale scores. (35) Internal consistency is adequate to good with coefficient alphas ranging from .83 to .91. Test-retest reliability is adequate to good with coefficient alphas ranging from .65 to .86 and paired sample t tests revealing no significant difference between administrations.(33) Convergent validity is supported by significant positive associations between the KIMS and openness to experience ($r=0.47$, $p<0.01$), and the KIMS and emotional intelligence ($r=0.61$, $p<0.01$). Discriminant validity of the KIMS is supported by its negative associations with neuroticism ($r=-0.37$, $p<0.01$), thought suppression ($r=-0.42$, $p<0.01$) and difficulties in emotional regulation ($r=-0.56$, $p<0.01$).(35) The KIMS was validated in a non-clinical college student sample. The MAAS is a 15-item measure developed with a college sample and subsequently cross-validated with a nationwide sample of the U.S. adults. It has good reliability, and is associated with enhanced self-awareness and numerous other constructs indicative of well-being. It can differentiate mindfulness practitioners from non-practitioners, and predicts self-regulation and positive emotional states.(34) The mean of all items was calculated to generate the final score.

Data Analysis

Analyses were conducted using SPSS Version 16.0 statistical software. Distributional data characteristics were evaluated by conducting skewness analyses on the 31 dependent variables examined in the paper. Using the rule of thumb that a skew of less than 2 standard errors is not significant, only 7 of the 31 variables were significantly skewed (5 of 16 scales from the WISDM, the HSI, and 1 scale from the WWS). Since the sample primarily included heavier smokers, it is not surprising that some of the measures of dependence were negatively skewed. None of the agency scales were skewed. Considering the sample size and the actual amount of skewness within these 7 variables, we elected to use multiple linear regression without correction.(36) Descriptive statistics were used to describe participants' demographic and smoking history characteristics. Associations of the mindfulness measures with demographics and smoking history were examined using Pearson product moment correlations for continuous variables, and point biserial correlations for dichotomous variables. Multiple linear regression analysis, adjusted for age, gender, race/ethnicity,

educational attainment, income, and education, examined the associations of degree of mindfulness with levels of nicotine dependence, withdrawal severity, and agency. All statistical tests were two-tailed with significance levels of $p < 0.05$. All individuals ($N=158$) enrolled in the pilot study were included in the analyses. Results are presented as mean (standard deviation, SD) unless indicated otherwise.

Results

All baseline measures were completed by 158 participants, with the exception of the Self-Efficacy Scale that was completed by 116 participants.

Participant Characteristics

Participants were 45% female; 50% were Caucasian, 34% African American, 10% Hispanic, and 6% other. The mean age was 43.8 years (11.8), and the mean years of education completed was 13.4 years (2.5). Thirty-eight percent were married or cohabitating with a significant other, 57% were employed, and 34% reported their annual household income below \$20,000.

They smoked an average of 20.8 (9.2) cigarettes per day, for an average of 24.8 (12.1) years. The mean baseline exhaled CO level was 21.3 (11.3) parts per million. The mean MAAS and KIMS scores were 4.2 (1.0) and 31.4 (3.8), respectively.

Associations between Mindfulness, and Demographic / Smoking Variables

Age and years of smoking were the only demographic and smoking variables significantly associated with the degree of mindfulness; participants who were older and had longer smoking histories reported greater mindfulness as assessed by the MAAS and KIMS scores (Table 1).

Mindfulness and Dependence

As hypothesized, greater degree of mindfulness was associated with lesser nicotine dependence severity. Both the MAAS and the KIMS scores were significantly negatively associated with scores on virtually all of the WISDM-68 subscales, with the exception of Social/Environmental Goals and Tolerance subscales for the MAAS, and the Tolerance subscale for the KIMS, which were not significantly correlated with the WISDM-68 subscales (Table 2). Neither the KIMS nor the MAAS score was associated with the HSI score.

Mindfulness and Withdrawal Severity

The MAAS and KIMS scores were significantly negatively associated with all of the WSWWS subscale scores with the exception of Hunger. All significant associations were in the expected direction such that greater degree of mindfulness was associated with lesser nicotine withdrawal severity (Table 2).

Mindfulness and Agency

Degree of mindfulness was overall positively associated with self-efficacy ratings regarding one's ability to abstain from smoking in high-risk situations. The MAAS score was positively associated with the total and subscale scores of the Self-Efficacy measure. However, the KIMS score was significantly associated with only Habitual/Craving Situations of this measure. Finally, as hypothesized, the MAAS and KIMS scores were significantly associated with scores of two AIPQ subscales: positively with the Affect Control by Other Means score, and negatively with the Affect Control by Smoking score (Table 2).

Discussion

The current findings provide the first evidence that degree of trait mindfulness is significantly associated with a combination of factors that strongly predict relapse among smokers enrolled in a cessation trial. Consistent with hypotheses, smokers reporting a higher degree of mindfulness were less nicotine dependent, experienced fewer withdrawal symptoms prior to quitting, and a stronger sense of agency regarding their ability to successfully quit smoking. Moreover, the degree of mindfulness remained significantly associated with severity of nicotine dependence and withdrawal, and level of agency, even after controlling for key demographic variables including age, gender, race/ethnicity, educational attainment, income, and marital status. This is important because each of these characteristics has been demonstrated to increase relapse vulnerability. Thus, the results suggest that the degree of mindfulness may be an important incremental predictor of vulnerability to relapse among smokers preparing to quit.

Many established predictors of the level of nicotine dependence, withdrawal and agency (e.g., educational attainment, income, race/ethnicity, gender, years smoked) are difficult or impossible to target through a therapeutic intervention. The results indicate that levels of trait mindfulness may ultimately be useful in predicting cessation outcomes, and considerable evidence supports the efficacy of targeted interventions to enhance level of mindfulness among diverse populations and for varied outcomes.(37, 38) Therefore, in addition to having incremental predictive utility as a marker of dependence, withdrawal severity, and agency, level of mindfulness among smokers may be malleable through intervention. We are currently conducting a large, randomized controlled trial to evaluate the efficacy of a mindfulness-based treatment for smoking cessation outcomes, and the mechanisms and effects posited to mediate the treatment's impact on tobacco abstinence.

In addition to having utility as a target for intervention, levels of trait mindfulness may be useful in matching smokers with optimal treatments. It may be that smokers who are naturally more “mindful” have an easier time quitting and may require less intensive interventions. On the other hand, more “mindful” smokers may respond better to intensive mindfulness-based interventions because they relate better to the treatment content and are more compliant. Those with low degree of mindfulness may also benefit from interventions teaching mindfulness skills, to increase their “mindfulness”, if they agree to such therapeutic modality.

It is interesting, although not surprising, that virtually all of the WISDM-68 scales, evaluating multidimensionally dependence, were negatively associated with the degree of mindfulness, whereas the HSI scores, evaluating physiological dependence, were not. It was hypothesized that mindfulness would be associated with lower levels of dependence through its effects on enhancing attentional control and positive affect, and reducing automaticity and negative affect. The WISDM-68 comprises 13 scales that assess distinct motives for smoking, 7 of which directly reflect our proposed mechanisms. Automaticity, Cue Exposure-Associative Processes, Loss of Control, and Social-Environmental Goads subscales reflect attentional control and automaticity, and Affiliative Attachment, Negative Reinforcement, and Positive Reinforcement subscales reflect affect. Thus, mindfulness appeared to be strongly and consistently associated with a broad range of motivational bases for smoking that ultimately contribute to dependence severity, but may be unrelated to purely physiological hallmarks of dependence.

A counterintuitive finding was that mindfulness was positively (although modestly) associated with years smoked, suggesting, on one hand, that mindfulness may actually inhibit one's ability to successfully quit smoking. On the other hand, years smoking and degree of mindfulness were positively associated with age. Thus, the association of mindfulness with years smoking may have simply been an artifact of these associations.

Another interesting finding was that the self-efficacy scale scores were positively and consistently associated with the MAAS, but not the KIMS scores; only one of the three self-efficacy subscales – Habitual/Craving Situations – was related to the KIMS. This lack of association was inconsistent with our hypotheses and surprising given that both the MAAS and KIMS total scores yielded a virtually identical pattern of results for all other outcomes. One possible explanation is that power may have been limited because the self-efficacy measure was not completed by all participants. It is notable that all found associations, both significant and trends, were in the expected direction. Relationship between the KIMS and the measures of self-efficacy should be examined in future research.

Several limitations should be acknowledged. First, because the data were cross-sectional, we were unable to assess whether or not degree of mindfulness was associated with cessation outcomes, or whether or not dependence severity may have mediated or moderated such potential outcomes. An additional question is whether training in mindfulness could impact levels of nicotine dependence, withdrawal or agency, or cessation outcomes. These questions should be addressed using longitudinal data in future studies. Also, because withdrawal severity was assessed prior to cessation, participants were likely not in physiological withdrawal at the time of the assessment. However, the goal of assessing withdrawal severity at baseline was to examine associations of mindfulness with the more affective aspects of anticipated withdrawal that may emerge prior to actual cessation. Selection bias may present an additional limitation; participants were aware of the study focus on mindfulness. Therefore, they may have had higher levels of mindfulness than the general population of smokers. Our participants may not be representative of all smokers; thus, these results may not generalize beyond the current study.

Although a large proportion of smokers attempt to quit each year, few are successful.(39) The majority experiences increased levels of negative affect after quitting that can persist for months, and considerable evidence indicates that difficulty with negative affect, among other factors, contributes strongly to relapse.(40) Broad and consistent evidence suggests that mindfulness enhances emotional and behavioral regulation. Thus, degree of mindfulness may help reduce the distress of quitting and ultimately prevent relapse. This study provides the first preliminary evidence that degree of trait mindfulness among smokers seeking assistance with quitting is significantly associated with level of nicotine dependence, withdrawal, and agency, three factors that have been established as critical in predicting vulnerability to relapse. Taken together, the results indicate that degree of trait mindfulness is associated with several factors known to predict smoking cessation and relapse. Future research should investigate potential associations of levels of trait mindfulness with cessation outcomes, as well as the efficacy and effectiveness of smoking cessation interventions intended to enhance levels of mindfulness.

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Figure 1. Participant recruitment, screening, and study enrollment

Table 1

Pearson and Point Biserial Correlations of Demographic and Smoking-related Variables with the Degree of Mindfulness measures: KIMS and MAAS scores (N=158); results are presented as correlation coefficient, *r* value.

Demographics and Smoking History	MAAS score	KIMS score
Age (years)	.263 ***	.216 **
Gender (male vs. female)	-.018	.026
Married / living with significant other (vs. not)	-.034	-.109
Education (years)	-.032	-.076
Unemployed (vs. employed)	.048	.135
Annual household income < \$20,000 (vs. >= 20,000)	.131	.115
Cigarettes per day (number)	.039	-.019
Years smoked (years)	.186 *	.167 *
Carbon Monoxide (CO) level (ppm)	-.021	-.034

*
 $p < .05$;

**
 $p < .01$;

***
 $p < .001$

MAAS = Mindfulness Attention Awareness Scale

KIMS = Kentucky Inventory of Mindfulness Skills

Table 2
Means and Unstandardized Multiple Linear Regression Coefficients for Primary Study Variables

Variable	Mean (SD)	MAAS score*			KIMS Score*		
		B	SE	p	B	SE	p
WISDM-68 (n=158), scores							
Subscales:							
Affiliative Attachment	3.6 (1.8)	-.540	.156	.001	-.158	.039	<.001
Automaticity	4.6 (1.6)	-.373	.145	.011	-.117	.037	.002
Loss of Control	5.2 (1.5)	-.358	.132	.008	-.080	.034	.020
Behavioral Choice/Melioration	3.6 (1.5)	-.504	.129	<.001	-.156	.032	<.001
Cognitive Enhancement	3.9 (1.8)	-.501	.153	.001	-.128	.039	.001
Craving	5.2 (1.4)	-.350	.126	.006	-.082	.032	.012
Cue Exposure	4.9 (1.2)	-.573	.100	<.001	-.117	.027	<.001
Negative Reinforcement	4.6 (1.5)	-.476	.122	<.001	-.132	.031	<.001
Positive Reinforcement	4.1 (1.6)	-.465	.136	.001	-.138	.034	<.001
Social/Environmental Goals	3.8 (2.0)	-.192	.165	.247	-.085	.042	.044
Taste and Sensory Processes	4.4 (1.5)	-.380	.130	.004	-.131	.032	<.001
Tolerance	5.2 (1.4)	-.004	.130	.976	-.043	.033	.194
Weight Control	3.2 (1.7)	-.354	.143	.014	-.105	.036	.004
Total	56.4 (14.6)	-5.07	1.25	<.001	-1.473	.314	<.001
WISDM primary	5.0 (1.2)	-.271	.108	.013	-.081	.027	.004
WISDM secondary	4.0 (1.2)	-.443	.101	<.001	-.128	.025	<.001
Heaviness of Smoking Index (HSI)	3.4 (1.4)	-.042	.030	.165	-.108	.119	.366
WSWS (n=158), scores							
Subscales:							
Anger	1.9 (1.1)	-.524	.086	<.001	-.125	.022	<.001
Anxiety	2.1 (0.9)	-.499	.070	<.001	-.118	.018	<.001
Concentration Difficulty	1.6 (0.9)	-.485	.065	<.001	-.126	.017	<.001
Craving	2.7 (0.7)	-.150	.063	.018	-.033	.016	.044
Hunger	2.1 (0.7)	-.060	.058	.298	-.008	.015	.587
Sadness	1.6 (0.9)	-.467	.067	<.001	-.135	.016	<.001

Variable	MAAS score*			KIMS Score*		
	Mean (SD)	B	SE	p	B	SE
Sleep Problems	2.1 (1.0)	-.379	.087	<.001	-.078	.023
Total	2.0 (0.6)	-.366	.048	<.001	-.089	.012
Self-Efficacy/Confidence (n=116), scores						
Subscales:						
Positive Affect/Social Situations	2.5 (1.0)	.281	.098	.005	.030	.027
Negative Affect Situations	2.2 (0.9)	.246	.091	.008	.039	.025
Habitual/Craving Situations	2.6 (1.0)	.238	.097	.016	.063	.026
Total	2.4 (0.9)	.255	.087	.004	.044	.024
AIPQ (n=158), subscale scores						
Affect control by other means	4.2 (1.5)	.355	.106	.001	.144	.025
Affect control by smoking	4.4 (1.2)	-.342	.126	.007	-.081	.032

B=unstandardized beta weight; SE = Standard Error; p = significance level

* All Bs and SEs are adjusted for age, gender, educational attainment, race/ethnicity, marital status, and annual household income

WISDM-68 = Wisconsin Inventory of Smoking Dependence Motives; WSWs = Wisconsin Smoking Withdrawal Scale; AIPQ = Affective Information Processing Questionnaire; MAAS = Mindfulness Attention Awareness Scale; KIMS = Kentucky Inventory of Mindfulness Skills