Published in final edited form as:
Drug Alcohol Depend. 2010 June 1; 109(1-3): 90–95. doi:10.1016/j.drugalcdep.2009.12.020.

Single versus Recurrent Depression History: Differentiating risk-factors among current U.S. Smokers

David R. Strong[1], **Amy Cameron**[2], **Shelley Feuer**[1], **Amy Cohn**[3], **Ana M. Abrantes**[1], and **Richard A. Brown**[1]

[1] Butler Hospital, The Warren Alpert Medical School of Brown University, 345 Blackstone Blvd., Providence, RI, 02906 USA

[2] Department of Psychology, Clark University, 950 Main Street, Worcester, MA 01610 USA

[3] Center of Alcohol Studies, Rutgers, the State University of New Jersey, 607 Allison Road, Piscataway, New Jersey 08854 USA

Abstract

Introduction—The strong relationship between persistent tobacco use and Major Depressive Disorder (MDD) has motivated clinical trials of specialized treatments targeting smokers with a history of MDD. Meta-analyses suggest positive responses to specialized treatments have been observed consistently among smokers with history of recurrent rather than a single episode of MDD. Approximately 15% of current US smokers have a history of recurrent MDD. Little is known about the risk factors that contribute to persistent smoking and differentiate these at-risk smokers. US.

Methods—The National Comorbidity Survey – Replication (NCS-R) included a survey of 1560 smokers participants aged 18 and older in the United States. Lifetime history of MDD was categorized according to chronicity: No History (No MDD), single episode (MDD-S) and recurrent depression (MDD-R). The relationship between the chronicity of MDD, smoking characteristics, cessation history, nicotine dependence, comorbidity with psychiatric disorders, and current functional impairments were examined.

Results—MDD-R smokers reported fewer lifetime cessation efforts, smoked more cigarettes, had higher levels of nicotine dependence, had higher rates of co-morbid psychiatric disorders and greater functional impairment than smokers with No MDD. MDD-S smokers were not consistently distinguished from No MDD smokers on cessation attempts, level of daily smoking, nicotine dependence or functional impairment indices.

Conclusions—The study highlights the importance of chronicity when characterizing depression related risk of persistent smoking behavior. Although, clinical trials suggest MDD-R smokers specifically benefit from specialized behavioral treatments, these services are not widely available and more efforts are needed to engage MDD-R smokers in efficacious treatments. Abstract Word Count: 249

Keywords

Smoking; Depression; Recurrent Depression; Nicotine Dependence; Item

Corresponding Author: David R. Strong, PhD, Butler Hospital, The Warren Alpert Medical School of Brown University, 345 Blackstone Blvd., Providence, RI, 02906, phone:(401) 455-6294, fax:(401) 455-6424, david_strong@brown.edu.

1. Introduction

Despite the decreasing prevalence in cigarette smoking in the United States (Grant, et al., 2004), rates of smoking remain high among individuals with Major Depressive Disorder (MDD). Risk factors associated with a lifetime history of MDD such as increased nicotine dependence (Grant et al, 2004), higher levels of negative affect (Dalack, 1995; Ginsberg, 1995; Hall, 1994; Covey et al., 1999), higher levels of comorbid psychiatric disorders (Kessler, 2003), and higher incidence of psychosocial impairments (Cassano & Fava, 2002) are likely to interfere with efforts at cessation. The strong relationship between MDD and these risk factors has motivated clinical trials of specialized treatments for depression (Brown et al, 2001; Hall et al, 1994) to ameliorate risks for poor cessation outcomes among smokers with a history of MDD. These trials have yielded mixed results (Hitsman et al, 2003). However, follow-up analyses have supported consistent positive responses to specialized behavioral treatments among smokers with recurrent rather than single episodes of MDD (Brown et al., 2001; Haas et al., 2004). These findings motivate this research, as we were not aware of any studies that describe the relationship between MDD and cessation-related risk factors using a representative sample of current smokers characterized by their history of single episode or recurrent MDD.

The possibility that associations between MDD history and smoking may be largely accounted for by chronic and recurrent MDD (MDD-R) emerges in part from depression research documenting the etiological heterogeneity (Winokur, 1997) of single episodes of MDD and concentration of recurrent MDD at the highest levels of a continuum of depression severity (Kessler, 1997; Judd, 1997). Relative to single episode MDD (MDD-S), MDD-R has been associated with increased rates of comorbidity (e.g., anxiety and substance use disorders), higher incidence of functional impairments (Klein, 2008; Mondimore et al., 2006) and weakened response to depression treatment and other health interventions (Hamilton & Dobson, 2002; Kocsis, 2003; Thase et al., 1994). Among smokers, a limited amount of information about the prevalence of risk factors for poor cessation among recurrent MDD smokers can be gleaned from clinical trials. While few smoking cessation trials specifically report outcomes for smokers with past MDD-R, studies that do allow extrapolation suggest cessation-related risk factors such as increased negative affect and more severe withdrawal may be attributable to those with past MDD-R rather than past MDD-S (Brown et al., 2001; Covey, 1997; Haas et al., 2004, Kahler et al., 2002). While these results suggest reasons for the differential benefit MDD-R smokers receive from specialized depression treatments, these studies do not inform efforts to identify risk factors that may facilitate persistent smoking or risk for poor outcomes in standard cessation treatment among current populations of smokers.

Currently, examinations of risk for poor smoking outcomes associated with MDD-R have been limited to treatment seeking smokers enrolled in clinical trials where a large number of smokers with psychiatric risk factors are excluded. The degree to which these risk factors are distributed disproportionately among smokers with MDD-R in the general population is unknown. We expect that current smokers with a history of MDD-R relative to smokers with MDD-S or No MDD will be characterized by higher levels of smoking, fewer quit attempts, higher levels of nicotine dependence and the concentration of factors such as comorbid psychiatric disorders and greater functional impairment. Further, we expect that self-reports of higher nicotine dependence will be associated specifically with a history of MDD-R and not to depression-related negative bias (Dierker, et al., 2008) or comorbidity with other psychiatric disorders. Given the expectation for higher rates of comorbidity with psychiatric disorders associated with increased functional impairment and difficulty quitting smoking (e.g., anxiety, substance use disorders; Dierker, et al., 2008; Glassman, 1993), we also expect that MDD-R smokers will have greater functional impairment after taking into account comorbidity histories.

2. Method

2.1. Sample

A full description of the field procedures for the nationally representative face-to-face household survey conducted by the NCS-R can be found in Kessler et al., 2004. The current study draws from the 5,692 respondents who completed both Part I and the smoking-specific questions from Part II of the survey (Kessler et al., 2004). Participants who endorsed being current smoker were included if they reported at least 1 day of smoking in the past year, and had smoked at least 1 cigarette on that day in the past year (n = 1560).

2.2 Measures

2.2.a. NCS-R Sociodemographics and Smoking characteristics—Table 1 shows the sociodemographic and smoking characteristics for this population of current smokers.

2.2.b. DSM-IV symptoms of Nicotine Dependence—Responses to nicotine dependence-related questions were recoded to correspond with symptoms that are considered for a diagnosis of nicotine dependence in the DSM IV-TR (http://www.hcp.med.harvard.edu/ncs/diagnosis.php). The NCS-R uses skip-outs after a person has met diagnosis for nicotine dependence after the first three questions in this section (n = 345 current smokers). Overall, of the 1,560 current smokers included in this study 22.1% (n = 344) met the full NCS-R criteria for nicotine dependence, and 77.9% (n = 1216) did not.

2.2.c. History of Major Depressive Disorder—Depression history was recoded into no depression history (No MDD) or a single major depressive episode (MDD-S), based on an NCS-R diagnosis of lifetime history of depression. If the participant had multiple lifetime episodes or 2 or more separate years with a major depressive episode, they were categorized as recurrent major depression (MDD-R). Of the 1560 current smokers, 12 did not provide information on depressive disorder and were not included in the final analyses of 1548 smokers. Of these respondents, 1,083 in the No-MDD category were current smokers; along with 128 in the MDD-S and 337 in the MDD-R categories.

2.2.d History of anxiety and substance use disorders—We adopted the diagnostic algorithms described in the NCS-R documentation to identify current smokers meeting DSM-IV criteria for comorbid anxiety and substance use disorder. A history of an anxiety disorder was present if current smokers reported a lifetime history of agoraphobia, generalized anxiety disorder, panic disorder, post-traumatic stress disorder, or social phobia. Substance use disorder was coded as present if smokers ever met full DSM-IV criteria for alcohol abuse, alcohol dependence, drug abuse, or drug dependence.

2.2.e Impairment in Functioning—The NCS-R interview inquired about recent impairment in functioning using a primary question that asked “How many days in the past 30 were you limited at all in carrying out your normal daily activities because of problems with your physical health, mental health, or substance use?” Answers were provided continuously and ranged from 0 to 30.

2.3. Data analyses

2.3.1. Establishing a continuous index for Nicotine Dependence (ND)—To construct our primary dependent variable, a continuous score was generated to reflect ND severity. Several studies support the validity of a unidimensional continuous index of ND (Muthen & Asporov, 2003; Strong et al., 2007; 2009). With skip-out rules a simple sum of symptoms was not possible and we used an item response model to generate our continuous index of ND. With planned missing data among sets of symptom questions, responses within

sets of questions shared a methodological relationship. This relationship can be accommodated statistically, by adding a random effect to a standard unidimensional item response model that is common to the group of questions or 'testlets' (Thissen, 1993; Wainer, Bradlow, & Wang 2007; Wainer, 2007). The testlet model (SCORIGHT; Wang, et al., 2005) we employed uses Bayesian methods (Gelman, et al., 1995) for obtaining estimates of statistical parameters that reflect the level of ND for each respondent (*mean* = 0; *SD* = 1) along with parameters describing the relative level of ND and discriminative power associated with each DSM-IV symptom (a = discrimination; b = ND severity). The focus of the SCORIGHT method is on obtaining samples from the posterior distribution of each of the model parameters using two separate Markov chains (Markov chain Monte Carlo: MCMC). To generate evidence for convergence of the Gibbs sampler before drawing inferences, we allowed 100,000 iterations (Sinharay, 2004) and compared resulting outputs using the F-test convergence criterion of less than 1.2 to indicate reasonable convergence (Gelman & Rubin, 1992).

2.3.1.a. Evaluating depression-related bias in self-reports of Nicotine Dependence: One advantage of MCMC methods is the ability to obtain separate samples of symptom parameters from groups of smokers with No MDD, MDD-S, and MDD-R smokers who have been equated for their level of ND (Wang, Bradlow, Wainer, & Muller, 2008). This approach allows direct comparisons of depression-related bias in each symptom of ND and uses a series of models in which the discrimination and severity of each symptom is evaluated separately for each group of smokers using the remaining 6 symptoms as the anchor (c.f. Thissen, Steinberg, & Wainer, 1988). We established a priori that the magnitude of bias in the severity of symptoms must exceed 0.25 (a small effect) before we attributed clinically significant differences in symptom performance (Steinberg and Thissen, 2000). Differences in discrimination were evaluated using a visual inspection of item response curves to determine the potential impact on observed levels of ND.

2.3.2. Relationship between MDD history, Nicotine Dependence (ND), and impairment in functioning—Linear regressions were used to estimate the association between a lifetime history of depression (MDD-R, MDD-S, No MDD) and the continuous index of ND with sequential control for a) sociodemograhic factors (age, gender, race, household income) and b) current quantity of smoking. After entering sets of control variables (a, b), the relationship between depression history and ND was captured in two dummy codes comparing No MDD to MDD-S and No MDD to MDD-R. A final multivariable model included the sets of covariates along with dummy codes for MDD, ANX, and SUD. Two-way interactions were included as a block after all other terms to test whether the relationship between ND and each of the covariates was similar for those with different histories of MDD. We conducted the same series of models to evaluate impairment in functioning in the last 30 days. For the analyses of recent impairment in functioning, we attempted to control for the acute effects of current psychiatric disorders by excluding smokers who met criteria for a current MDD (n=92), current ANX (n=268) or current SUD (n=68) in the past 30 days. Regression models were fit using the appropriate sample weights to accommodate the complex survey design using the 'survey' package (Lumley, 2004) developed for R data analysis software (R Development Core Team, 2008).

3. Results

3.1.a Sample characteristics

Among smokers, weighted prevalence of depression history subgroups was 15.2 % (SE = 0.01), 5.6% (SE = 0.01), and 79.1% (SE = 0.01) for current smokers with MDD-R, MDD-S, and No MDD histories, respectively. Relative to smokers with no history of MDD, there were similar numbers of women in the MDD-S group ($\beta = 0.06$, $SE = 0.12$, $t = 0.50$, $p < 0.62$) and there

were significantly more women in the MDD-R group ($\beta = 0.63$, $SE = 0.16$, $t = 4.05$, $p < 0.001$). There was an unequal racial distribution across MDD groups (Rao and Scott adjusted χ^2: $F = 2.31$, $ndf = 5.61$, $p < 0.03$). Relative to smokers with No MDD, smokers with MDD-S were slightly older ($\beta = 0.17$, $SE = 0.08$, $t = 2.170$, $p < 0.03$). Level of household income did not differ across MDD history groups.

3.1.b. Smoking characteristics

When compared to No MDD, smokers with MDD-R had higher average cigarettes each day ($\beta = 2.77$, $SE = 0.80$, $p < 0.001$). Average cigarettes each day were not significantly different for MDD-S and No MDD smokers ($\beta = 1.17$, $SE = 1.06$, $p < 0.27$). When compared to No MDD, both MDD-S and MDD-R smokers reported experiencing their first symptoms of Nicotine Dependence at a similar age and reported a similar number of years smoking ($p's > .10$). Using generalized linear poisson models, MDD-S smokers reported a similar number of quit attempts to smokers with No MDD ($\beta = -0.38$, $SE = 0.38$, $p < 0.31$) and MDD-R smokers reported fewer lifetime attempts to quit smoking ($\beta = -0.69$, $SE = 0.33$, $p < 0.04$). Smokers with MDD-S ($\beta = -0.20$, $SE = 0.30$ $p < 0.52$) and MDD-R ($\beta = 0.03$, $SE = 0.29$, $p < 0.92$) did not differ in the number of quit attempts that lasted 3 months or more. In logistic regression, among those who attempted to quit, MDD-S ($\beta = 0.17$, $SE = 0.23$, $p < 0.46$) and MDD-R ($\beta = 0.31$, $SE = 0.16$, $p < 0.06$) smokers did not differ in the likelihood of using smoking cessation aids.

3.1.c. Psychiatric comorbidity

Rates of comorbid anxiety disorders were 60.4% ($SE = 0.03$), 41.8% ($SE = 0.05$), and 24.5% ($SE = 0.01$) for smokers with MDD-R, MDD-S, and no MDD history, respectively. Smokers with a history of MDD-R or MDD-S had significantly higher odds of reporting a history of an anxiety disorder even after adjusting for sociodemographic covariates, with adjusted odds ratios of 4.22 (95CI = 3.01 – 5.91, $p < 0.001$) and 2.11 (95CI = 1.29 – 3.45, $p < 0.002$), respectively. Rates of comorbid substance use disorders were 40.1% ($SE = 0.03$), 37.0% ($SE = 0.05$), and 28.1% ($SE = 0.02$) for smokers with MDD-R, MDD-S, and no MDD history respectively. MDD-R and MDD-S smokers had significantly higher rates of SUD than smokers with no MDD history and the adjusted odds ratios were 2.04 (95CI = 1.43 – 2.89, $p < 0.001$) and 1.73 (95CI = 1.01 – 2.97, $p < 0.05$), respectively.

3.1.d. Establishing a Continuous index for Nicotine Dependence

Evaluation of convergence estimates supported SCORIGHT model results for ND parameters with estimates ranging from 1.0 – 1.05. The mean level of ND was 0.45 ($SD = 0.38$) and −0.24 ($SD = 0.73$) for respondents with and without a DSM-IV diagnosis of ND. The observed differences in means (sample mean = 0, $SD = 1$) and difference in the variability (i.e. SD) of continuous scores of ND among respondents with and without a diagnosis of DSM-IV ND suggested a potential advantage of a continuous rather than categorical diagnostic indicator of ND. The correlation of smoking rate and level of ND was significant statistically and reflected a small and significant relationship ($r = 0.19$, $p < 0.001$).

3.1.d.1. Evaluating depression-related bias in self-reports of Nicotine Dependence—

We compared samples of severity and discrimination parameters for each subgroup of MDD-R and MDD-S and No MDD smokers. To compare parameters, we repeatedly computed the difference of 10,000 independent random draws from posterior distributions obtained for each subsample and then counted the frequency of differences > 0 (Wang, Bradlow, Wainer, & Muller, 2008). Three items evidenced differences > 0 in symptom parameters across >95% of comparisons. Smokers with a history of MDD-R on average had lower severity estimates than other smokers for both Tolerance ($b_{MDD\text{-}R} = -1.57$; $SE = 0.42$; $b_{No\text{-}MDD} = -0.84$; $SE = 0.13$; $d = 0.73$) and Withdrawal ($b_{MDD\text{-}R} = -0.67$; $SE = 0.12$;

$b_{No\text{-}MDD} = -0.40$; $SE = 0.06$; $d = 0.27$) symptoms suggesting increased likelihood of reporting these symptoms at lower levels of nicotine dependence. Time spent smoking also was found to be less discriminating among smokers with MDD-R than among other smokers. When compared to No MDD (a=1.04, SE =0.20), the symptom appeared to become less discriminating across MDD-S (a=0.82, SE=0.34) smokers and was consistently less discriminating among MDD-R smokers (a=0.51, SE=0.19).

3.1.d.2. Relationship between single and recurrent MDD history and Levels of Nicotine Dependence—A series of linear regressions was used to first estimate the association between level of ND first with a block (a) of sociodemographic indices (age, gender, race, household income) and then with (b) the current quantity of smoking after controlling for sociodemographic indices (see Table 2). After controlling for levels of smoking, Hispanic smokers had lower levels of ND than White smokers ($d = 0.64$, $p < 0.001$) and women reported slightly higher levels of ND than men ($d = .15$; $p < 0.03$). Among smokers with MDD-R and MDD-S and No MDD smokers, respectively, the mean levels of ND were 0.14 ($SD = 0.65$), −0.01 ($SD = 0.70$), −0.17 ($SD = 0.73$). The adjusted univariate associations suggested smokers with lifetime MDD-R had significantly higher levels of ND than smokers with No MDD ($d = 0.33$, $p < .001$). Levels of ND were not significantly higher for smokers with MDD-S ($d = 0.16$; $p > 0.11$). Both a lifetime history of ANX ($d = 0.52$; $p < 0.001$) and a history of SUD ($d = 0.30$; $p < 0.001$) were related to higher levels of ND. In the multivariable model that controlled for sociodemographic and smoking levels, MDD-R ($p < 0.05$), ANX ($p < 0.001$), and SUD ($p < .05$) each were uniquely related to higher levels of ND. We evaluated all two-way interactions of psychiatric disorders with sociodemographic and smoking levels. Results suggested that the relationship between MDD-R and ND was not significantly different across sociodemographic groups and was not significantly different among men and women ($\beta = -0.06$, $SE = 0.10$, $p < 0.54$). We did observe that the relationship between ANX and ND was stronger among men then women. After removing all non-significant interactions, the effect remained significant statistically ($\beta = -0.20$, $SE = 0.08$, $p < 0.03$) although the magnitude of this effect was small ($d = 0.14$).

3.1.e. Relationship between single and recurrent MDD history and functional impairment

Prior to regression analysis of group differences, we applied a log transformation of the reported days of impairment (range = 0–30; median = 0; skew = 2.9) given the beneficial effect on normalizing residuals from the models. We mirrored the above procedures in modeling the relationships with the level of reported functional impairment in the past 30 days (see Table 2). In univariate analyses controlling for sociodemographic variables and smoking level, MDD-R ($d = 0.38$; $p < 0.001$), ANX ($d = 0.36$; $p < 0.001$), and SUD ($d = 0.23$; $p < 0.002$) were each related to higher levels of impairment in the past month. MDD-S was not related to levels of impairment ($d = 0.04$; $p > 0.84$). In multivariable models that controlled for comorbidity with other disorders, MDD-R ($d = 0.27$; $p < 0.05$), ANX ($d = 0.29$; $p < 0.001$), and SUD ($d = 0.18$; $p < 0.05$) each had unique and additive associations with increasing levels of impairment in the past 30 days.

4. Discussion

Using a representative sample of current smokers in the United States, the current study supported the hypothesis that depression related risk for higher levels of smoking, higher levels of ND and the concentration of factors such as comorbid psychiatric disorders and greater functional impairment that may lead to poor cessation outcomes may be found primarily among MDD-R smokers. Smokers with MDD-S did not differ from No MDD smokers on smoking characteristics, levels of ND, or levels of functional impairment. Careful examination of differential symptom functioning suggested that observed differences in overall levels of ND

are not likely to arise from depression-related biases in responding to the symptom questions (Dierker and Donny, 2008). Although rates of comorbidity with psychiatric disorders that also convey risk for poor cessation outcomes were substantial, analyses suggested that a history of MDD-R continued to convey significant risk for higher ND and higher functional impairment that was independent of comorbid disorders. Given the disproportionately high rates of smoking, evidence supporting a concentration of cessation-related risk factors, and evidence for differential efficacy of specialized treatments, research efforts are needed to better identify and deliver targeted interventions to increase quit attempts and facilitate access to specialized cessation programs for smokers with MDD-R.

Although MDD-R smokers evidence higher levels of ND and reported fewer lifetime attempts to quit smoking than other smokers, these smokers did not appear to have a more chronic smoking history. The onset of nicotine dependence symptoms and number of years smoking did not differ significantly across depression history groups. Depression history was not related to the effectiveness of quitting given similar reports of quit attempts that were sustained for three months or more and a similar rate of using smoking cessation aids during quit attempts. A recent US survey reported that while middle-aged and older adulthood is developmentally the period associated with the majority of quit attempts, depressive disorders were related to persistent smoking during this period (Agrawal et al, 2008). Thus it may not be the chronicity of smoking or decreased capacity for quitting alone, but the chronic and recurrent features of depressive disorders that reduce the likelihood of initiating attempts and increase probability of relapse.

MDD-R smokers were characterized by more frequent days of impairment in functioning as a result of their physical health, mental health, or substance use. There is a strong link between day-to-day functioning (Manning, et al., 2005), stress (Kassel et al., 2003) and increased smoking (Shiffman et al., 2008). These effects may be particularly strong among those with a history of MDD-R who may be prone to experience more frequent stressful events (Hammen, 1991) and after stressful events, suffer greater decreases in self-efficacy and greater increases negative affect than individuals without a history of depressive disorder (Maciejewski, et al., 2000). The expected higher frequency of stressors associated with increased incidence of functional impairment among MDD-R smokers may sustain smoking in this population by both decreasing confidence in the ability to quit successfully and convey risk for relapse after quit attempts.

We did not observe a difference in the strength of association between the MDD history and levels of nicotine dependence among men and women. Previous studies have documented gender differences in the strength of relationships between MDD and smoking (Grant et al, 2004; Husky et al, 2008). However, each study included different classifications of smokers with regard to both MDD and smoking status when examining the relationship between MDD and nicotine dependence. A combination of decreasing gender-related effects within the range of nicotine dependence examined in the current study and our reduced sample size relative to previous studies may have left the current study underpowered to detect gender differences among current smokers.

There are limitations to the data presented. First, while the NCS-R data allowed us to evaluate smoking characteristics, quitting histories, and functional impairment in a representative sample from the United States, these data do not allow for sequencing of events over time and data are subject to bias inherent in retrospective self-reports. Given the potential for depression-related recall bias, these smokers may also under identify smoking-related events. Although research on this phenomenon is limited, available longitudinal work among young adults (Stanton et al, 2007) suggested that biased recall may increase with severity of depression, and thus respondents in the current survey classified as MDD-R may be more likely to be

underreport their smoking history. Second, the NCS-R survey by design did not require all smokers respond to all of the ND criteria questions and we imputed continuous scores using methods based in IRT.

In summary, results from a nationally representative sample of current smokers extend previous investigations by clarifying risk factors for persistent smoking associated with a history of chronic rather than single episodes of major depressive disorder. Although clinical trials have suggested differential benefit of cessation treatments for smokers with MDD-R that include mood management along with behavioral or pharmacological treatments for nicotine dependence (Brown et al, 2001; Haas et al. 2004), this study uniquely examined differential prevalence of risk factors that may impede cessation efforts among current smokers with MDD-R. Future research is needed to better identify opportunities to engage this population of smokers in specialized cessation treatments targeting this high-risk population that are cost-effective and easily disseminated.

References

Agrawal A, Lynskey MT. Tobacco and cannabis co-occurrence: Does route of administration matter? Drug Alcohol Depend 2009;99(1–3):240–247. [PubMed: 18926646]

Andrade L, Caraveo-Anduaga JJ, Berglund P, Bijl RV, De Graaf R, Vollebergh W, Dragomirecka E, Kohn R, Keller M, Kessler RC, Kawakami N, Kilic C, Offord D, Ustun TB, Wittchen HU. The epidemiology of major depressive episodes: Results from the international consortium of psychiatric epidemiology (ICPE) surveys. Int J Methods Psychiatr Res 2003;12(1):3–21. [PubMed: 12830306]

Breslau N, Johnson EO. Predicting smoking cessation and major depression in nicotine-dependent smokers. Am J Public Health 2000;90(7):1122–1127. [PubMed: 10897192]

Breslau N, Kilbey MM, Andreski P. Nicotine withdrawal symptoms and psychiatric disorders: Findings from an epidemiologic study of young adults. Am J Psychiatry 1992;149(4):464–469. [PubMed: 1554030]

Brown RA, Kahler CW, Niaura R, Abrams DB, Sales SD, Ramsey SE, Goldstein MG, Burgess ES, Miller IW. Cognitive-behavioral treatment for depression in smoking cessation. J Consult Clin Psychol 2001;69(3):471–480. [PubMed: 11495176]

Brown RA, Lewinsohn PM, Seeley JR, Wagner EF. Cigarette smoking, major depression, and other psychiatric disorders among adolescents. J Am Acad Child Adolesc Psychiatry 1996;35(12):1602–1610. [PubMed: 8973066]

Brown RA, Niaura R, Lloyd-Richardson EE, Strong DR, Kahler CW, Abrantes AM, Abrams D, Miller IW. Bupropion and cognitive-behavioral treatment for depression in smoking cessation. Nicotine Tob Res 2007;9(7):721–730. [PubMed: 17577801]

Cassano P, Fava M. Depression and public health: An overview. J Psychosom Res 2002;53(4):849–857. [PubMed: 12377293]

Choi WS, Patten CA, Gillin JC, Kaplan RM, Pierce JP. Cigarette smoking predicts development of depressive symptoms among u.S. Adolescents. Ann Behav Med 1997;19(1):42–50. [PubMed: 9603677]

Covey LS. Tobacco cessation among patients with depression. Prim Care 1999;26(3):691–706. [PubMed: 10436294]

Covey LS, Glassman AH, Stetner F. Depression and depressive symptoms in smoking cessation. Compr Psychiatry 1990;31(4):350–354. [PubMed: 2387147]

Covey LS, Glassman AH, Stetner F. Major depression following smoking cessation. Am J Psychiatry 1997;154(2):263–265. [PubMed: 9016279]

Dalack GW, Glassman AH, Rivelli S, Covey L, Stetner F. Mood, major depression, and fluoxetine response in cigarette smokers. Am J Psychiatry 1995;152(3):398–403. [PubMed: 7864266]

Dierker L, Donny E. The role of psychiatric disorders in the relationship between cigarette smoking and DSM-IV nicotine dependence among young adults. Nicotine Tob Res 2008;10(3):439–446. [PubMed: 18324562]

Dierker L, He J, Kalaydjian A, Swendsen J, Degenhardt L, Glantz M, Conway K, Anthony J, Chiu WT, Sampson NA, Kessler R, Merikangas K. The importance of timing of transitions for risk of regular smoking and nicotine dependence. Ann Behav Med 2008;36(1):87–92. [PubMed: 18704617]

Gelman A, Rubin DB. Inference from iterative simulation using multiple sequences. Statistical Science 1992;7(4):457–472.

Gelman, A.; Carlin, J.; Stern, H.; Rubin, D. Bayesian Data Analysis. 1995.

Gilbert DG, McClernon FJ, Rabinovich NE, Plath LC, Masson CL, Anderson AE, Sly KF. Mood disturbance fails to resolve across 31 days of cigarette abstinence in women. J Consult Clin Psychol 2002;70(1):142–152. [PubMed: 11860040]

Ginsberg D, Hall SM, Reus VI, Muñoz RF. Mood and depression diagnosis in smoking cessation. Experimental and Clinical Psychopharmacology 1995;3(4):389–395.

Ginsberg JP, Klesges RC, Johnson KC, Eck LH, Meyers AW, Winders SA. The relationship between a history of depression and adherence to a multicomponent smoking-cessation program. Addict Behav 1997;22(6):783–787. [PubMed: 9426796]

Glassman AH. Cigarette smoking: Implications for psychiatric illness. Am J Psychiatry 1993;150(4): 546–553. [PubMed: 8465868]

Glassman AH, Helzer JE, Covey LS, Cottler LB, Stetner F, Tipp JE, Johnson J. Smoking, smoking cessation, and major depression. JAMA 1990;264(12):1546–1549. [PubMed: 2395194]

Glassman AH, Stetner F, Walsh BT, Raizman PS, Fleiss JL, Cooper TB, Covey LS. Heavy smokers, smoking cessation, and clonidine. Results of a double-blind, randomized trial. JAMA 1988;259(19): 2863–2866. [PubMed: 3367452]

Goodman E, Capitman J. Depressive symptoms and cigarette smoking among teens. Pediatrics 2000;106 (4):748–755. [PubMed: 11015518]

Grant BF, Hasin DS, Chou SP, Stinson FS, Dawson DA. Nicotine dependence and psychiatric disorders in the United States: Results from the national epidemiologic survey on alcohol and related conditions. Arch Gen Psychiatry 2004;61(11):1107–1115. [PubMed: 15520358]

Gritz E. Smoking Cessation and Gender: The Influence of Physiological, Psychological, and Behavioral Factors. JAMWA 51:35–42.

Haas AL, Munoz RF, Humfleet GL, Reus VI, Hall SM. Influences of mood, depression history, and treatment modality on outcomes in smoking cessation. J Consult Clin Psychol 2004;72(4):563–570. [PubMed: 15301640]

Hall SM, Munoz RF, Reus VI. Cognitive-behavioral intervention increases abstinence rates for depressive-history smokers. J Consult Clin Psychol 1994;62(1):141–146. [PubMed: 8034816]

Hamilton KE, Dobson KS. Cognitive therapy of depression: Pretreatment patient predictors of outcome. Clin Psychol Rev 2002;22(6):875–893. [PubMed: 12214329]

Hammen C. Generation of stress in the course of unipolar depression. Journal of Abnormal Psychology 1991;100:555–561. [PubMed: 1757669]

Hitsman B, Borrelli B, McChargue DE, Spring B, Niaura R. History of depression and smoking cessation outcome: A meta-analysis. J Consult Clin Psychol 2003;71(4):657–663. [PubMed: 12924670]

Hughes JR. Pharmacotherapy for smoking cessation: Unvalidated assumptions, anomalies, and suggestions for future research. Journal of Consulting and Clinical Psychology 1993;61:751–760. [PubMed: 8245273]

Hughes JR. Comorbidity and smoking. Nicotine and Tobacco Research 1999;1:S149–S152. [PubMed: 11768173]

Husky MM, Mazure CM, Paliwal P, McKee SA. Gender differences in the comorbidity of smoking behavior and major depression. Drug and Alcohol Dependence 2008;93:176–179. [PubMed: 17850991]

Judd LL. The clinical course of unipolar major depressive disorders. Arch Gen Psychiatry 1997;54(11): 989–991. [PubMed: 9366654]

Kahler CW, Brown RA, Ramsey SE, Niaura R, Abrams DB, Goldstein MG, Mueller TI, Miller IW. Negative mood, depressive symptoms, and major depression after smoking cessation treatment in smokers with a history of major depressive disorder. J Abnorm Psychol 2002;111(4):670–675. [PubMed: 12428781]

Kandel DB, Chen K. Extent of smoking and nicotine dependence in the United States: 1991–1993. Nicotine & Tobacco Research 2000;2:263–274. [PubMed: 11082827]

Kahler CW, Brown RA, Strong DR, Lloyd-Richardson EE, Niaura R. History of major depressive disorder among smokers in cessation treatment: Associations with dysfunctional attitudes and coping. Addict Behav 2003;28(6):1033–1047. [PubMed: 12834649]

Kassel JD, Stroud LR, Paronis CA. Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking. Psychol Bull 2003;129(2):270–304. [PubMed: 12696841]

Kendler KS, Gardner CO. Boundaries of major depression: An evaluation of DSM-IV. American Journal of Psychiatry 1998;155:172–177. [PubMed: 9464194]

Kessler RC, Merikangas KR. The national comorbidity survey replication (NCS-R): Background and aims. Int J Methods Psychiatr Res 2004;13(2):60–68. [PubMed: 15297904]

Kessler RC, Berglund P, Chiu WT, Demler O, Heeringa S, Hiripi E, Jin R, Pennell BP, Walters EE, Zaslavsky A, Zheng H. The US National Comorbidity Survey Replication (NCS-R): Design and field procedures. The International Journal of Methods in Psychiatric Research 2004;13(2):69–92.

Kessler RC, Berglund P, Demler O, Jin R, Koretz D, Merikangas KR, Rush AJ, Walters EE, Wang PS. The epidemiology of major depressive disorder: Results from the national comorbidity survey replication (NCS-R). JAMA 2003;289(23):3095–3105. [PubMed: 12813115]

Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, Eshleman S, Wittchen HU, Kendler KS. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: Results from the National Comorbidity Survey. Archives of General Psychiatry 1994;51(1):8–19. [PubMed: 8279933]

Klein DN. Classification of depressive disorders in the dsm-v: Proposal for a two-dimension system. J Abnorm Psychol 2008;117(3):552–560. [PubMed: 18729608]

Kocsis JH, Rush AJ, Markowitz JC, Borian FE, Dunner DL, Koran LM, Klein DN, Trivedi MH, Arnow B, Keitner G, Kornstein SG, Keller MB. Continuation treatment of chronic depression: A comparison of nefazodone, cognitive behavioral analysis system of psychotherapy, and their combination. Psychopharmacol Bull 2003;37(4):73–87. [PubMed: 15131518]

Lumley T. Analysis of Complex Survey Samples. Journal of Statistical Software 2004;9(8):1 – 19.

Melartin T, Rytsälä H, Leskelä U, Lestelä-Mielonen P, Sokero TP, Isometsä E. Severity and Comorbidity Predict Episode Duration and Recurrence of DSM-IV Major Depressive Disorder. Journal of Clinical Psychiatry 2004;65(6):810–819. [PubMed: 15291658]

Mondimore FM, Zandi PP, MacKinnon DF, McInnis MG, Miller EB, Schweizer B, Crowe RP, Scheftner WA, Weissman MM, Levinson DF, DePaulo JR Jr, Potash JB. A comparison of the familiality of chronic depression in recurrent early-onset depression pedigrees using different definitions of chronicity. J Affect Disord 2007;100(1–3):171–177. [PubMed: 17126912]

Munoz RF, Marin BV, Posner SF, Perez-Stable EJ. Mood management mail intervention increases abstinence rates for spanish-speaking latino smokers. Am J Community Psychol 1997;25(3):325–343. [PubMed: 9332966]

Muthen B, Asparouhov T. Item response mixture modeling: Application to tobacco dependence criteria. Addict Behav 2006;31(6):1050–1066. [PubMed: 16675147]

Niaura R, Abrams DB, Shadel WG, Rohsenow DJ, Monti PM, Sirota AD. Cue exposure treatment for smoking relapse prevention: A controlled clinical trial. Addiction 1999;94(5):685–695. [PubMed: 10563033]

Patz RJ, Junker BW. A straightforward approach to markov chain monte carlo methods for item response models. Journal of Educational and Behavioral Statistics 1999;24(2):146–178.

Perkins KA, Scott J. Sex differences in long-term smoking cessation rates due to nicotine patch. Nicotine and Tobacco Research 2008;10:1245–1250. [PubMed: 18629735]

Pomerleau OF, Pomerleau CS, Snedecor SM, Gaulrapp S, Brouwer RN, Cameron OG. Depression, smoking abstinence and hpa function in women smokers. Hum Psychopharmacol 2004;19(7):467–476. [PubMed: 15378674]

R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing; Vienna, Austria: 2008. URL http://www.R-project.org. (date accessed)

Shiffman S, Hickcox M, Paty J, Gnys M, Kassel J, Richards. Progression from a smoking lapse to relapse: Prediction from abstinence violation effects, nicotine dependence, and lapse characteristics. J Consul Clin Psychol 1996;64(5):993–1002.

Sinharay S. Experiences with MCMC convergence assessment in two psychometric examples. Journal of Educational and Behavioral Statistics 2004;29(4):461–488.

Solomon DA, Keller MB, Leon AC, Mueller TI, Lavori PW, Shea MT, Coryell W, Warshaw M, Turvey C, Maser JD, Endicott J. Multiple recurrences of major depressive disorder. Am J Psychiatry 2000;157(2):229–233. [PubMed: 10671391]

Stanton CA, Papandonatos G, Lloyd-Richardson E, Niaura R. Consistency of self-reported smoking over a 6-year interval from adolescence to young adulthood. Addiction 2007;102:1831–1839. [PubMed: 17784897]

Strong DR, Kahler CW, Abrantes AM, MacPherson L, Myers MG, Ramsey SE, Brown RA. Nicotine dependence symptoms among adolescents with psychiatric disorders: Using a Rasch model to evaluate symptom expression across time. Nicotine Tob Res 2007;9(5):557–569. [PubMed: 17454712]

Strong DR, Kahler CW, Colby SM, Griesler PC, Kandel D. Linking measures of adolescent nicotine dependence to a common latent continuum. Drug Alcohol Depend 2009;99(1–3):296–308. [PubMed: 18938047]

Thase ME, Reynolds CF 3rd, Frank E, Simons AD, McGeary J, Fasiczka AL, Garamoni GG, Jennings JR, Kupfer DJ. Do depressed men and women respond similarly to cognitive behavior therapy? Am J Psychiatry 1994;151(4):500–505. [PubMed: 8147447]

Thissen, D. Repealing rules that no longer apply to psychological measurement. In: Frederiksen, N.; Mislevy, RJ.; Bejar, I., editors. Test theory for a new generation of test. Hillsdale, NJ: Erlbaum; 1993. p. 79-97.

Tsoh JY, Humfleet GL, Munoz RF, Reus VI, Hartz DT, Hall SM. Development of major depression after treatment for smoking cessation. Am J Psychiatry 2000;157(3):368–374. [PubMed: 10698811]

U.S. Dept. of Health and Human Services. Women and Smoking: A Report of the Surgeon General - 2001. Office of the Surgeon General. Centers for Disease Control and Prevention (U.S.) National Center for Chronic Disease Prevention and Health Promotion. Office on Smoking and Health; Rockville, MD : U.S: 2001.

U.S. Dept. of Health and Human Services. Smoking and Tobacco Control Monograph No. 15. Bethesda, MD: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute; 2002. Those Who Continue to Smoke: Is Achieving Abstinence Harder and Do We Need to Change Our Interventions?.

Wainer, H.; Bradlow, ET.; Du, Z. Testlet response theory: An analog for the 3-PL useful in adaptive testing. In: van der Linden, WJ.; Glas, CAW., editors. Computerized adaptive testing: Theory and practice. Boston, MA: Kluwer-Nijho; 2000. p. 245-270.

Wang, X.; Bradlow, ET.; Wainer, H. User s guide for SCORIGHT (Version 3.0): A computer program for scoring tests built of testlets including a module for covariate analysis (Research Report 04–49). Princeton, NJ: Educational Testing Services; 2005.

Wang X, Bradlow ET, Wainer H, Muller ES. A Bayesian method for studying DIF: A cautionary tale filled with surprises and delights. Journal of Educational and Behavioral Statistics 2008;33:363–384.

Windle M, Windle RC. Depressive symptoms and cigarette smoking among middle adolescents: Prospective associations and intrapersonal and interpersonal influences. J Consult Clin Psychol 2001;69(2):215–226. [PubMed: 11393599]

Winokur G. All roads lead to depression: Clinically homogeneous, etiologically heterogeneous. J Affect Disord 1997;45(1–2):97–108. [PubMed: 9268779]

Wu LT, Anthony JC. Tobacco smoking and depressed mood in late childhood and early adolescence. Am J Public Health 1999;89(12):1837–1840. [PubMed: 10589312]

Table 1

Comparison of smokers with a history of depression to smokers with no history of depression (n=1548).

	No MDD (n=1083)		MDD-S (n=128)		MDD-R (n=337)	
	Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***
Demographics:						
Race						
White	73.47%		76.06%		76.76%	
Black	10.76%		10.95%		7.84%	
Hispanic	11.68%		7.38%		7.44%	
Other	4.1%		5.61%		7.96%	
Female	47.0%		53.39%		62.56%*	
Age	41.14	15.96	49.31*	13.86	38.77	12.83
Household Income	49985.73	43056.31	59464.77	53887.24	44943.92	40096.36
Smoking Characteristics:						
Average cigarettes each day	15.79	11.99	16.96	10.12	18.57**	11.46
Age of first TBD symptoms	27.55	13.25	27.94	10.69	26.67	10.46
Years smoked	20.61	15.11	20.65	14.25	19.38	13.04
Number of quit attempts	6.82	47.54	4.64	10.98	3.42*	7.25
Number of quits >3 months	2.91	4.71	2.39	2.66	2.99	5.51
Use of cessation aid	27.1%		30.5%		33.5%	

Note: TBD: DSM-IV Tobacco Dependence; Use of cessation aid includes nicotine patch, other pharmacotherapy, nicotine-free cigarettes, behavioral counseling. Statistical tests compare MDD-R and MDD-S to No MDD smokers.

* p<0.05;

** p<0.01

Table 2

Univariate and multivariable relationships between levels of Nicotine Dependence and the number of days of impairment in functioning in the past 30 days with a history of recurrent and single episode Major Depressive Disorder among current smokers.

	Nicotine Dependence (n=1548)						Days of Impairment In Functioning (n=1228)					
	Univariate			Multivariable			Univariate			Multivariable		
	β	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*
Demographics												
Age	−0.02	0.02	0.383	−0.01	0.02	0.681	−0.02	0.11	0.884	−0.09	0.10	0.378
Female	0.11	0.05	0.021	0.11	0.05	0.021	0.70	0.21	0.002	0.78	0.22	0.001
Race												
Hispanic[A]	−0.45	0.01	0.001	−0.33	0.09	0.000	−0.81	0.32	0.012	−0.86	0.33	0.011
Black[A]	−0.17	0.07	0.025	−0.10	0.08	0.222	−0.24	0.34	0.476	−0.22	0.36	0.545
Other[A]	0.17	0.09	0.067	0.11	0.09	0.131	0.23	0.44	0.607	−0.09	0.46	0.839
Household Income	0.02	0.02	0.457	0.03	0.02	0.187	−0.05	0.11	0.633	−0.08	0.12	0.500
Average Daily Cigarettes	0.12	0.04	0.004	0.08	0.04	0.021	−0.04	0.09	0.680	0.08	0.11	0.481
MDD History												
MDD-S[B]	0.01	0.08	0.102	0.04	0.07	0.546	−0.08	0.40	0.837	0.12	0.39	0.756
MDD-R[B]	0.24	0.05	0.001	0.10	0.05	0.044	0.85	0.30	0.005	1.21	0.29	0.001
Comorbidity												
ANX[C]	0.38	0.04	0.001	0.34	0.05	0.001	0.93	0.24	0.001	1.16	0.22	0.001
SUD[C]	0.22	0.05	0.001	0.15	0.05	0.001	0.57	0.23	0.015	0.73	0.23	0.001

Note: MDD=Major Depressive Disorder. ANX=Anxiety Disorder. SUD=Substance Use Disorder. Impairment index was log transformed to correct for positive skewness and analyses exclude smokers with a current depressive episode in the past 30 days. All continuous variables were scaled to a mean of 0 (SD=1).

[A]Compared to White smokers;

[B]Compared to no MDD history;

[C]Compared to no comorbidity.