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Smoking and suicidal behaviours in a sample of US adults with low mood: a retrospective analysis of longitudinal data

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ABSTRACT

Objective: To investigate whether: (1) smoking predicts suicide-related outcomes (SROs), (2) prior SRO predicts smoking, (3) smoking abstinence affects the risk of SRO and (4) psychiatric comorbidity modifies the relationship between smoking and SRO.

Design: Retrospective analysis of longitudinal data obtained in wave 1 (2001–2002) and wave 2 (2004–2005) of the National Epidemiologic Survey on Alcohol and Related Conditions.

Setting: Face-to-face interviews conducted with persons in the community.

Participants: US adults (N=43 093) aged 18 years or older were interviewed in wave 1 and reinterviewed (N=34 653) 3 years later. For the present study, the sample was the subset of persons (N=7352) who at the wave 2 interview reported low mood lasting 2 weeks or more during the past 3 years and were further queried regarding SRO occurring between waves 1 and 2.

Outcome measures: SRO composed of any of the following: (1) want to die, (2) suicidal ideation, (3) suicide attempt, reported at wave 2. Current smoking reported at wave 2.

Results: Current and former smoking in wave 1 predicted increased risk for wave 2 SRO independently of prior SRO, psychiatric history and socio-demographic characteristics measured in wave 1 (adjusted OR (AOR)=1.41, 95% CI 1.28 to 1.55 for current smoking; AOR=1.32, 95% CI 1.21 to 1.43 for former smoking). Prior SRO did not predict current smoking in wave 2. Compared with persistent never-smokers, risk for future SRO was highest among relapsers (AOR=3.42, 95% CI 2.85 to 4.11), next highest among smoking beginners at wave 2 (AOR=1.82, 95% CI 1.51 to 2.19) and lowest among long-term (4+ years) former smokers (AOR=1.22, 95% CI 1.12 to 1.34). Compared with persistent current smokers, risk for SRO was lower among long-term abstainers ($p<0.0001$) but not among shorter-term abstainers ($p=0.26$).

Conclusions: Smoking increased the risk of future SRO independently of psychiatric comorbidity. Abstinence of several years duration reduced that risk.

ARTICLE SUMMARY

Article focus

To investigate among persons reporting low mood lasting 2 weeks or more during the past 3 years whether:

- smoking predicts SROs (want to die, suicidal ideation, suicide attempt); prior SROs predict smoking;
- smoking abstinence affects the risk of SROs;
- psychiatric comorbidity modifies the relationship between smoking and SROs.

Key messages

- Current and former smoking (<4 years' reported abstinence) predicted increased risk for SROs independently of prior SROs, psychiatric history and socio-demographic characteristics.
- Prior SROs did not predict future current smoking.
- Compared with persistent current smokers, risk of SROs was reduced with long-term (≥4 years) but not with shorter-term (<4 years) abstinence.

Strengths and limitations of this study

- Face-to-face interviews, a longitudinal design, a large representative sample, a validated diagnostic instrument, a comprehensive range of putative predictors that permitted statistical control of the key background factors and comorbidities.
- Only persons with self-reported low mood were questioned about SROs; consequently, no generalisability to other populations.
- The sample did not include persons who had completed suicide.
- No assessment of the effects of medical conditions that are possibly causally related to smoking and to SROs.
- Smoking information was self-reported, not biologically verified.
- No information from adolescents, a high-risk population for both smoking and SROs.

INTRODUCTION

Suicide is a leading cause of death worldwide. Close to 1 million persons die of suicide

each year. The WHO predicts that by 2020 suicide deaths will rise to 1.5 million.[1] Completed suicides are largely predicted by the wish to die, thoughts of suicide and unsuccessful previous suicidal attempts,[2] making it important to understand the risks posed by suicide-related outcomes (SROs). A history of mental disorders[3–5] and particular demographic characteristics (female gender, younger age, unmarried status and unemployment) are putative risk factors for suicide and SRO.[2] Smoking, long known as a major risk factor for numerous medical illnesses,[6] and recently, for psychiatric outcomes as well,[7 8] has received increasing attention for its potential contribution to the risk of completed suicides and SROs.[9] Nevertheless, whether the association between smoking and suicidal behaviours is causal or correlational remains unclear.

A link between smoking and suicide was observed as early as 1976 by Doll and Peto[10] in their study of mortality due to smoking in male British doctors. Clinical and epidemiological studies that subsequently investigated the issue are in general, but not universal, agreement in finding a significant association between smoking and suicide and suicidal behaviours. Among studies that focused on SRO, three that used cross-sectional epidemiological data found a positive correlational association between smoking and SRO.[11–13] Of seven longitudinal studies that also used community-based data, three[14–16] found that current smoking predicted suicidal behaviours even after controlling for the effects of demographic and psychiatric variables; four studies did not find a positive relationship.[17–20]

The effect of smoking abstinence on risk of SRO is also unclear. A study of young adults followed for 10 years found that recent, but not presurvey, cigarette smoking predicted suicidal thoughts and attempts.[14] Another study showed higher incidence rates of suicidal ideation among former smokers than never smokers, but the difference was no longer significant after adjustment with depressive disorder, anxiety symptoms and alcohol dependence.[16] A study based on wave 1 data from the National Epidemiological Survey of Alcohol and Related Conditions (NESARC) initially found that longer duration of abstinence decreased risk for SRO, but this effect disappeared upon controlling for psychiatric comorbidity.[21]

A further question of theoretical and practical importance is whether prior SRO increases the risk of future smoking. In the single study that has addressed this question, longitudinal data obtained from adolescents showed that smoking predicted suicidal ideation and suicide attempts, but prior suicidality was not associated with subsequent smoking.[15]

The present study was conducted to address these conundrums of the smoking–suicide relationship: (1) whether prior smoking predicts SRO; (2) whether prior SRO predicts smoking; (3) whether smoking cessation and its corollary, duration of smoking abstinence, affects risk for SRO and (4) whether these relationships are independent of comorbid psychiatric illness. Also explored were the effects of smoking status changes between the two waves of the NESARC on risk of future SRO. The two-wave format, the large sample and extensive data on psychiatric comorbidity that characterised the NESARC[22] permitted assessment of these questions.

The survey instrument had asked questions regarding the past occurrence of SRO—want to die, suicidal ideation and suicide attempt, only of persons reporting low mood. This restriction limits the generalisability of findings to the general population, but the much higher occurrence of suicidal behaviours among persons with low mood[3 4] provided a more sensitive context for detecting the risk potential of smoking for suicidal behaviours.[23]

METHODS

Sample

The NESARC data were collected to obtain a representative national sample of US adults. In wave 1 (2001–2002), face-to-face interviews were completed with 43 093 persons aged 18 years or older. The overall response rate was 81.0%. The wave 1 sample was reinterviewed in wave 2 (2004–2005) 3 years later (mean interval =36.6 months, SE=2.62), with a response rate of 80.4% (N=34 653) based on the wave 1 sample. The NESARC sample size was chosen to be sufficiently large to produce nationally representative proportions for the study of substance abuse and dependence and mental disorders by demographic group with CIs equal to or smaller than extant studies. Following NESARC guidelines,[24 25] the original NESARC data set was transformed to account for survey design effects and sampling weights upon responses in order to adjust for sample selection procedures, non-response from selected households or individuals, over-sampling (of young adults, blacks and Hispanics) and non-response at the wave 2 time point. Those weights and survey design effects, employed in other studies based on NESARC data, as well as other methodological details of waves 1 and 2 are described in published NESARC Source and Accuracy Statements.[24 25]

Data for the present study were obtained from a subset of persons (N=7352) who reported low mood at the wave 2 interview, irrespective of low mood in wave 1. This subsample was selected for the present analysis because it produced the largest number of persons from whom evaluable information for predicting wave 2 SRO was available. The latter subsample is also referred to herein as the 'at-risk sample'. Persons who did not report low mood were skipped out of the SRO sections in waves 1 and 2. The questions for low mood at the wave 2 interview were: "Since your LAST interview in (month/year), have you ever had a time when you felt sad, blue, depressed, or down most of the time for at least 2 weeks?" and "Since your LAST interview, have you ever had a time, lasting at least 2 weeks, when you didn't care about the things that you usually cared about, or when you didn't enjoy the things you usually enjoyed?" At the wave 1 interview, respondents were asked these same questions referenced to their *entire lifetime*.

Variables

The outcome variables for this study were wave 2 SRO and wave 2 current smoking. The main covariates were prior SRO and smoking status at wave 1. The individual SRO questions are: "During that time when (your mood was at its [sic] lowest/you enjoyed or cared the least about things), did you…feel like you wanted to die? think about committing suicide? attempt suicide?" Responses to these items were summed to create the total SRO question and measured as a dichotomous variable (none of the three = 0; any of the three = 1). Respondents who did not report low mood in wave 1 and were not asked the SRO questions were assigned a value of 0 for prior SRO.

The questions on tobacco use at wave 1 are: "In your ENTIRE LIFE, have you ever … (1) Smoked at least 100 cigarettes? (2) Smoked at least 50 cigars? (3) Smoked a pipe at least 50 times? (4) Used snuff, such as Skoal, Skoal Bandit [sic] or Copenhagen at least 20 times? (5) Used chewing tobacco, such as Redman, Levi Garrett or Beechnut at least 20 times?" Persons who smoked cigarettes, cigars and/or pipes comprised (a weighted) 95.9% (3368/3497) of all tobacco users. Following the coding rule of the NESARC, all tobacco users, including the 129 persons who reported using snuff or chewing tobacco only, were labelled as 'smokers'. A *never smoker* had responded 'No' to each of the questions regarding lifetime use of at least 100 cigarettes, at least 50 cigars, smoked a pipe at least 50 times, used snuff at least 20 times and used chewing tobacco at least 20 times. A *former smoker* was a 'Yes' responder to at least one of the prior questions who also reported that he or she had not smoked or used tobacco in the past 12 months. (N.B. Very few, if any, of this latter group would have been experiencing withdrawal; thus, the current study is not an adequate test of post-cessation withdrawal as a predictor of SRO). A *current smoker* was a 'Yes' respondent who had smoked or used tobacco within the past 12 months. At the wave 2 interview, these same questions on tobacco use were asked with regard to the period since the last interview (in month/year).

The smoking status variable (ie, never, former, current) rather than Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) defined nicotine dependence was selected to assess tobacco use because: (1) the adequacy of the DSM-IV criteria as a valid measure of nicotine dependence remains controversial[26 27] and (2) response to the single question on smoking status is easier to elicit in the clinical setting, with more validity, than responses to a multi-item measure of tobacco use for which no consensus, standalone instrument yet exists.[26 27] To categorise long-term or recent status as never-, former, or current smokers, a change variable was created with the following categories according to their report of smoking at waves 1 and 2: (1) never smoker to never smoker, (2) former smoker to former smoker, (3) current smoker to former smoker, (4) current smoker to current smoker, (5) never smoker to current smoker, (6) former smoker to current smoker and (7) never smoker to former smoker.

Other potential confounders or effect modifiers because of their known correlations with smoking and/or SRO, measured at wave 1, were: demographic characteristics (age, gender, race/ethnicity, marital status, education, employment status, income, urban residence, geographic region) and lifetime measures of DSM-IV Axis I and Axis II disorders. The Axis I disorders were categorised into mood disorders (major depression, dysthymia, bipolar I and bipolar II), anxiety disorders (panic disorder, social phobia, specific phobia, generalised anxiety), alcohol use disorders (alcohol abuse or dependence) and other substance use disorders (drug abuse or dependence). A history of attention deficit hyperactivity disorder (ADHD), queried only at wave 2, was used among the wave 1 predictors, its lifetime quality presumed since the DSM-IV criteria for ADHD include the presence of ADHD symptoms before age 7. All 10 of the Axis II personality disorders measured in Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS-IV) (shown in table 1), measured at wave 1, were included as well.

Assessment

For both waves 1 and 2, the AUDADIS-IV was administered by interviewers from the US Census Bureau. The reliability and validity of the DSM-IV diagnoses obtained through the AUDADIS-IV have been demonstrated in clinical and general samples in the USA and in other countries.[28]

Statistical analysis

Weighted percentages and SEs measured the distribution of the covariates (demographic characteristics and lifetime psychiatric variables) reported at wave 1 for the sample with low mood and for the complementary sample of persons with no low mood. χ^2 Tests were used to assess differences between comparison groups, for example, the at-risk sample and the complementary sample of NESARC participants who did not report low mood. Unadjusted and adjusted ORs (OR and AOR) and 95% CIs were calculated from univariate logistic regressions and multivariate logistic regressions, respectively, to assess prediction of wave 2 SRO in the sample of persons reporting low mood. The incidence of SRO at wave 2 (since the wave 1 interview) by smoking status, prior SRO and all other covariates at wave 1 were also calculated. The opposite temporal relationship of prior SRO (reported in wave 1) on future current smoking (reported in wave 2) was tested using the identical covariates for assessing predictors of wave 2 SRO, following Granger.[29] All models were estimated with the PROC SURVEYLOGISTIC function of SAS statistical software V.9.2, with the results verified through an internal statistical review at the US Census Bureau.

Missing values were replaced through imputation using assignment and allocation methods as described in the NESARC Source and Accuracy Statements.[24 25] Sensitivity

Table 1 Wave 1 characteristics of the low mood sample and the rest of the NESARC wave 2 sample (weighted percentages* (%) and SE)

Variable	Total wave 2 sample (%)	SE	Low mood sample† (%)	SE	Rest of sample‡ (%)	SE
Sample size	34 653		7352		27 301	
Smoking status						
Current smoker	27.02	0.17	31.65	0.38	25.85	0.19
Former smoker	19.58	0.16	17.84	0.28	20.02	0.17
Never smoker	53.40	0.19	50.51	0.42	54.13	0.20
Wave 1 suicide-related outcomes	11.42	0.10	25.55	0.27	7.84	0.10
Want to die	10.17	0.10	23.35	0.26	6.82	0.10
Suicidal ideation	8.42	0.09	19.27	0.27	5.66	0.09
Suicide attempt	2.35	0.04	6.09	0.17	1.40	0.04
Demographics						
Gender						
Female	52.08	0.16	64.13	0.40	49.02	0.17
Male	47.92	0.16	35.87	0.40	50.98	0.17
Race/ethnicity						
White	70.93	0.24	71.39	0.40	70.81	0.25
Black	10.75	0.20	10.61	0.22	10.79	0.21
Hispanic	11.56	0.10	11.20	0.15	11.65	0.12
Asian/Pac. Islander	4.36	0.06	3.50	0.10	4.58	0.06
Amer. Indian/Alaska Native	2.40	0.11	3.29	0.20	2.17	0.11
Age (years)						
18–19	4.02	0.07	4.47	0.15	3.91	0.08
20–29	17.78	0.14	19.28	0.30	17.40	0.15
30–44	30.90	0.17	32.28	0.29	30.54	0.18
45–64	31.08	0.15	31.64	0.24	30.94	0.17
65 and older	16.22	0.10	12.32	0.25	17.21	0.12
Household income						
<$20 000	20.35	0.17	25.07	0.32	19.15	0.19
$20 000–$34 999	19.62	0.13	20.84	0.27	19.31	0.15
$35 000–$59 999	26.27	0.16	24.85	0.31	26.63	0.17
$60 000 and over	33.76	0.16	29.24	0.33	34.91	0.17
Marital status						
Married	59.81	0.17	54.75	0.35	61.10	0.17
Cohabiting	3.25	0.06	3.60	0.11	3.16	0.07
Widowed	6.04	0.07	5.37	0.12	6.21	0.08
Divorced	8.45	0.06	10.73	0.19	7.87	0.07
Separated	1.98	0.04	2.98	0.12	1.73	0.04
Never married	20.46	0.17	22.57	0.33	19.93	0.17
Education						
Less than high school	14.65	0.13	16.25	0.26	14.24	0.14
High school diploma	29.03	0.18	29.35	0.35	28.95	0.20
College	56.32	0.22	54.40	0.38	56.81	0.23
Unemployed	7.16	0.09	12.31	0.25	5.85	0.09
Not unemployed	92.84	0.09	87.69	0.25	94.15	0.09
Urban	28.89	0.26	30.59	0.41	28.46	0.25
Rural/not in central city	71.11	0.26	69.41	0.41	71.54	0.25
Northeast	19.67	0.08	18.57	0.15	19.95	0.10
Midwest	23.15	0.16	23.52	0.32	23.05	0.21
South	35.21	0.15	34.89	0.39	35.29	0.19
West	21.97	0.11	23.02	0.23	21.71	0.15
Lifetime psychiatric disorders						
Axis I disorders						
Alcohol use	30.43	0.20	33.57	0.39	29.63	0.20
Substance use	10.42	0.11	15.06	0.26	9.25	0.11
Nicotine dependence	17.47	0.13	24.33	0.37	15.73	0.13
Anxiety disorder	17.88	0.17	31.00	0.34	14.55	0.17

Continued

Table 1 Continued

Variable	Total wave 2 sample (%)	SE	Low mood sample† (%)	SE	Rest of sample‡ (%)	SE
Mood disorder	21.09	0.13	41.82	0.33	15.82	0.13
Attention deficit hyperactivity disorder	2.51	0.06	5.82	0.19	1.67	0.05
Axis II disorders						
Borderline	5.89	0.08	18.44	0.28	2.70	0.07
Schizotypal	3.93	0.06	11.20	0.24	2.09	0.05
Narcissistic	6.18	0.08	11.88	0.23	4.74	0.08
Avoidant	2.32	0.05	6.14	0.17	1.36	0.05
Antisocial	3.63	0.07	5.86	0.21	3.07	0.07
Dependent	0.43	0.02	1.36	0.09	0.19	0.01
Obsessive-compulsive	8.07	0.10	13.50	0.31	6.69	0.09
Paranoid	4.33	0.07	9.66	0.21	2.98	0.06
Schizoid	3.06	0.06	6.44	0.21	2.21	0.05
Histrionic	1.80	0.04	3.68	0.15	1.32	0.04

*The sampling weight variable in wave 2 was used.
†Respondents in NESARC wave 2 who reported low mood lasting 2 weeks or more during the 3-year interval covered in the wave 2 NESARC and were asked the three suicidal behaviour questions.
‡Respondents in NESARC wave 2 who did not report low mood and were not asked the three suicidal questions.
NESARC, National Epidemiological Survey of Alcohol and Related Conditions.

analyses were performed that included: comparison of the at-risk subsample to the complementary wave 2 NESARC sample; using different sets of control variables with and without education, and census region; and including help-seeking behaviour controls. In response to reviewer concerns, we performed the multiple logistic regression models for assessing prediction of wave 2 SRO and of wave 2 current smoking based on the unweighted data adjusted for design effects. These various sensitivity analyses did not alter the associations between smoking and SRO reported below.

RESULTS

Wave 1 characteristics

Table 1 shows weighted percentages by smoking status, SRO taken together and individually, demographic characteristics and psychiatric disorders (DSM-IV Axis I and Axis II) in the sample of persons reporting low mood at wave 1 and the rest of the NESARC sample. Current smoking, SRO and the prevalence of psychiatric disorders were markedly higher among the low mood sample, confirming their at-risk status. Other demographic characteristics previously associated with higher risk of suicide and SROs were also higher in the low mood subsample: more females, more low-income and fewer high-income responders, fewer married and more separated or never married, and more unemployed individuals. Differences by race/ethnicity, age, urban or rural residence and geographic area were also observed.

Effects of wave 1 characteristics on wave 2 SRO

From here on, reported statistics are for the sample of persons reporting low mood at wave 2. The overall incidence rate of SRO (occurring between the wave 1 and wave 2 interviews) was 28.2% (SE = 0.33%). Table 2 shows weighted percentages and ORs for wave 2 SRO by smoking history, prior SRO and the control variables as reported in wave 1. Unadjusted ORs and 95% CI for future SRO are shown as reference points. The AORs and 95% CIs show significantly higher risk of wave 2 SRO for both wave 1 current smokers (AOR=1.41, 95% CI 1.28 to 1.55) and former smokers (AOR=1.32, 95% CI 1.21 to 1.43) relative to never smokers. The difference in point estimates of risk between current versus former smokers was not significant (χ^2=1.95, p=0.16).

The multivariate model showed that SRO in wave 1 is the strongest predictor of a wave 2 SRO (AOR=3.49, 95% CI 3.18 to 3.84). Significant independent risk of future SRO was also observed for individuals who were woman, Hispanic, younger, cohabiting, divorced or separated, of lower income, unemployed and resided outside the Northeast region. Of the DSM-IV Axis I disorders, only anxiety (AOR=1.08, 95% CI 1.01 to 1.17) and ADHD (AOR=1.56, 95% CI 1.36 to 1.79) showed significantly elevated risk of wave 2 SRO; mood disorder was correlated with reduced wave 2 SRO risk (AOR=0.77, 95% CI 0.70 to 0.84). Three of the DSM-IV Axis II disorders, that is, borderline personality, schizotypal and avoidant personality, showed significantly increased risk for wave 2 SRO.

Smoking status change from wave 1 to wave 2

The great majority of the sample (90.5%) did not change their smoking status as never-, former, or current smoker, between waves 1 and 2 (table 3). Among the remaining 9.5%, over half (5.3%) had shifted from being current smokers to former smokers; more than a fourth (2.6%) were never smokers in wave 1 who became current smokers in wave 2; and a smaller proportion (<2%) who were former smokers in wave 1 relapsed to smoking in wave 2.

Effects on wave 2 SRO

Table 3 shows AORs indicating significant risk for SRO among all categories of ever smokers relative to the

Table 2 Weighted percentage of suicide-related outcomes (SRO)* reported in wave 2 by wave 1 characteristics, and unadjusted ORs and AORs for risk of wave 2 SRO among persons reporting low mood at the NESARC wave 2 interview (N=7352)†

Variable	n/N	Weighted percentage of wave 2 SRO	SE	OR‡ (95% CI)	AOR§ (95% CI)
Smoking history					
Current smoker in wave 1	809/2217	35.73	0.64	1.77 (1.64 to 1.90)	1.41 (1.28 to 1.55)
Former smoker in wave 1	339/1280	26.68	0.67	1.16 (1.07 to 1.25)	1.32 (1.21 to 1.43)
Never smoker in wave 1	981/3855	23.94	0.43	1.00	1.00
SRO in wave 1	1009/1940	50.01	0.76	3.84 (3.60 to 4.10)	3.49 (3.18 to 3.84)
Demographics					
Gender					
Female	1488/5090	28.51	0.36	1.05 (0.98 to 1.12)	1.13 (1.04 to 1.22)
Male	641/2262	27.54	0.59	1.00	1.00
Race/ethnicity					
White	1253/4295	28.38	0.36	1.00	1.00
Black	333/1352	26.53	0.70	0.91 (0.84 to 0.99)	0.84 (0.76 to 0.92)
Hispanic	438/1342	30.33	0.52	1.10 (1.04 to 1.17)	1.26 (1.16 to 1.36)
Asian/Pacific Islander	47/169	22.68	0.84	0.74 (0.67 to 0.82)	0.93 (0.82 to 1.06)
American Indian	58/194	27.18	2.81	0.94 (0.71 to 1.25)	0.69 (0.51 to 0.92)
Age (years)					
18–19	94/264	36.65	1.73	1.00	1.00
20–29	410/1287	31.40	0.67	0.83 (0.69 to 0.98)	0.77 (0.63 to 0.94)
30–44	750/2438	29.32	0.62	0.75 (0.64 to 0.88)	0.73 (0.60 to 0.90)
45–64	679/2395	26.82	0.63	0.66 (0.56 to 0.78)	0.69 (0.56 to 0.84)
65 and older	196/968	20.90	0.93	0.47 (0.39 to 0.57)	0.68 (0.54 to 0.86)
Marital status					
Married	836/3309	24.87	0.49	1.00	1.00
Cohabiting	86/230	35.58	1.67	1.67 (1.42 to 1.96)	1.27 (1.07 to 1.51)
Widowed	128/562	24.26	1.09	0.97 (0.85 to 1.10)	0.92 (0.78 to 1.07)
Divorced	390/1104	36.01	0.84	1.70 (1.57 to 1.84)	1.20 (1.10 to 1.32)
Separated	130/338	37.93	1.78	1.85 (1.58 to 2.15)	1.29 (1.06 to 1.56)
Never married	559/2129	30.87	0.69	1.35 (1.24 to 1.46)	0.97 (0.87 to 1.09)
Education					
Less than high school	440/1358	31.58	0.92	1.17 (1.04 to 1.32)	1.09 (0.95 to 1.25)
High school diploma	606/2111	28.27	0.74	1.00	1.00
Some college or more	1083/3883	27.08	0.35	0.94 (0.87 to 1.02)	1.08 (1.00 to 1.17)
Lifetime psychiatric disorder					
Axis I disorders					
Alcohol use	811/2350	32.74	0.60	1.40 (1.31 to 1.49)	0.95 (0.87 to 1.04)
Substance use	427/1033	38.42	0.94	1.75 (1.61 to 1.89)	0.98 (0.88 to 1.09)
Anxiety	843/2278	37.57	0.60	1.72 (1.62 to 1.83)	1.08 (1.01 to 1.17)
Mood	1217/3151	36.62	0.48	2.04 (1.92 to 2.17)	0.77 (0.70 to 0.84)
Attention deficit hyperactivity disorder	208/394	51.14	1.42	2.87 (2.56 to 3.22)	1.56 (1.36 to 1.79)
Axis II disorders					
Borderline	821/1433	55.75	0.79	4.49 (4.22 to 4.77)	2.91 (2.69 to 3.16)
Schizotypal	485/886	53.41	1.26	3.44 (3.09 to 3.84)	1.50 (1.31 to 1.72)
Narcissistic	443/993	42.49	1.01	2.08 (1.89 to 2.29)	1.03 (0.92 to 1.14)
Avoidant	245/446	51.87	1.37	2.97 (2.66 to 3.32)	1.29 (1.05 to 1.58)
Antisocial	188/395	41.55	1.39	1.89 (1.68 to 2.13)	0.85 (0.72 to 1.01)
Dependent	58/90	56.90	2.90	3.44 (2.74 to 4.30)	1.04 (0.76 to 1.41)
Obsessive-compulsive	377/961	36.07	1.05	1.53 (1.39 to 1.69)	0.90 (0.80 to 1.00)
Paranoid	364/756	45.74	1.16	2.37 (2.14 to 2.62)	0.95 (0.82 to 1.10)
Schizoid	210/473	43.81	1.26	2.10 (1.89 to 2.33)	1.01 (0.88 to 1.16)
Histrionic	129/266	44.42	1.83	2.10 (1.82 to 2.43)	0.76 (0.63 to 0.93)

*SRO: feel like want to die, suicide ideation, suicide attempt; 0 = none, 1 = any SRO.
†Missing observations for specific variables: race, 43; Hispanic origin, 2; age, 13; marital status, 4; educational attainment, 70; household income, 2544; unemployed, 28; wave 2 individual SRO, 12–18 'unknown' changed to 'no'. Treatment of unknown values in determination of psychiatric diagnosis variables is known only to original NESARC project staff at National Institute on Alcohol Abuse and Alcoholism.
‡ORs and 95% CIs based on simple regression models estimating wave 2 SRO as a function of an individual predictor variable.
§AORs and 95% CIs based on a multiple logistic regression estimating wave 2 SRO as a function of age, sex, race/ethnicity, marital status, income, education, unemployed status, Census region, urban residence, smoking status, Axis I and Axis II disorders (as described in text) and lifetime SRO prior to wave 1.
AOR, adjusted OR; NESARC, National Epidemiological Survey of Alcohol and Related Conditions; SRO, suicide-related outcome.

Table 3 Effects on wave 2 suicide-related outcomes (SRO) according to smoking status change as reported in NESARC wave 1 and wave 2 interviews

Smoking status in wave 1 to wave 2	n/N	Weighted percentage* (SE)	Wave 2 SRO† AOR‡ (95% CI)
1. Consistent never smoker (in wave 1 and wave 2)	897/3653	47.8 (0.40)	1.00
2. Long-term former smoker (in wave 1 and wave 2)	293/1185	16.4 (0.26)	1.22 (1.12 to 1.34)
3. Recent former smoker (current smoker in wave 1, former smoker in wave 2)	126/393	5.3 (0.14)	1.37 (1.16 to 1.63)
4. Persistent current smoker (in wave 1 and wave 2)	683/1824	26.3 (0.35)	1.50 (1.35 to 1.66)
5. New current smoker (never smoker in wave 1, current smoker in wave 2)	82/194	2.6 (0.10)	1.82 (1.51 to 2.19)
6. Relapser (former smoker in wave 1, current smoker in wave 2)	46/95	1.5 (0.08)	3.42 (2.85 to 4.11)
	N=7352§		

*The sampling weight variable in wave 2 was used.
†Any of three items: want to die, suicidal ideation, suicide attempt.
‡AORs are adjusted OR with 95% CIs based on multiple logistic regression of wave 2 SRO as a function of age, sex, race/ethnicity, marital status, income, education, unemployed status, Census region, urban residence, smoking status, Axis I and Axis II disorders (as described in text) and lifetime SRO reported in wave 1.
§The seventh group (n=8), which consisted of persons who were never smokers in wave 1, began to smoke and then stopped smoking in wave 2, was too small for a valid assessment of risk.
NESARC, National Epidemiological Survey of Alcohol and Related Conditions.

persistent never smokers. The highest risk was seen for relapsers (former smoker to current smoker) (AOR=3.42, 95% CI 2.85 to 4.11); new smokers (never-smoker to current smoker) showed the next highest risk (AOR=1.82, 95% CI 1.51 to 2.19); and long-term former smokers (during both wave 1 and 2) showed the least elevated, yet still significant, risk (AOR=1.22, 95% CI 1.12 to 1.34). The seventh category consisting of never smokers in wave 1 who reported former smoker status in wave 2 was too small for a valid analysis.

Comparative risks by abstinence duration, relapse and new smoking

Pair-wise χ^2 tests for equality of coefficients permitted a comparison of risk estimates for wave 2 SRO (shown in table 3) between categories of smoking status change. Given the 3-year interval between waves 1 and 2 and the coding requirement that former smoking status is assigned only upon reporting of at least 12 months of abstinence, long-term former smokers (category 2, table 3) would have been abstinent for at least 4 years. Persons who shifted from current smoking in wave 1 to former smoking in wave 2 (category 3, table 3) would have been abstinent for at least 12 months and a maximum of 4 years.

The analysis showed that the AOR for wave 2 SRO among recent former smokers (category 3) did not differ from persistent current smokers (category 4) (χ^2 (1)=1.26, p=0.26). However, long-term former smokers (category 2) showed a significantly lower AOR for wave 2 SRO than persistent current smokers (χ^2 (1)=16.9, p<0.0001). These data suggest that a reduction in risk for future SRO with past smoking becomes apparent after a considerable period of abstinence. Of additional interest were the risk estimates associated with re-starting (ie, relapse) and with beginning to smoke in wave 2. Compared with persistent current smokers, the AOR for wave 2 SRO was significantly higher for both relapsers (χ^2 (1) =56.00, p<0.0001) and smoking beginners in wave 2 (χ^2 (1) =4.11, p=0.04). Furthermore, the AOR for wave 2 SRO was significantly higher among relapsers than beginning smokers (χ^2 (1)=19.0, p<0.0001).

Does prior SRO predict smoking?

A multiple regression model on current smoking in wave 2 was fit using the identical list of control variables for predicting wave 2 SRO. This second model did not show a direct effect of prior SRO on wave 2 current smoking. Persons with wave 1 SRO were *less* likely to report current smoking status at wave 2 than were persons who did not experience SRO in wave 1 (AOR=0.81, 95% CI 0.72 to 0.90).

To understand the temporal relationship between smoking and SRO, the effects of the interaction of wave 1 smoking status (current vs never smoker and former vs never smoker) with history of SRO were examined. Table 4 shows AORs from separate multiple regression models on SRO and on current smoking in wave 2 for combined effects of smoking status and prior SRO reported in wave 1. Never smokers without a prior SRO at wave 1 comprised the reference group in each model. These analyses did not fundamentally change the finding that smoking predicts increased risk of SRO and that the reverse relationship does not hold but indicates nuanced impact of both SRO and smoking history.

The model on wave 2 SRO (table 4, section a) shows that other characteristics (eg, demographics and psychopathology) being equal: (1) all combinations of smoking status and SRO history had statistically significant risks for wave 2 SRO relative to never smokers without prior SRO and (2) for each smoking category, the risks were considerably greater when the combined group involved a prior SRO. The data also show that

Table 4 Combined effects of smoking status and prior SRO* reported in wave 1 on a) wave 2 SRO and b) wave 2 current smoking

Wave 1 smoking status and wave 1 SRO	n/N	Weighted percentages (SE)	AOR† (95% CI)
a) Effect on wave 2 SRO			
Never smoker—no prior SRO (referent)	550/2978	17.5 (0.4)	1.00 (NA)
Never smoker—prior SRO	431/877	46.8 (1.0)	4.12 (3.65 to 4.64)
Former smoker—no prior SRO	187/968	20.6 (0.8)	1.42 (1.28 to 1.57)
Former smoker—prior SRO	152/312	48.2 (1.6)	4.58 (3.60 to 5.82)
Current smoker—no prior SRO	383/1466	26.6 (0.7)	1.56 (1.41 to 1.74)
Current smoker—prior SRO	426/751	54.1 (1.2)	4.77 (3.70 to 5.87)
b) Effect on wave 2 current smoking			
Never smoker—no prior SRO (referent)	166/2978	5.3 (0.2)	1.00 (NA)
Never smoker—prior SRO	28/877	4.3 (0.4)	0.70 (0.60 to 0.82)
Former smoker—no prior SRO	71/968	8.6 (0.5)	2.20 (1.77 to 2.31)
Former smoker—prior SRO	24/312	6.9 (0.6)	1.15 (0.83 to 1.61)
Current smoker—no prior SRO	1204/1466	82.7 (0.5)	82.9 (73.7 to 93.2)
Current smoker—prior SRO	620/751	84.2 (0.8)	77.0 (57.6 to 104.8)

*Any of three items: want to die, suicidal ideation, suicide attempt.
†AORs are adjusted ORs with 95% CIs based on multiple logistic regression models controlling for demographics and psychiatric history at wave 1 (shown in table 1).
SRO, suicide-related outcome.

former smoking and current smoking, in the absence of prior SRO, are valid predictors of an *initial* SRO. However, once a person has had a SRO, smoking status history does not change the risk prediction—the risk of *recurrence* is fully predicted by that prior SRO and the other characteristics. The second model, on wave 2 current smoking (table 4, section b), shows an expectedly substantial likelihood of being a current smoker in wave 2 for current smokers in wave 1, regardless of SRO history. Of interest, prior SRO predicted a contrasting *reduction* in the likelihood of smoking uptake in wave 2 for former smokers and never smokers.

DISCUSSION

The main findings from the present sample of persons reporting low mood are: (1) current and past smoking predicted increased risk for SRO independently of demographics, psychiatric factors and prior SRO; (2) long-term smoking abstinence was associated with lower risk than persistent smoking; (3) new smoking due to relapse after a period of abstinence or to initiation of smoking by erstwhile never smokers was associated with an increased risk of SRO relative to persistent smoking; (4) prior SRO did not increase the risk of future smoking.

For three Axis I disorders, that is, mood, alcohol use and substance use, the AORs indicated either insignificant effects or a decreased risk of future SRO. These results differ from the increased risks found in the unadjusted analyses, indicating confounding effects of correlated predictors of SRO, for example, prior SRO and comorbid psychiatric disorders.[3–5] In further analysis that excluded prior SRO in the multivariate model, a positive predictive effect of mood disorder on future SRO (AOR=2.05, 95% CI 1.92 to 2.17) was observed, contrary to the reduced effect of mood disorder in the full model that adjusted for prior SRO (results available upon request). This finding exemplifies an instance when collinearity with a stronger predictor (eg, wave 1 SRO) overwhelmed the explanatory power of other predictors with weaker relationships. It is thus remarkable that significant effects of smoking on risk of SRO remained despite the evidence of effect suppression due to confounding. Ranked in decreasing order, the significant predictors of SRO risk in the present sample were: prior SRO, borderline personality disorder, ADHD, schizotypal disorder, current smoking, former smoking, avoidant personality disorder and selected demographic characteristics.

Other than the present one, there have been seven longitudinal epidemiological studies of smoking and SRO.[14–20] The positive effect of current smoking on future SRO reported here was also observed in three studies.[14–16] Problems of recall due to the long 10-year interval between data time points could explain the negative finding of the study by Kessler *et al*[17]; while the younger age of the samples in two studies[19 20] could have masked a future effect. Of clinical and public health importance is the finding, first reported here, that longer abstinence from smoking decreased the risk for SRO. The latter observation, not considered in two negative studies regarding past smoking,[14 16] could account for the inconsistent findings. Notably, the divergence according to longevity of abstinence is consistent with evidence for lung cancer and other smoking-related disorders that risk reduction from stopping smoking occurs only after multiple years of abstinence.[30 31] The worrisome observation that relapsers and new smokers are at even higher risk of future SRO than persistent smokers suggests particular targets for increased therapeutic attention. Finally, the data negated a reverse

temporal relationship of SRO on smoking, as also seen in a study of adolescents.[15] Instead, a reduction in risk for future smoking was observed among former and never-smokers with prior SRO in wave 1 compared with their counterparts without prior SRO. Perhaps among those former and never smokers, already inclined towards the pro-health behaviour of not currently smoking, was a subset spurred by the prior SRO to undertake further health-promoting and therapeutic actions, which immunised them against future smoking. Their counterparts who did not experience a prior SRO were less likely to be as self-protective or to seek counselling and similar treatments and were less immunised against resorting to new smoking. The serendipitous observation from the present sample that prior SRO and treatment seeking were well correlated (r=0.43, p=0.0001) is consistent with that conjecture.

Strengths and limitations of the study are noted. An important strength is the concomitance of rigorous methods and materials not found in prior work on the smoking–suicide question—face-to-face interviews, a longitudinal design, a large sample, a validated instrument and a comprehensive range of putative predictors that permitted statistical control of key background factors and comorbidities. A further strength is the use of a simple yet meaningful measure of smoking status (ie, never, former or current smoking) that is easy for a questioner to administer and for the respondent to recall and understand. Even so, study limitations call for cautious interpretation of the findings. The present sample comprised the subgroup (22%) of wave 2 participants (N=34 653) who self-reported low mood during the 3-year interval between the interviews. This selectivity yields findings relevant to mental health settings that are likely to serve persons experiencing mood problems; however, they may not generalise to the rest of the NESARC sample or to the national population. Second, the sample did not include persons who had completed suicide attempts. Using the US rate of 11.1 per 100 000 population per year,[32] the wave 1 sample of 43 093 could be expected to include about 14 persons with completed suicides before wave 2 (95% CI 6.8 to 21.6), introducing a non-trivial, although likely small, selection bias. Third, the present study did not assess the effects of medical conditions that are possibly causally related, albeit in different directions, to smoking and to SRO. Fourth, self-reported smoking information was not biologically validated. Fifth, the NESARC did not obtain information from adolescents, a subgroup with a known high risk for SRO.[2] Finally, in exploratory unadjusted analyses, predictive effects of current smoking were observed across the individual SRO, whereas past smoking predicted want to die and suicidal ideation but not suicide attempt. Validation and articulation of these preliminary observations need to be accomplished in future work.

The rigorous methodology employed in the NESARC gives eminent credence to the central findings of this analysis—an independent effect of smoking on SRO and the absence of a positive influence of prior SRO on future smoking. These results are consistent with the hypothesis that smoking exerts a contributing, and not simply a correlational, effect on risk of SRO. By contrast, these results are inconsistent with the hypothesis that SRO causes smoking or that a third factor causes both smoking and SRO. The neurobiological, genetic, psychiatric and psychological underpinnings of these associations warrant further investigation. The knowledge gained could advance prevention and treatment options for reducing the prevalence of tobacco use and suicide.

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Author footnote
The study is a secondary analysis of data collected by the National Institute of Health—National Institute of Alcohol and Alcohol Abuse of the US government. Before data collection, each respondent was informed of the nature of the survey and its potential uses, ensured of confidentiality and told that participation was voluntary. All participants signed a consent form prior to participating in the interviews. Individual data files are deidentified to prevent full anonymity of participants. Approval for conducting this secondary analysis of previously collected data was not required.

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Contributors LSC and IB conceptualised this study and together with M-CH designed the analysis. JKH had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. LSC was the lead writer of the manuscript. All authors participated in the interpretation of findings and writing of the manuscript. All authors had full access to the statistical reports, tables and the manuscript and take responsibility for the integrity of the data and the accuracy of the data analysis. The US Census Bureau, National Institute on Alcohol Abuse and Alcoholism (NIAAA) and other employers of the authors had no role in the study design, implementation of the study, analysis and interpretation of data, in the writing of the report and the decision to submit the article for publication.

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Competing interests All authors have completed the Unified Competing Interest form (www.icmje.org/coi_disclosure.pdf). (1) JKH received support from NIAAA through the US Census Bureau for the submitted work; (2) LSC, IB and M-CH received no specific support for this work; (3) IB received occasional honoraria for participating in advisory panels of Pfizer Ltd during the past 3 years; (4) in February 2011, LSC provided educational consultation to a law firm regarding mood effects of smoking cessation; (5) JKH and M-CH had no relationships with any company that might have an interest in the submitted work in the previous 3 years; (6) none of the spouses of the authors had financial relationships that may be relevant to the submitted work; (7) none of the authors had a non-financial interest that may be relevant to the submitted work.

Ethics approval Ethics approval was provided by the US Census Bureau and the US Office of Management and Budget.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement In order to safeguard sensitive personal information, data are not available for public use. The restricted use data sets are maintained by the US Census Bureau on behalf of NIAAA, and any requests to use NESARC data for replication or other purposes may be directed to the NIAAA coordinator for NESARC, Aaron White (whitea4@mail.nih.gov).

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, explain how loss to follow-up was addressed
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Report numbers of outcome events or summary measures over time
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.