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Effects of State-Level Tobacco Environment on Cigarette Smoking are Stronger Among Those With Individual-Level Risk Factors

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Abstract

Introduction: To better understand the impact of the state-level tobacco environment (eg, tobacco control policies, attitudes towards smoking) on cigarette smoking, we examined whether the relationship of state tobacco environments to smoking is modified by individual-level vulnerability factors.

Methods: In a nationally representative sample of US adults ($N = 34\,638$), past-year smoking and heavy smoking were examined. State-level tobacco environment was defined by tobacco-related control policies and attitudes, ranging from permissive to restrictive; individual vulnerability was defined by childhood maltreatment and/or parental substance problems. Additive interaction tested differences in state-level tobacco environment effects on smoking and heavy smoking by individual-level vulnerability.

Results: Significant interactions (P values $< .01$) indicated that the state tobacco environment had the strongest relationship to smoking outcomes among individuals with greatest individual vulnerability. For example, among respondents with childhood maltreatment and parental substance problems, those in states with permissive tobacco environments had 13.3% greater prevalence of smoking than those in restrictive states. Among respondents with neither individual-level risk factor, those in permissive states had 2.8% greater prevalence than those in restrictive states (interaction P value = .0002).

Conclusions: Further restricting states' smoking environments could help reduce the prevalence of smoking and heavy smoking, particularly among those at increased individual risk in the general population.

Implications: This study shows that the protective effect of restrictive state-level tobacco environments on smoking or heavy smoking was stronger among those especially vulnerable due to individual-level risk factors (parental substance problems, childhood maltreatment). Thus, public health campaigns to influence attitudes towards smoking or legislation to strengthen tobacco control could have a broad effect, particularly impacting those with vulnerability to smoking, which may help decrease smoking prevalence and reduce the massive public health burden of tobacco-related morbidity and mortality.

Introduction

Cigarette smoking declined substantially in the United States between the 1960s and 1990s. However, despite vigorous public health efforts, current smoking has decreased only gradually since then, remaining at ~20% of adults over the past 20 years.^{1,2} Because cigarette smoking is the largest cause of preventable morbidity and mortality in the United States,^{3,4} better knowledge of the interplay of environmental and individual factors that affect the risk for smoking is a major public health priority.

Several individual-level variables, including demographic characteristics and life experiences, influence smoking. The consistent association of childhood maltreatment (abuse, neglect) with smoking prevalence and cigarette consumption^{5–14} makes childhood maltreatment a robust early risk factor for smoking. In addition, parental history of substance use problems¹⁵ is also associated with offspring smoking and nicotine dependence,^{16–19} likely due to shared genetic liability for alcohol, nicotine, and drug use and disorders.^{20–24} Childhood maltreatment and parental substance problems therefore represent key early “vulnerability factors” for substance use and addiction, encompassing genetic, familial, and stress-related factors.¹⁵

Group-level factors, including environmental factors defined in terms of geographic areas, also influence smoking.^{25,26} For example, state-level tobacco control policies strongly influence smoking.²⁷ Cigarette taxation/price shows a strong and robust negative relationship with smoking,^{3,25,28} tobacco control funding is negatively associated with smoking,^{29,30} and smoke-free air policies are consistently negatively associated with smoking.^{25,31,32} Additionally, societal attitudes towards smoking are associated with smoking. Examples include smoking by others in the same social network (positively associated),³³ perceived social acceptability of smoking (positively associated),^{34,35} and perceptions of health risks due to smoking (negatively associated).^{25,36} These group-level price, policy and attitudinal factors are related and have been jointly conceptualized as a state-defined “tobacco environment”; individuals living in states with more restrictive tobacco environments were less likely to smoke.²⁶

Aspects of the tobacco environment (tobacco attitudes, control policies) are potentially modifiable, and therefore of interest in the design of public health prevention and intervention strategies. To better understand the impact of tobacco environment, information is needed on whether individual-level risk factors modify the relationships between the tobacco environment and smoking.^{25,26,31,37} Observing weaker effects of group-level tobacco variables in vulnerable individuals (with individual-level risk factors for smoking) than in others would indicate the need for tailored interventions focused on vulnerable individuals.²⁶ However, observing similar or stronger effects of group-level tobacco factors in vulnerable individuals than in others would suggest continued value in further restriction of the tobacco environments to reduce smoking, since these environmental factors would differentially affect those at greater risk.³⁷ Therefore, we investigated differential effects of state-level tobacco attitudes/policies on the prevalence of past-year smoking and heavy smoking in subgroups defined by key individual-level vulnerability factors (childhood maltreatment; parental substance problems), controlling for state and individual characteristics, including psychiatric comorbidity. We conducted this research using a large, nationally representative sample of US adults.

Methods

Sample

Data were from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), an in-person survey of the adult US

population, conducted in two waves.^{38,39} Participants were residents of households and group quarters from the 50 states and the District of Columbia. For Wave 1 (W1; 2001–2002³⁸), one adult (18 years or older) was randomly selected from each housing unit, which were selected from primary sampling units representing geographical regions.^{40,41} Black and Hispanic housing units and young adults (18–24) were oversampled. [Supplementary Figure 1](#) provides details about the sampling. Data were weighted for oversampling and non-response, and adjusted to represent the US population from the 2000 Census. W1 included 43 093 participants, with an 81.0% response rate.³⁸ For Wave 2 (W2; 2004–2005), after excluding ineligible participants ($N = 3134$), 34 653 of the W1 participants were re-interviewed, for an 86.7% response rate, and a cumulative response rate across both waves of 70.2%.³⁹ Participants provided informed consent prior to inclusion. The US Office of Management and Budget approved all protocols.⁴² This study includes W2 participants (when childhood maltreatment was assessed), excluding 15 participants missing information on cigarette smoking ($N = 34\ 638$).

Measures

Individual-level variables were measured using the Alcohol Use Disorders and Associated Disabilities Interview Schedule (AUDADIS), a structured diagnostic interview designed for experienced lay interviewers for large-scale surveys.^{43,44} Large studies of both general and clinical samples in many countries used the AUDADIS.^{38,45–49}

Past-Year Smoking Outcomes

Smokers (smoked 100+ cigarettes since the W1 interview, 2–3 years prior) were asked the most recent time they smoked a cigarette. Responses were recoded to “hours ago,” with less than 8766 hours ago (365.25 days $\times$ 24 hours) indicating “past-year smoking.” “Current smokers” were smokers whose most recent cigarette was within the past week (<168 hours ago). “Past-year heavy smoking” was defined as smoking a pack or more of cigarettes a day, based on number of cigarettes smoked per day. The AUDADIS measure of cigarettes smoked showed excellent test-retest reliability (intra-class correlation coefficient = 0.83)⁴³; self-report of number of cigarettes smoked generally has good-to-excellent reliability.⁵⁰ Since the risk factors affect the likelihood of smoking, which affects the likelihood of heavy smoking, past-year nonsmokers ($N = 27\ 575$) were included as “no” for heavy smoking. Subsequently, to explore if the association of heavy smoking was independent of the association of smoking, heavy smoking was analyzed among past-year smokers ($N = 7063$).

Individual-Level Smoking Risk Factors

“Childhood maltreatment” was assessed through 19 items from two validated scales (Conflict Tactics Scale⁵¹ and Childhood Trauma Questionnaire⁵²) assessing 5 types of maltreatment with very good-excellent reliability⁵³; operationalization of each maltreatment type was similar to previous studies.⁵⁴ Supported by research showing that the 5 childhood maltreatment types were similarly related to nicotine dependence,⁵⁵ we created one parsimonious binary variable indicating occurrence of any of the five types before age 18, as done previously.⁵⁶ Physical abuse (weighted prevalence = 17.3% [standard error [SE] = 0.3]) was positive if a parent/caregiver caused physical harm at least “sometimes.” Emotional abuse (7.8% [SE = 0.2]) was positive if a parent/caregiver verbally threatened or abused at least “fairly often.” Sexual abuse (10.2% [SE = 0.2]) was positive if there was unwanted sexual contact with an adult. Physical neglect (7.7% [SE = 0.2]) was positive if a parent/caregiver did not provide basic

needs at least “fairly often.” Emotional neglect (9.2% [$SE = 0.2$]) was determined using questions about family emotional support.

“Parental problems with alcohol or drug use” were ascertained as described previously.^{57,58} In separate modules, interviewers described observable manifestations of alcohol or drug use disorder diagnostic criteria, which are most likely to be apparent to offspring,^{58–60} and then asked separately whether the participant’s biological father or mother experienced such problems with alcohol or drugs. These measures show excellent reliability^{43,47} and validity.^{61–63} A binary variable was created, representing problems with alcohol or drugs, for either biological parent. Due to shared variance across substances,^{23,64} a composite measure is most likely to be related to cigarette outcomes.

Because parental substance problems and childhood maltreatment are related, to facilitate interpretation of results, we created a combined individual-level smoking risk factor with four categories: neither childhood maltreatment nor parental substance problems; childhood maltreatment only; parental substance problems only; and both childhood maltreatment and parental substance problems.

Tobacco Environment Factor

Multiple state-level tobacco control policies and attitudes jointly influence smoking prevalence and amount.^{25,26} To provide a parsimonious indicator of the state’s tobacco environment, we used a previously described latent factor.²⁶ This factor incorporated information on 12 tobacco-related variables using data from the ImpacTeen Database,⁶⁵ including cigarette taxation, tobacco control funding, smoke-free air laws and pre-emption, acceptability of smoking (smoking prevalence), and perception of risk due to smoking. These 12 items fit a single factor (Tucker-Lewis Index (TLI) = 0.94, comparative fit index (CFI) = 0.95), with factor scores indicating how the items jointly assess the smoking environment.²⁶ States with low factor scores were considered to have more permissive environments, with lower taxes, less spent on tobacco control, weaker smoke-free air protection, and more positive attitudes towards smoking (higher prevalence, lower perception of harm). States with higher scores had more restrictive environments, with higher taxes, more control funding, stronger smoke-free protection, and more negative attitudes. To facilitate analysis and interpretation, states were categorized into quartiles based on factor score (Figure 1): highly permissive

environment (17 states); moderately permissive (11 states); moderately restrictive (17 states); and highly restrictive (six states). Quartiles were used since no established cut-point exists to define a priori “high” or “low” values.

Data on tobacco environment variables were from 2005, for maximal overlap (8 months) with the W2 data collection (August 25, 2004 to August 31, 2005). To clarify whether marked changes occurred in these variables from 2004 (4 months overlapped with the W2 data collection), we examined change in cigarette tax, smoke-free laws, and past-month cigarette use. These changed minimally (cigarette tax, cigarette use) or not at all (smoke-free laws) in 8 states (two largest within each tobacco environment quartile), suggesting that 2005 data adequately represented the environment during data collection. Smoking prevalence (in the factor) was from other national datasets to prevent potential bias that could occur if prevalence was derived from the same dataset on the state- and individual-levels.²⁶ Furthermore, using quartiles of a latent factor composed of multiple indicators limits its potential problems with any specific environment variable.

Covariates

We controlled for demographic characteristics associated with cigarette smoking on the state and individual level. State-level demographics were derived from the American Community Survey,⁶⁶ and indicated the proportions of adult state residents in 2005 who were: male, white, married, completed high school, over 30 years of age, and below the poverty line. Individual-level demographics included sex, age, race/ethnicity, education level, marital status, personal income, and urbanicity. To control for common psychiatric comorbidity, we included two covariates: (1) any externalizing disorder (alcohol or drug dependence or abuse, or antisocial personality disorder); (2) any internalizing disorder (mood disorder [major depression or dysthymia] or anxiety disorder [generalized anxiety, post-traumatic stress, panic, social phobia, or specific phobia]).⁶⁷

Statistical Analysis

Main Effects

Logistic regression procedures evaluated the association of past-year smoking outcomes with the four-level individual risk variable

Figure 1. Composite tobacco environment,²⁶ by state, 2005.

(childhood maltreatment only, parental substance problems only, or both, vs. neither [reference]) and the state-level tobacco environment factor (highly permissive, moderately permissive, or moderately restrictive, vs. highly restrictive [reference]), adjusting for demographic covariates and psychiatric comorbidity. Additive effects (prevalence differences) were evaluated using model-predicted marginal log-odds of past-year smoking or heavy smoking back-transformed to the prevalence scale, by comparing the adjusted prevalence between population subgroups.⁶⁸ Data were analyzed using SUDAAN 11.0.1, which provides robust estimation of SEs using sample weights and adjusts for potential clustering due to complex sampling, so that population average models can appropriately assess the relationships between individual-level and state-level predictors and individual-level outcomes on the population level.²⁶

Additive Interaction

An interaction term in the regression models assessed additive interaction between the combined individual-level risk factor and the state-level tobacco environment factor. The general consensus in epidemiology is that additive interaction corresponds well to the current understanding of biological interaction and synergy^{69,70} and should be used to examine interactions with public health importance.^{71,72} The interaction contrast⁶⁹ estimates a “difference in differences,” or the difference in the additive effects (prevalence differences) of each state-level quartile versus the reference (highly restrictive), for participants in each category of the individual-level risk variable versus the reference (neither childhood maltreatment or parental substance problems). Wald *t* tests assessed the statistical significance of the prevalence differences and interaction contrasts.

Sensitivity Analysis

To determine if results could be due to respondents who quit smoking recently, analysis of main effects and additive interaction was repeated for “current smoking” and current “heavy smoking” (“past-year heavy smokers” who were “current smokers”).

Hypothetically Predicted Smoking Prevention

We estimated the number of smokers who might not have been smokers if the highly permissive states had been highly restrictive. Predicted probabilities of past-year smoking for each category of the four-level individual risk factor within highly permissive and highly restrictive states were calculated using logistic regression coefficients, unadjusted for covariates. Predicted probabilities were translated into estimates of the number of smokers within the relevant states (using 2005 state Census data⁷³), and differences in the number of predicted smokers between highly permissive and highly restrictive states were calculated. Since the analytical model only estimates what might be occurring, we report rounded estimates of the number of people, to provide a general idea of the potential impact of the tobacco environment.

Results

Sample Characteristics

About half the sample were female, about 70% non-Hispanic white, most were older than 30, about 60% had some college, about two-thirds were married, about 40% had average income <\$20 000, most lived in an urban area, 37% had any externalizing disorder, and 38% had any internalizing disorder (Table 1). Of the sample,

20.0% (*SE* = 0.3) reported childhood maltreatment only, 12.3% (*SE* = 0.3) reported parental substance problems only, and 10.4% (*SE* = 0.3) reported both (Table 2). Across the full sample, prevalence of past-year smoking was 20.4% (unweighted; *N* = 7063), 21.1% (weighted, *SE* = 0.4); and prevalence of heavy smoking (at least a pack a day) was 8.6% (unweighted; *N* = 2962), 9.9% (weighted, *SE* = 0.3).

Main Effects

Past-year smoking and heavy smoking were significantly associated with the four-level individual risk factor and the state-level tobacco environment (Table 2). Higher prevalence of any smoking was observed for those with childhood maltreatment only (prevalence increase of 4.1%, or +4.1%), parental substance problems only (+4.9%), and both (+8.2%), as compared to those with neither risk factor, and for tobacco environments (as compared to highly restrictive): highly permissive (+4.7%), moderately permissive (+2.4%), or moderately restrictive (+3.2%). Similarly, higher prevalence of heavy smoking was observed for those with childhood maltreatment only (+2.3%), parental substance problems only (+3.3%), and both (+5.5%), and tobacco environments: highly permissive (+4.0%), moderately permissive (+2.1%), or moderately restrictive (+2.7%).

Additive Interaction

For both smoking outcomes, interactions between the state-level tobacco environment factor and the individual-level risk factor were significant. The additive effects of the tobacco environment were generally stronger among participants with both individual vulnerabilities (childhood maltreatment and parental substance problems) or with parental substance problems only than among participants with neither individual vulnerability (Table 3).

For any smoking, the additive effect (prevalence difference) for the highly permissive versus highly restrictive tobacco environment was 13.3% ($P \leq .0001$) among participants with childhood maltreatment and parental substance problems, while the difference was 2.8% ($P = .02$) among participants with neither individual vulnerability factor, for an interaction contrast of 10.5% ($P = .0002$; Supplementary Figure 2). The tobacco environment effect (moderately permissive vs. highly restrictive) was stronger among participants with both individual vulnerability factors (interaction $P = .004$) or with only parental substance problems (interaction $P = .04$) than among participants with neither individual vulnerability factor. Similarly, the tobacco environment effect (moderately vs. highly restrictive) was also stronger among participants with both individual vulnerability factors (interaction $P = .001$) or with only parental substance problems (interaction $P = .035$) than among participants with neither.

For heavy smoking, the tobacco environment effect (highly permissive vs. highly restrictive) was significantly stronger among participants with both individual vulnerability factors than among participants with neither (interaction $P \leq .0001$; Supplementary Figure 3). The tobacco environment effect (moderately permissive vs. highly restrictive) was stronger among those with both vulnerability factors (interaction $P = .003$) or parental substance problems only (interaction $P = .02$) than among participants with neither. The tobacco environment effect (moderately vs. highly restrictive) was stronger among those with both individual vulnerability factors (interaction $P \leq .0001$) or parental substance problems only (interaction $P = .001$) than among participants with neither.

Table 1. Characteristics of the Study Sample ($N = 34\,638$)

	N	Unweighted prevalence %	Weighted prevalence ^a % (SE)
Sex			
Male	14 557	42.0	47.9 (0.3)
Female	20 081	58.0	52.1 (0.3)
Age			
20–29	4912	14.2	16.3 (0.3)
30–39	6618	19.1	18.7 (0.3)
40–49	7536	21.8	21.5 (0.3)
≥50	15 572	45.0	43.5 (0.5)
Race/ethnicity			
White (non-Hispanic)	20 154	58.2	70.9 (1.5)
Black (non-Hispanic)	6584	19.0	11.1 (0.7)
Native American/Alaska native	577	1.7	02.2 (0.2)
Asian/Native Hawaiian/Pacific Islander	968	2.8	04.3 (0.5)
Hispanic	6355	18.4	11.6 (1.2)
Education			
High school or less	14 956	43.2	41.5 (0.6)
Some college	19 682	56.8	58.5 (0.6)
Marital status			
Married/living together	18 862	54.5	63.8 (0.5)
Single/widowed/separated/divorced	15 776	45.6	36.2 (0.5)
Personal income			
\$0–19 999	15 181	43.8	42.2 (0.6)
\$20–34 999	8082	23.3	23.1 (0.4)
\$35–69 999	8178	23.6	24.3 (0.4)
>\$70 000	3197	9.2	10.4 (0.4)
Urbanicity			
Metropolitan statistical area	29 032	83.8	83.7 (0.6)
Not in a metropolitan statistical area	5606	16.2	16.3 (0.6)
Any externalizing disorder			
Any alcohol or drug use disorder, or antisocial personality disorder	12 284	35.5	37.4 (0.8)
Any internalizing disorder			
Any mood (major depression, dysthymia) or anxiety (generalized anxiety disorder, post-traumatic stress disorder, panic disorder, specific or social phobia) disorder	13 791	39.8	38.1 (0.5)

SE = standard error.

^aAdjusted for complex sampling using SUDAAN 11.0.1, to yield robust estimates of standard errors.

Among past-year smokers ($N = 7063$), heavy smoking prevalence was 46.7% ($SE = 0.9$). Compared to participants with neither individual vulnerability factor, the prevalence of heavy smoking was significantly higher among participants with parental substance problems only (+6.1%) or with both individual factors (+7.8%); compared to participants in highly restrictive tobacco environments, the prevalence of heavy smoking was higher in highly permissive (+8.6%), moderately permissive (+5.0%), or moderately restrictive (+6.3%) environments ([Supplementary Table 1](#)). The tobacco environment effect (highly permissive vs. highly restrictive) was stronger among those with both childhood maltreatment and parental substance problems than among participants with neither (interaction $P = .006$; [Supplementary Table 2](#)). The tobacco environment effect (moderately vs. highly restrictive) was significantly stronger among those with both individual vulnerability factors (interaction $P = .01$) or parental substance problems only (interaction $P = .009$) than among participants with neither.

Sensitivity Analysis

Of past-year smokers, 91.8% ($SE = 0.4$) were current smokers ($N = 6488$); of past-year heavy smokers, 94.3% ($SE = 0.6$) were current smokers ($N = 2797$). Results for current smoking and heavy

smoking (redefined to include only current smokers) were very similar to those for past-year smoking and heavy smoking. Prevalence of current smoking or heavy smoking (with current smoking) was increased in those with individual-level risk factors as compared to those without either individual-level risk factor, and was increased in the highly permissive, moderately permissive, and moderately restrictive environments as compared to the highly restrictive environment ([Supplementary Table 3](#)). Significant additive interaction indicated that the effect of the tobacco environment was stronger among those with childhood maltreatment and parental substance problems, for both outcomes ([Supplementary Table 4](#)). Thus, past-year smoking results were not due to respondents who recently quit smoking.

Hypothetically Predicted Smoking Prevention

Model-based estimates suggest that restricting the smoking environment in the highly permissive states could have resulted in additional numbers of nonsmokers: ~900 000 among those with childhood maltreatment only; ~600 000 among those with parental substance problems only; ~1.1 million among those with both risk factors; and ~1.6 million among those with neither risk factor, for ~ 4.2 million additional nonsmokers.

Table 2. Prevalence of Individual-Level Combined Risk Factor and State-Level Tobacco Environment Factor, and of Past-Year Smoking Outcomes by Those Factors, NESARC Wave 2 (N = 34 638)

	Predictor			Outcome: past-year smoking		Outcome: past-year heavy smoking	
	N	Unweighted prevalence %	Prevalence [%] (SE) ^a	Prevalence [%] (SE) ^{a,b}	Prevalence difference [%] (SE) ^{a,b}	Prevalence [%] (SE) ^{a,b}	Prevalence difference [%] (SE) ^{a,b}
Individual-level combined risk factor							
Neither	19 258	55.6	57.2 (0.5)	18.6 (0.4)	Reference	08.2 (0.3)	Reference
Childhood maltreatment only	7285	21.0	20.0 (0.3)	22.7 (0.7)	4.1 (0.6)***	10.5 (0.5)	2.3 (0.5)*
Parental substance problems only	4253	12.3	12.3 (0.3)	23.5 (0.8)	4.9 (0.9)***	11.5 (0.7)	3.3 (0.7)***
Childhood maltreatment and parental substance problems	3842	11.1	10.4 (0.3)	26.8 (1.0)	8.2 (1.0)***	13.7 (0.8)	5.5 (0.8)***
State-level composite tobacco environment							
Highly permissive	7718	22.3	23.6 (2.3)	23.2 (0.7)	4.7 (1.0)***	11.5 (0.5)	4.0 (0.8)***
Moderately permissive	9415	27.2	25.5 (2.9)	20.8 (0.6)	2.4 (0.8)*	09.6 (0.4)	2.1 (0.6)**
Moderately restrictive	8603	24.8	25.6 (3.4)	21.7 (0.6)	3.2 (0.8)***	10.2 (0.5)	2.7 (0.6)***
Highly restrictive	8902	25.7	25.3 (3.8)	18.5 (0.7)	Reference	07.5 (0.5)	Reference

NESARC = National Epidemiologic Survey on Alcohol and Related Conditions; SE = standard error. Past-year smoking is positive when smokers (smoked 100+ cigarettes since Wave 1 interview) smoked at least one full cigarette in the past year; past-year heavy smoking indicates smoking at least a pack or more of cigarettes a day; “childhood maltreatment” includes any sexual abuse, physical abuse, emotional neglect, or emotional neglect; “parental substance problems” includes participants with a father or mother who had problems with alcohol or drugs; “composite tobacco environment” refers to a published latent factor including 12 items assessing different aspects of the state tobacco environment, including taxation, control funding, smoke-free air protection, and smoking norms and prevalence.²⁶ The composite tobacco environment factor (Figure 1) was categorized into quartiles: highly permissive (−1.21 to −0.38); moderately permissive (−0.36 to −0.02); moderately restrictive (0 to 1.42); and highly restrictive (1.56 to 2.19).

^aAdjusted for complex sampling using SUDDAN 11.0.1.

^bFrom logistic regression (with back-transformation to the prevalence scale) adjusted for covariates on the individual-level (sex, age, race/ethnicity, urbanicity, personal income, marital status, education level, any externalizing disorder, any internalizing disorder) and state-level (percent of state: over 30 years old, male, married, finished high school, white, and below the poverty line).

P values: * ≤ .01; ** ≤ .001; *** ≤ .0001.

Table 3. Differential Effects of the State-Level Tobacco Environment Factor on Past-Year Smoking Outcomes, by the Individual-Level Risk Factor, NESARC Wave 2 (N = 34 638)

	Highly permissive quartile	Moderately permissive quartile	Moderately restrictive quartile	Highly restrictive quartile	Highly permissive vs. highly restrictive			Moderately permissive vs. highly restrictive			Moderately restrictive vs. Highly restrictive		
					Prevalence difference [%] (SE) ^{a,b}	Interaction contrast [%] (SE) ^{a,c}	Prevalence difference [%] (SE) ^{a,b}	Interaction contrast [%] (SE) ^{a,c}	Prevalence difference [%] (SE) ^{a,b}	Interaction contrast [%] (SE) ^{a,c}	Prevalence difference [%] (SE) ^{a,b}	Interaction contrast [%] (SE) ^{a,c}	
Past-year smoking													
Neither individual-level factor	20.2 (0.8)	18.2 (0.8)	18.5 (0.7)	17.4 (0.9)	2.8 (1.2)*	Reference	0.8 (1.1)	Reference	1.1 (1.0)	Reference	Reference	Reference	
Childhood maltreatment only	25.0 (1.3)	21.5 (1.0)	24.1 (1.2)	20.1 (1.2)	4.9 (1.8)**	2.1 (1.8)	1.4 (1.5)	0.6 (1.7)	4.1 (1.6)**	3.0 (1.7)	4.1 (1.6)**	3.0 (1.7)	
Parental substance problems only	25.0 (1.6)	24.7 (1.5)	24.9 (1.4)	19.1 (1.4)	5.9 (2.2)**	3.0 (2.4)	5.6 (2.0)**	4.7 (2.3)*	5.8 (2.0)**	4.7 (2.2)*	5.8 (2.0)**	4.7 (2.2)*	
Both individual-level factors	32.4 (1.9)	26.9 (1.6)	28.2 (1.5)	19.1 (1.7)	13.3 (2.5)***	10.5 (2.6)***	7.8 (2.3)***	7.0 (2.4)**	9.1 (2.2)***	8.1 (2.7)***	9.1 (2.2)***	8.1 (2.7)***	
Past-year heavy smoking													
Neither individual-level factors	9.6 (0.6)	7.9 (0.5)	7.8 (0.6)	7.1 (0.6)	2.5 (0.9)**	Reference	0.8 (0.8)	Reference	0.6 (0.8)	Reference	Reference	Reference	
Childhood maltreatment only	11.1 (0.8)	10.2 (0.8)	11.8 (1.0)	8.7 (1.0)	2.4 (1.3)	-0.1 (1.4)	1.5 (1.2)	0.7 (1.4)	3.2 (1.3)*	2.5 (1.5)	3.2 (1.3)*	2.5 (1.5)	
Parental substance problems only	12.8 (1.3)	11.9 (1.3)	13.1 (1.2)	7.1 (0.9)	5.8 (1.6)***	3.3 (1.7)	4.8 (1.6)**	4.0 (1.7)*	6.0 (1.5)***	5.4 (1.6)***	6.0 (1.5)***	5.4 (1.6)***	
Both individual-level factors	18.5 (1.6)	13.1 (1.4)	14.8 (1.4)	7.2 (0.9)	11.3 (1.9)***	8.8 (1.9)***	5.9 (1.6)***	5.1 (1.6)**	7.6 (1.6)***	6.9 (1.7)***	7.6 (1.6)***	6.9 (1.7)***	

NESARC = National Epidemiologic Survey on Alcohol and Related Conditions; SE = standard error. Past-year smoking is positive when smokers (smoked ≥ 100 cigarettes since Wave 1 interview) smoked at least one full cigarette in the past year; past-year heavy smoking indicates smoking at least a pack or more of cigarettes a day; "childhood maltreatment" includes any sexual abuse, physical abuse, emotional abuse, physical neglect, or emotional neglect; "parental substance problems" includes participants with a father or mother who had problems with alcohol or drugs; "composite tobacco environment" refers to a published latent factor including 12 items assessing different aspects of the state tobacco environment, including taxation, control funding, smoke-free air protection, and smoking norms and prevalence.²⁶ The composite tobacco environment factor (Figure 1) was categorized into quartiles: highly permissive (-0.36 to -0.02); moderately permissive (-0.02 to 0.02); moderately restrictive (0 to 1.42); and highly restrictive (1.56 to 2.19).

^aFrom logistic regression (with back-transformation to the prevalence scale) adjusted for complex sampling using SUDAAN 11.0.1, and for covariates on the individual-level (sex, age, race/ethnicity, urbanicity, personal income, marital status, education level, any externalizing disorder, any internalizing disorder) and state-level (percent of state: over 30 years old, male, married, finished high school, white, below the poverty line).

^bDifference in the prevalence as compared to the reference (states with highly restrictive environments), for each category of the combined individual-level risk factor.

^cInteraction contrast is the difference in the prevalence differences (effect of state-level composite tobacco environment) for those in each category of the combined individual-level risk factor vs. those with neither individual-level risk factor; when significantly different from zero, this indicates additive interaction.

P values: * $\leq .05$; ** $\leq .01$; *** $\leq .001$; **** $\leq .0001$.

Discussion

Using a large, nationally-representative US sample, we showed both main effects of the combined individual-level risk factor and the state-level tobacco environment factor, and significant interaction between the state-level and individual-level factors, on past-year smoking. Interaction results indicated that those with both childhood maltreatment and parental substance problems show the greatest differences in smoking prevalence in states with permissive smoking environments compared to states with restrictive smoking environments. These findings persisted after controlling for demographic characteristics and psychiatric comorbidity. Results suggest that further restricting permissive state tobacco environments would reduce smoking, especially impacting those with individual vulnerability to smoking.

Similar to previous studies showing association between cigarette smoking and childhood maltreatment⁵⁻¹⁴ or parental substance problems,¹⁶⁻¹⁸ respondents with those experiences were more likely than those without such experiences to smoke and be heavier smokers. In addition, similar to previous studies showing relationships between cigarette smoking and aspects of the tobacco environment factor (eg, perception of health risks, cigarette taxation/price, control funding, smoke-free air policies^{3,25,28,31,32}), respondents in states with more permissive smoking environments (with lower factor scores, indicating greater acceptability of smoking, lower perception of risk, lower tax, lower control funding, and weaker smoke-free air protection), smoked more, on average, than those in more restrictive states. With these results on the state-level composite tobacco environment using national data, future studies should investigate specific tobacco policies (eg, smoke-free air laws) that may have important local (eg, city, county) effects.

Our findings bring the individual and environmental levels together to indicate that the most vulnerable individuals, that is, those with childhood maltreatment and parental substance problems, showed the largest effects of the state-level tobacco environment. Among respondents with the individual vulnerability factors, those in restrictive states had lower prevalence of past-year smoking and heavy smoking compared to those living in more permissive states. These findings suggest that smoking behaviors of adults who experienced childhood risk factors (whose effects often persist across the life-course) are most influenced by the group-level environment. These results appear to differ from studies suggesting less effectiveness of tobacco control policies/campaigns among individuals with psychiatric vulnerabilities (eg, substance use disorders, depression^{74,75}). However, studies formally testing the interaction between psychiatric disorders and tobacco environment are lacking and are warranted to more fully understand the interplay of individual-level vulnerability and group-level environment on smoking. Here, we controlled for psychiatric vulnerability, suggesting that the more general individual risk factors we examined are important indicators of individual vulnerability in the context of group-level environmental factors. Therefore, further restriction of the tobacco environment, through public health campaigns to influence attitudes towards smoking or legislation to strengthen tobacco control policies, could have broad effects, particularly impacting those with general vulnerability to smoking.

Predictive models estimate that if the highly permissive states had been like the highly restrictive states, there may have been greater than 4 million additional nonsmokers, with a concomitant reduction in premature deaths and morbidity due to smoking. These additional nonsmokers could have meant ~1.5 million fewer individuals with

smoking-related diseases, since ~38% of current smokers suffer from diseases caused by smoking, such as lung (and other) cancers and cardiovascular disease, and second-hand smoke causes serious health problems (eg, strokes).⁴ While one could argue that the remaining smokers are “hardened,”⁷⁶ results presented here suggest otherwise, since the environmental effect is strongest among those with individual vulnerabilities associated with increased risk for smoking or decreased ability to quit. Thus, restricting the tobacco environments in the permissive states could help reduce the national prevalence of smoking and smoking-related morbidity and mortality.

Limitations

First, individuals were not randomly assigned to states, and may select into states based on smoking-related environments or other reasons. The state-level tobacco environment factor and the individual vulnerability variable showed mild association ($\chi^2(9) = 2.64$, $P = .012$), although the most informative vulnerability group (both childhood maltreatment and parental substance problems) showed similar distribution in the tobacco environment quartiles. While selection seems unlikely, whether this occurs is unknown and merits further study. Furthermore, there may be unobserved differences in other state-level variables that could play a role in the observed state-level effects. Second, participants could have moved, and their measured state tobacco environment may not be the environment most influential to their smoking behaviors. Although less than 15% of Americans moved in 2005, with a majority (75%) of those who moved remaining within the same state,⁷⁷ future studies should investigate the effects on smoking behaviors of moving between environments with different restrictiveness levels. Third, individual-level factors such as stressful life events, reasons for smoking, or motivation to quit or reduce use, may influence the relationship between the predictors and smoking. Additional research can further elucidate the complex mechanisms through which both state-level smoking environment and individual-level risk factors affect smoking. Fourth, there were few individuals in some of the joint distributions of state-level tobacco environment and state-level poverty (eg, highly restrictive/high poverty) but the same significant main and interaction effects were observed whether or not state-level poverty was included in the analysis. Fifth, parental smoking or related problems were not assessed in NESARC. However, evidence for the shared genetic variance across addiction to nicotine, alcohol, and drugs^{23,24,64} supports the use of a composite variable indicating parental alcohol or drug problems to assess parental substance problems. Since parental smoking may confer additional vulnerability beyond shared genetic effects, further studies should investigate if greater effects of the tobacco environment are observed among those with even more vulnerability to smoking due to parental smoking. Sixth, results were from an observational study in cross-sectional data. The state-level tobacco environment may have changed slightly during the data collection period; longitudinal studies should determine the directionality and extent of the association between tobacco environment and change in smoking over time, particularly among vulnerable individuals. Seventh, multi-level (hierarchical) models should be used in future studies as these may provide more precise estimates of *SEs* for state-level effects. Eighth, the hypothetical estimates of additional nonsmokers had permissive states been more restrictive are model-based predictions. Ninth, these data were collected ~10 years ago; subsequently, several states became more restrictive towards tobacco. Studies using more recent data could determine the enduring effects of such changes. Nevertheless, these

results remain salient because the tobacco industry may continue to seek ways to roll back laws or policies that restrict smoking; information on more permissive control policies provides a reminder of the possible impact of such roll-backs. Additionally, many states still have considerable distance to go in adopting restrictive smoking policies. In 2013, 20 states had taxes of <\$1.00 (below the recommended \$2.00), 19 states did not have comprehensive smoke-free laws, and 41 states spent below 50% of the recommended amount for tobacco control.²⁷

Conclusions

This study provides new evidence on individual-level moderators of the association of state-level tobacco environment and smoking. The lower risk for smoking or heavy smoking associated with restrictive environments was primarily observed among those with individual risk factors (parental substance problems with or without childhood maltreatment). Showing that the tobacco environment effect is strongest in more vulnerable individuals underscores the influence of the tobacco environment. Finding effective ways to have permissive states restrict their smoking environments may help accomplish the major public health goal of reducing smoking prevalence, which should reduce the massive health burden of tobacco-related morbidity and mortality.⁷⁸

Supplementary Material

Supplementary Tables 1–4 and Figures 1–3 can be found online at <http://www.ntr.oxfordjournals.org>

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Declaration of Interests

None declared.

References

- Fletcher JM. Why have tobacco control policies stalled? Using genetic moderation to examine policy impacts. *PLoS One*. 2012;7(12):e50576. doi:10.1371/journal.pone.0050576.
- Centers for Disease Control and Prevention. Trends in current cigarette smoking among high school students and adults, United States, 1965–2011. 2013. www.cdc.gov/tobacco/data_statistics/tables/trends/cig_smoking/. Accessed May 4, 2015.
- The Community Guide. Guide to Community Preventive Services. Reducing tobacco use and secondhand smoke exposure. 2014. www.thecommunityguide.org/tobacco/index.html. Accessed September 4, 2014.
- US Department of Health and Human Services. The health consequences of smoking: 50 years of progress: A Report of the Surgeon General. 2014. www.surgeongeneral.gov/library/reports/50-years-of-progress/fact-sheet.html. Accessed June 28, 2015.
- Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking during adolescence and adulthood. *JAMA*. 1999;282(17):1652–1658. doi:joc81372.
- Chartier MJ, Walker JR, Naimark B. Health risk behaviors and mental health problems as mediators of the relationship between childhood abuse and adult health. *Am J Public Health*. 2009;99(5):847–854. doi:10.2105/AJPH.2007.122408.
- Ford ES, Anda RF, Edwards VJ, et al. Adverse childhood experiences and smoking status in five states. *Prev Med*. 2011;53(3):188–193. doi:10.1016/j.ypmed.2011.06.015.
- King G, Guilbert P, Ward DG, Arwidson P, Noubary F. Correlates of sexual abuse and smoking among French adults. *Child Abuse Negl*. 2006;30(6):709–723. doi:10.1016/j.chiabu.2006.02.011.
- Nelson EC, Heath AC, Lynskey MT, et al. Childhood sexual abuse and risks for licit and illicit drug-related outcomes: a twin study. *Psychol Med*. 2006;36(10):1473–1483. doi:10.1017/S0033291706008397.
- Papadodima SA, Sakellidis EI, Sergeantanis TN, Giotakos O, Sergeantanis IN, Spiliopoulou CA. Smoking in prison: a hierarchical approach at the crossroad of personality and childhood events. *Eur J Public Health*. 2010;20(4):470–474. doi:10.1093/eurpub/ckp209.
- Roberts ME, Fuemmeler BF, McClernon FJ, Beckham JC. Association between trauma exposure and smoking in a population-based sample of young adults. *J Adolesc Health*. 2008;42(3):266–274. doi:10.1016/j.jadohealth.2007.08.029.
- Spratt EG, Back SE, Yeatts SD, et al. Relationship between child abuse and adult smoking. *Int J Psychiatry Med*. 2009;39(4):417–426. doi:10.2190/PM.39.4.f.
- Topitzes J, Mersky JP, Reynolds AJ. Child maltreatment and adult cigarette smoking: a long-term developmental model. *J Pediatr Psychol*. 2010;35(5):484–498. doi:10.1093/jpepsy/jsp119.
- Vander Weg MW. Adverse childhood experiences and cigarette smoking: the 2009 Arkansas and Louisiana Behavioral Risk Factor Surveillance Systems. *Nicotine Tob Res*. 2011;13(7):616–622. doi:10.1093/ntr/ntr023.
- Sinha R. How does stress increase risk of drug abuse and relapse? *Psychopharmacology (Berl)*. 2001;158(4):343–359. doi:10.1007/s002130100917.
- Dierker LC, Avenevoli S, Merikangas KR, Flaherty BP, Stolar M. Association between psychiatric disorders and the progression of tobacco use behaviors. *J Am Acad Child Adolesc Psychiatry*. 2001;40(10):1159–1167. doi:10.1097/00004583-200110000-00009.
- Dierker LC, Canino G, Merikangas KR. Association between parental and individual psychiatric/substance use disorders and smoking stages among Puerto Rican adolescents. *Drug Alcohol Depend*. 2006;84(2):144–153. doi:10.1016/j.drugalcdep.2006.01.008.
- Hayatbakhsh R, Mamun AA, Williams GM, O'Callaghan MJ, Najman JM. Early childhood predictors of early onset of smoking: a birth prospective study. *Addict Behav*. 2013;38(10):2513–2519. doi:10.1016/j.addbeh.2013.05.009.
- Scherrer JF, Xian H, Pan H, et al. Parent, sibling and peer influences on smoking initiation, regular smoking and nicotine dependence. Results from a genetically informative design. *Addict Behav*. 2012;37(3):240–247. doi:10.1016/j.addbeh.2011.10.005.
- Lubke GH, Stephens SH, Lessem JM, Hewitt JK, Ehringer MA. The CHRNA5/A3/B4 gene cluster and tobacco, alcohol, cannabis, inhalants and other substance use initiation: replication and new findings using mixture analyses. *Behav Genet*. 2012;42(4):636–646. doi:10.1007/s10519-012-9529-y.
- Yang BZ, Han S, Kranzler HR, Farrer LA, Elston RC, Gelernter J. Autosomal linkage scan for loci predisposing to comorbid dependence on multiple substances. *Am J Med Genet B Neuropsychiatr Genet*. 2012;159B(4):361–369. doi:10.1002/ajmg.b.32037.
- Gruza RA, Bierut LJ. Co-Occurring risk factors for alcohol dependence and habitual smoking. *Alcohol Res Health*. 2006;29(3):172–178.
- Vrieze SI, McGue M, Miller MB, Hicks BM, Iacono WG. Three mutually informative ways to understand the genetic relationships among behavioral disinhibition, alcohol use, drug use, nicotine use/dependence, and their co-occurrence: twin biometry, GCTA, and genome-wide scoring. *Behav Genet*. 2013;43(2):97–107. doi:10.1007/s10519-013-9584-z.
- Hicks BM, Foster KT, Iacono WG, McGue M. Genetic and environmental influences on the familial transmission of externalizing disorders in adoptive and twin offspring. *JAMA Psychiatry*. 2013;70(10):1076–1083. doi:10.1001/jamapsychiatry.2013.258.

25. Warner KE, Mendez D. Tobacco control policy in developed countries: yesterday, today, and tomorrow. *Nicotine Tob Res.* 2010;12(9):876–887. doi:10.1093/ntr/ntq125.
26. Hatzenbuehler ML, Keyes KM, Hamilton A, Hasin DS. State-level tobacco environments and sexual orientation disparities in tobacco use and dependence in the USA. *Tob Control.* 2014;23(e2):e127–132. doi:10.1136/tobaccocontrol-2013-051279.
27. Centers for Disease Control and Prevention. Prevention Status Report: Tobacco Use. 2014. www.cdc.gov/psr/tobacco/index.html. Accessed May 4, 2015.
28. Wilson LM, Avila Tang E, Chander G, et al. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review. *J Environ Public Health.* 2012;2012:961724. doi:10.1155/2012/961724.
29. Farrelly MC, Pechacek TF, Chaloupka FJ. The impact of tobacco control program expenditures on aggregate cigarette sales: 1981–2000. *J Health Econ.* 2003;22(5):843–859. doi:10.1016/S0167-6296(03)00057-2.
30. Tauras JA, Chaloupka FJ, Farrelly MC, et al. State tobacco control spending and youth smoking. *Am J Public Health.* 2005;95(2):338–344. doi:10.2105/AJPH.2004.039727.
31. Hopkins DP, Razi S, Leeks KD, Priya Kalra G, Chattopadhyay SK, Soler RE. Smokefree policies to reduce tobacco use. A systematic review. *Am J Prev Med.* 2010;38(2 Suppl):S275–289. doi:10.1016/j.amepre.2009.10.029.
32. Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behaviour: systematic review. *BMJ.* 2002;325(7357):188. doi:10.1136/bmj.325.7357.188.
33. Christakis NA, Fowler JH. The collective dynamics of smoking in a large social network. *N Engl J Med.* 2008;358(21):2249–2258. doi:10.1056/NEJMsa0706154.
34. Harakeh Z, Scholte RH, Vermulst AA, de Vries H, Engels RC. Parental factors and adolescents' smoking behavior: an extension of the theory of planned behavior. *Prev Med.* 2004;39(5):951–961. doi:10.1016/j.pymed.2004.03.036.
35. Van Zundert RM, Engels RC, Van den Eijnden RJ. Adolescent smoking continuation: reduction and progression in smoking after experimentation and recent onset. *J Behav Med.* 2006;29(5):435–447. doi:10.1007/s10865-006-9065-4.
36. Savoy E, Reitzel LR, Scheuermann TS, et al. Risk perception and intention to quit among a tri-ethnic sample of nondaily, light daily, and moderate/heavy daily smokers. *Addict Behav.* 2014;39(10):1398–1403. doi:10.1016/j.addbeh.2014.05.002.
37. Cavazos-Rehg PA, Krauss MJ, Spitznagel EL, et al. Differential effects of cigarette price changes on adult smoking behaviours. *Tob Control.* 2014;23(2):113–118. doi:10.1136/tobaccocontrol-2012-050517.
38. Grant BF, Stinson FS, Dawson DA, Chou SP, Ruan WJ, Pickering RP. Co-occurrence of 12-month alcohol and drug use disorders and personality disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry.* 2004;61(4):361–368. doi:10.1001/archpsyc.61.4.361.
39. Grant BF, Goldstein RB, Chou SP, et al. Sociodemographic and psychopathologic predictors of first incidence of DSM-IV substance use, mood and anxiety disorders: results from the Wave 2 National Epidemiologic Survey on Alcohol and Related Conditions. *Mol Psychiatry.* 2009;14(11):1051–1066. doi:10.1038/mp.2008.41.
40. Stetser M, Shepherd J, Moore TF. *Using the Census 2000/2001 Supplementary Survey as a Sampling Frame for the National Epidemiological Survey on Alcohol and Related Conditions*. Alexandria, VA: American Statistical Association; 2002. www.amstat.org/sections/srms/Proceedings/y2002/Files/JSM2002-000531.pdf. Accessed May 4, 2014.
41. Grant BF, Moore TC, Shepard J, Kaplan K. *Source and Accuracy Statement: Wave 1 National Epidemiologic Survey on Alcohol Abuse and Related Conditions (NESARC)*. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2003.
42. Grant BF, Dawson DA. Introduction to the National Epidemiologic Survey on Alcohol and Related Conditions. *Alcohol Res Health.* 2006;29(2):74–78.
43. Grant BF, Dawson DA, Stinson FS, Chou PS, Kay W, Pickering R. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. *Drug Alcohol Depend.* 2003;71(1):7–16. doi:10.1016/S0376-8716(03)00070-X.
44. Grant BF, Harford TC, Dawson DA, Chou PS, Pickering RP. The Alcohol Use Disorder and Associated Disabilities Interview schedule (AUDADIS): reliability of alcohol and drug modules in a general population sample. *Drug Alcohol Depend.* 1995;39(1):37–44. doi:10.1016/0376-8716(95)01134-K.
45. Hasin D, Carpenter KM, McCloud S, Smith M, Grant BF. The alcohol use disorder and associated disabilities interview schedule (AUDADIS): reliability of alcohol and drug modules in a clinical sample. *Drug Alcohol Depend.* 1997;44(2–3):133–141. doi:10.1016/S0376-8716(97)01332-X.
46. Pull CB, Saunders JB, Mavreas V, et al. Concordance between ICD-10 alcohol and drug use disorder criteria and diagnoses as measured by the AUDADIS-ADR, CIDI and SCAN: results of a cross-national study. *Drug Alcohol Depend.* 1997;47(3):207–216. doi:10.1016/S0376-8716(97)00091-4.
47. Hasin D, Paykin A. Alcohol dependence and abuse diagnoses: concurrent validity in a nationally representative sample. *Alcohol Clin Exp Res.* 1999;23(1):144–150. doi:10.1111/j.1530-0277.1999.tb04036.x.
48. Hasin DS, Stinson FS, Ogburn E, Grant BF. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry.* 2007;64(7):830–842. doi:10.1001/archpsyc.64.7.830.
49. Chatterji S, Saunders JB, Vraiti R, Grant BF, Hasin D, Mager D. Reliability of the alcohol and drug modules of the Alcohol Use Disorder and Associated Disabilities Interview Schedule–Alcohol/Drug-Revised (AUDADIS-ADR): an international comparison. *Drug Alcohol Depend.* 1997;47(3):171–185. doi:10.1016/S0376-8716(97)00088-4.
50. Soukaková JN, Hartman AM, Liu B, Willis GB, Augustine S. Reliability of adult self-reported smoking history: data from the tobacco use supplement to the current population survey 2002–2003 cohort. *Nicotine Tob Res.* 2012;14(8):952–960. doi:10.1093/ntr/ntq313.
51. Straus MA, Gelles RJ. *Physical Violence in American Families: Risk Factors and Adaptations to Violence in 8,145 Families*. New Brunswick, NJ: Transaction Publishing; 1990.
52. Bernstein DP, Fink L, Handelsman L, et al. Initial reliability and validity of a new retrospective measure of child abuse and neglect. *Am J Psychiatry.* 1994;151(8):1132–1136. doi:10.1176/ajp.151.8.1132.
53. Ruan WJ, Goldstein RB, Chou SP, et al. The alcohol use disorder and associated disabilities interview schedule-IV (AUDADIS-IV): reliability of new psychiatric diagnostic modules and risk factors in a general population sample. *Drug Alcohol Depend.* 2008;92(1–3):27–36. doi:10.1016/j.drugalcdep.2007.06.001.
54. Dube SR, Felitti VJ, Dong M, Chapman DP, Giles WH, Anda RF. Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: the adverse childhood experiences study. *Pediatrics.* 2003;111(3):564–572. doi:10.1542/peds.111.3.564.
55. Afifi TO, Henriksen CA, Asmundson GJ, Sareen J. Childhood maltreatment and substance use disorders among men and women in a nationally representative sample. *Can J Psychiatry.* 2012;57(11):677–686.
56. Kim JH, Martins SS, Shmulewitz D, et al. Childhood maltreatment, stressful life events, and alcohol craving in adult drinkers. *Alcohol Clin Exp Res.* 2014;38(7):2048–2055. doi:10.1111/acer.12473.
57. Fenton MC, Geier T, Keyes K, Skodol AE, Grant BF, Hasin DS. Combined role of childhood maltreatment, family history, and gender in the risk for alcohol dependence. *Psychol Med.* 2013;43(5):1045–1057. doi:10.1017/S0033291712001729.
58. Heiman GA, Ogburn E, Gorroochurn P, Keyes KM, Hasin D. Evidence for a two-stage model of dependence using the NESARC and its implications for genetic association studies. *Drug Alcohol Depend.* 2008;92(1–3):258–266. doi:10.1016/j.drugalcdep.2007.08.007.

59. Andreasen NC, Endicott J, Spitzer RL, Winokur G. The family history method using diagnostic criteria. Reliability and validity. *Arch Gen Psychiatry*. 1977;34(10):1229–1235.
60. Slutske WS, Heath AC, Madden PA, et al. Reliability and reporting biases for perceived parental history of alcohol-related problems: agreement between twins and differences between discordant pairs. *J Stud Alcohol*. 1996;57(4):387–395. doi: 10.15288/jsa.1996.57.387.
61. Dawson DA, Saha TD, Grant BF. A multidimensional assessment of the validity and utility of alcohol use disorder severity as determined by item response theory models. *Drug Alcohol Depend*. 2010;107(1):31–38. doi:10.1016/j.drugalcdep.2009.08.019.
62. Grant BF, Harford TC, Muthen BO, Yi HY, Hasin DS, Stinson FS. DSM-IV alcohol dependence and abuse: further evidence of validity in the general population. *Drug Alcohol Depend*. 2007;86(2–3):154–166. doi:10.1016/j.drugalcdep.2006.05.019.
63. Hasin DS, Liu X, Alderson D, Grant BF. DSM-IV alcohol dependence: a categorical or dimensional phenotype? *Psychol. Med.* 2006;36(12):1695–1705. doi:10.1017/S0033291706009068.
64. Agrawal A, Verweij KJ, Gillespie NA, et al. The genetics of addiction—a translational perspective. *Transl Psychiatry*. 2012;2:e140. doi:10.1038/tp.2012.54.
65. Impacteen. Tobacco Control Policy and Prevalence Data: 1991–2008. 2008. www.impacteen.org/tobaccodata.htm. Accessed August 10, 2014.
66. Ruggles S, Alexander JT, Genadek K, Goeken R, Schroeder MB, Sobek M. *Integrated Public Use Microdata Series: Version 5.0 [Machine-readable Database]*. Minneapolis, MN: University of Minnesota; 2010.
67. Keyes KM, Eaton NR, Krueger RF, et al. Childhood maltreatment and the structure of common psychiatric disorders. *Br J Psychiatry*. 2012;200(2):107–115. doi:10.1192/bjp.bp.111.093062.
68. Bieler GS, Brown GG, Williams RL, Brogan DJ. Estimating model-adjusted risks, risk differences, and risk ratios from complex survey data. *Am J Epidemiol*. 2010;171(5):618–623. doi:10.1093/aje/kwp440.
69. Rothman KJ. *Epidemiology: An Introduction*. New York, NY: Oxford University Press; 2002.
70. Schwartz S. Modern epidemiologic approaches to interaction: applications to the study of genetic interactions. In: Hernandez LM, Blazer DG, eds. *Genes, Behavior, and the Social Environment: Moving Beyond the Nature/Nurture Debate*. Washington, DC: National Academies Press; 2006:310–337. doi:10.17226/11693.
71. Knol MJ, VanderWeele TJ. Recommendations for presenting analyses of effect modification and interaction. *Int J Epidemiol*. 2012;41(2):514–520. doi:10.1093/ije/dyr218.
72. Rothman KJ, Greenland S, Walker AM. Concepts of interaction. *Am J Epidemiol*. 1980;112(4):467–470.
73. United States Census Bureau. Population estimates, Vintage 2005: State tables. 2005. www.census.gov/popest/data/historical/2000s/vintage_2005/state.html. Accessed June 4, 2015.
74. Secades-Villa R, Olfson M, Okuda M, et al. Trends in the prevalence of tobacco use in the United States, 1991–1992 to 2004–2005. *Psychiatr Serv*. 2013;64(5):458–465. doi:10.1176/appi.ps.002852012.
75. Cook BL, Wayne GF, Kafali EN, Liu Z, Shu C, Flores M. Trends in smoking among adults with mental illness and association between mental health treatment and smoking cessation. *JAMA*. 2014;311(2):172–182. doi:10.1001/jama.2013.284985.
76. Hughes JR. *The Case for Hardening of the Target. Monograph 15: Those Who Continue To Smoke: Is Achieving Abstinence Harder and Do We Need to Change Our Interventions? Smoking and Tobacco Control Monograph No. 15. (NIH Publication No. 03-5370)*. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; 2003:33–39.
77. United States Census Bureau. Migration/Geographic Mobility. 2015. www.census.gov/hhes/migration/data/cps.html. Accessed February 21, 2016.
78. Office of Disease Prevention and Health Promotion. 2020 Topics and objectives: Tobacco Use. 2015. www.healthypeople.gov/2020/topics-objectives/topic/tobacco-use. Accessed May 4, 2015.