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Clean indoor air laws, cigarette excise taxes, and smoking: Results from the current population survey-tobacco use supplement, 2003–2011

Ramin Mojtabai^a, Kira E. Riehm^a, Joanna E. Cohen^{b,c}, G. Caleb Alexander^{d,e,f}, Lainie Rutkow^{g,*}

^a Department of Mental Health, Hampton House, 624 North Broadway, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

^b Department of Health, Behavior and Society, Hampton House, 624 North Broadway, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

^c Institute for Global Tobacco Control, 2213 McElderry Street, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

^d Center for Drug Safety and Effectiveness, 615 North Wolfe Street, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

^e Department of Epidemiology, 615 North Wolfe Street, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

^f Division of General Internal Medicine, 1800 Orleans Street, Johns Hopkins Medicine, Baltimore, MD, United States

^g Department of Health Policy and Management, Hampton House, 624 North Broadway, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, United States

ABSTRACT

There was an increase in the number and coverage of state and local clean indoor air laws in the US during the past fifteen years. These laws coincided with increases in federal, state, and local cigarette excise taxes. In light of these changes, the objective of this study was to examine the association between clean indoor air laws, cigarette excise taxes and smoking patterns between 2003 and 2011. Using data on 62,165 adult participants in the 2003 and 2010/2011 Current Population Survey-Tobacco Use Supplement who reported smoking cigarettes in the past year, we examined the association of state and county workplace, bar, and restaurant clean indoor air laws and cigarette excise taxes with quitting and current every-day smoking. Between 2003 and 2011, quitting increased and daily smoking among those who continued to smoke decreased significantly. Participants living in states and counties with higher excise taxes and more comprehensive clean indoor air laws had a higher likelihood of quitting and lower likelihood of everyday smoking. Based on the assumption of no uncontrolled confounding, changes in taxes and laws accounted for 64.8% of the increase in smoking cessation and all of the reduction in everyday smoking. Implementation of state and county-level clean indoor air laws and cigarette taxes appears to have achieved the intended goal of encouraging smokers to either quit or reduce their frequency of smoking.

1. Introduction

Over the past five decades, the prevalence of smoking in the United States has significantly declined. The recently released Surgeon General's Report, *The Health Consequences of Smoking—50 Years of Progress*, noted that former smokers now outnumber current smokers in the U.S., and quit rates among smokers have increased (Office of the Surgeon General, 2014). Despite these successes, smoking remains a major public health problem, with over 18% of U.S. adults classified as current smokers (Centers for Disease Control and Prevention, 2014). Adults with lower income and lower education are especially likely to

smoke, and smoking continues to be the foremost cause of preventable death in the U.S. (Centers for Disease Control and Prevention, 2014)

While much of the decrease in overall smoking rates is attributable to a combination of cohort effects, changing social norms, and a greater knowledge about the adverse health consequences of smoking (Holford et al., 2014; Nelson et al., 2008; Cummings and Proctor, 2014), tobacco control policies at the national, state, and local levels have also impacted smoking trends (Choi and Boyle, 2013; McMullen et al., 2005; Siegel et al., 2008; Hoffman and Tan, 2015). Taxes on cigarettes have been associated with reduced prevalence of smoking as well as reduced consumption of cigarettes (Hoffman and Tan, 2015; Chaloupka et al.,

Abbreviations: CPS-TUS, Current Population Survey-Tobacco Use Supplement; ANRF, American Nonsmokers' Rights Foundation; FIPS, Federal Information Processing Standard; OR, odds ratio; aOR, adjusted odds ratio

* Corresponding author at: Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, 624 N. Broadway, Room 592, Baltimore, MD 21205, United States.

E-mail address: lrutkow@jhu.edu (L. Rutkow).

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2012), particularly among price-sensitive populations such as young adults and individuals with lower incomes (Franz, 2008). In addition, clean indoor air laws, which prohibit smoking in a variety of venues including workplaces, restaurants, bars, casinos, and recreational facilities, have been associated with decreased risk of cardiac and respiratory diseases (Tan and Glantz, 2012), and decreased hospitalization rates for these diseases (Loomis and Juster, 2012). These laws have also been associated with reduced smoking prevalence (Hoffman and Tan, 2015; Hahn, 2010; Hopkins et al., 2010) and increased cessation attempts (Hahn et al., 2009), including increases in individuals with voluntarily smoke-free homes (Cheng et al., 2011).

Importantly, state and local governments vary considerably in their adoption of tobacco control policies. For example, as recently as July 2018 state excise taxes ranged from a high of \$4.35/pack in Connecticut and New York to a low of \$0.30/pack in Virginia (Campaign for Tobacco-Free Kids, 2018). Similarly, clean indoor air laws vary significantly across states and localities. Approximately half of the U.S. population lives in a jurisdiction with clean indoor air laws for workplaces, bars, and restaurants (American Nonsmokers' Rights Foundation, 2014). Furthermore, excise taxes and clean indoor law coverage varies among racial and ethnic groups due to significant differences in states' racial/ethnic composition (Gonzalez et al., 2013; Golden et al., 2018). As of 2012, comprehensive clean indoor air laws had been implemented for only 30 of the 50 largest U.S. cities (Centers for Disease Control and Prevention, 2012). While U.S. state and local tobacco control efforts have been evaluated independently relative to adult smoking prevalence and cessation (Morley and Pratte, 2013; Frieden et al., 2005; Brown and Karson, 2013; Emont et al., 1993), with limited exceptions their combined effect has received less attention, particularly using a national sample and a longitudinal study design (Becker et al., 2017). Furthermore, there is little research on the role of these sub-national policies in temporal trends in smoking behavior in the U.S.

We examined the association between changes in state and county cigarette excise taxes and clean indoor air laws with smoking cessation and every day smoking between 2003 and 2011. During this time, there were rapid increases in state and county cigarette taxes and the passage of state and county clean indoor air laws in the U.S., with adoption plateauing just after this period. We used historical data on state and county clean indoor air laws and cigarettes taxes from the American Nonsmokers' Rights Foundation (ANRF) to assess whether any changes in smoking behavior between these dates could be explained by changes in these policies. Smoking behavior was ascertained using data from the 2003 and 2010–2011 Current Population Survey-Tobacco Supplement (CPS-TUS).

2. Methods

2.1. Sample

The CPS-TUS is a national population-level study of tobacco use conducted at regular intervals in conjunction with CPS. We used data from the 2003 and the 2010 and 2011 waves of the CPS-TUS. For 2003, the supplement was administered in February, June, and November 2003; for 2010 and 2011, TUS was administered in May and August 2010, and in January 2011. CPS uses a multi-stage stratified sampling procedure to interview a nationally representative sample of the non-institutionalized civilian U.S. population aged 15 years and older in 2003 and 18 years and older in 2010 and 2011. Approximately 64% of respondents complete the CPS-TUS by telephone and 36% in person. Most interviewees reported on their own tobacco use behavior; 20% reported as proxies for other household members. Additional information regarding the CPS-TUS can be found by visiting the TUS-CPS website (<https://cancercontrol.cancer.gov/brp/tcrb/tus-cps/>).

We limited our sample to past-year adult smokers, aged 18 and older, who reported on their own smoking behavior in CPS-TUS. A total

of 34,842 participants in 2003 and 27,323 in 2010 and 2011 (for simplicity referred to as the 2011 CPS-TUS henceforth) met these criteria and were included.

2.2. Variables

Past year smoker status was ascertained by asking participants: "Around this time 12 months ago, were you smoking cigarettes every day, some days, or not at all?" This question was asked separately from current every day and some day smokers as well as those who had quit in the past year. Individuals who reported smoking every day or on some days one year ago were rated as past-year smokers for this study.

Quitting in the past year and being a current every day smoker were ascertained by responses "not at all" and "every day", respectively, to the question "Do you now smoke cigarettes every day, some days, or not at all?" among past-year smokers. Among people who responded "not at all", 82.7% reported that they had last smoked 30 or more days ago.

Cigarette excise taxes and state and county clean indoor air laws were ascertained for each participant at the time point exactly one year before the time of their CPS-TUS interview. This timeframe was chosen because questions about smoking behavior in the CPS-TUS covered the past year. Thus, for example, for a person interviewed in January 2011 CPS-TUS, taxes and laws in effect at January 2010 were ascertained. We obtained data on state and county excise taxes and clean indoor air laws from ANRF. Total excise tax was computed as the sum of federal, state, and county taxes. ANRF ascertains data on state and county clean indoor air laws separately for laws affecting workplace areas, bars, and restaurants. We used the ANRF categorization of these laws into those imposing a "100% smoke free policy," a "qualified 100% smoke free policy" (e.g., smoking is only allowed in a separately ventilated enclosed room), laws providing "some" coverage, and a category of "no coverage" for states and counties with no clean indoor air laws. In situations where the state and county laws affecting a participant were inconsistent, we chose the more comprehensive law as the one affecting that individual. Of note, the ANRF legal data include FIPS codes at the county level only. Therefore, we were unable to account for additional laws that may have been in place at the city or municipal level.

While some states pre-empt, or disallow, county tobacco control laws, the number of such pre-emptive state laws affecting clean indoor air policies decreased markedly in the study period: 12 states had such laws in 2010, down from 18 in 2000 (Centers for Disease Control and Prevention, 2011). The state and county data were linked to the CPS-TUS data using state and county FIPS codes.

While in the main analyses we examined the effect of policies and taxes a year before the interview to allow for time-lag between the policies and smoking cessation, in sensitivity analyses we assessed the association of taxes and clean indoor air laws in effect at the time of the CPS-TUS interviews with the same outcome as in the main analysis.

In addition to questions about smoking status, CPS-TUS also collected socio-demographic data including sex, age, race/ethnicity, marital status, and employment status.

2.3. Analyses

We analyzed the data in four stages. First, we compared socio-demographic and smoking characteristics of past-year smokers in 2003 to those in 2011.

Second, we contrasted cigarette excise taxes and clean indoor air laws in effect in 2003 and 2011. We conducted separate analyses for workplace, bar and restaurant laws.

Third, we characterized the association of excise taxes and clean indoor air laws with quitting and current every-day smoking among past-year smokers. We used logistic regression models in these analyses in which the ordinal variables of total excise taxes (< 0.50\$, 0.50–0.99\$, 1.00–1.49\$, 1.50–1.99\$, 2.00–2.99\$, 3\$+) and state and

county clean indoor laws (100% smoke free, qualified 100% smoke free, some coverage, none) were entered into the models and their associations with the outcomes were assessed. The odds ratios from these models represent the change in the odds of the outcome for each one level of higher taxes or stricter laws. Due to limitations in interpretation of logistic regression coefficients (Norton and Dowd, 2018), we also computed marginal effects that represent change in the likelihood of each outcome for each unit change in the predictors. In all models, we adjusted for sex, age, race/ethnicity, marital status, employment status and region that could potentially confound the association of taxes and laws with smoking status.

Fourth, we conducted two sets of multivariable logistic regression analyses in which, first, the association of survey time periods (2003 vs. 2011) with smoking behavior was assessed, and next, this association was examined after entering excise taxes and clean indoor air laws into the models. These models tested whether any changes in smoking behavior over the 2003 to 2011 period were mediated by changes in taxes and clean indoor air laws in this time span. Mediation is suggested by a) a significant association between time period and smoking behavior; b) a significant association between time period and changes in taxes and clean indoor air laws; and c) attenuation of the association of time period with smoking behavior after entering taxes and clean indoor air laws into the same regression model (Vittinghoff et al., 2012). Percent of effect mediated was computed using the method proposed by Hosmer et al. (2013) as

$$\Delta\hat{\beta}\% = \frac{100 \times (\hat{\beta}_1^* - \hat{\beta}_1)}{\hat{\beta}_1^*}$$

where $\hat{\beta}_1^*$ is the regression coefficient for time period in a logistic model unadjusted for mediators and $\hat{\beta}_1$ is the regression coefficient for time period in a model that also includes the mediators.

As changes in smoking behavior could impact quitting behavior or frequency of smoking, the analyses were conducted separately for quitting in the past year and for current every day smoker status. We also adjusted for sex, age, race/ethnicity, marital status, employment status and region in these models.

In the main analyses we examined taxes and laws that were in effect one year before the CPS-TUS interviews to capture the effect of these policies on changes in smoking behavior that was measured over the past year. However, the timing of the implementation of the laws was not captured. Therefore, to allow for possible lags in implementation of laws, in sensitivity analyses we examined the association of changes in smoking behavior with taxes and laws that were in effect at the time of CPS-TUS interviews.

All analyses were conducted using Stata 15.1 software (StataCorp LLC, College Station, TX, 2018). Survey and replicate weights were included in all analyses to compute population representative estimates and confidence intervals. All percentages reported are weighted.

3. Results

Compared to past-year smokers in 2003, those in 2011 included a larger proportion of racial/ethnic minorities, adults in the 50+ years age range, divorced/separated, widowed or never married, unemployed individuals and participants from the South region of the U.S. (Table 1). Past-year smokers in the 2011 survey were also less likely to be every-day smokers and more likely to have quit smoking than those in the 2003 survey.

State and county cigarette excise taxes were significantly higher in 2011 than in 2003. A majority (57.7%) of 2003 participants paid less than \$1 in excise taxes in 2003; whereas, all of the 2011 participants paid more than this amount. In contrast, a majority (56.0%) of 2011 participants paid \$2 or more in excise taxes; whereas, none of the 2003 participants paid excise taxes in this range (Table 2). The median and 25–75 percentiles of excise taxes were \$0.94 (\$0.67–\$1.37) in 2003 and

Table 1
Sociodemographic characteristics of participants of the Current Population Survey—Tobacco Use Supplements 2003 and 2011 who had smoked during the past year.

Characteristics	2003 surveys		2011 surveys		Comparison
	N	%	N	%	
Total	34,842	100.0	27,323	100.0	–
Sex					
Male	16,792	53.7	13,538	54.1	$\chi^2_{df=1} = 1.87,$ $p = .172$
Female	18,050	46.3	13,785	45.9	
Race/ethnicity					
Non-Hispanic white	27,862	75.7	21,263	74.4	$\chi^2_{df=3} = 22.79,$ $p < .001$
Non-Hispanic black	2879	10.8	2587	11.2	
Hispanic	2180	8.6	1857	9.3	
Other	1921	5.0	1616	5.1	
Age, years					
18–29	7348	26.0	5306	25.3	$\chi^2_{df=3} = 523.46,$ $p < .001$
30–49	16,050	45.3	11,241	39.5	
50–64	8172	21.7	8080	27.1	
65+	2913	7.0	2696	8.0	
Marital status					
Married/living as married	15,854	43.7	11,380	39.9	$\chi^2_{df=3} = 102.92,$ $p < .001$
Divorced/separated	1806	4.4	1527	4.8	
Widowed	8015	21.6	6649	22.9	
Never married	9167	30.3	7767	32.4	
Employment status					
Employed	22,822	66.0	15,906	58.6	$\chi^2_{df=2} = 593.10,$ $p < .001$
Unemployed	2480	8.1	2908	11.9	
Not in labor force	9540	25.9	8509	29.4	
Region					
Northeast	6826	18.0	5060	16.4	$\chi^2_{df=3} = 40.25,$ $p < .001$
Midwest	9741	25.9	7503	25.7	
South	10,533	37.5	9135	39.3	
West	7742	18.7	5625	18.6	
Cigarette smoking status					
Smokes every day	26,944	76.1	20,637	74.7	$\chi^2_{df=1} = 22.34,$ $p < .001$ $\chi^2_{df=1} = 8.52,$ $p = .004$
Quit in the past year	2488	7.3	2114	7.8	

\$2.16 (\$1.80–\$3.00) in 2011.

There were also large changes over time in state and county clean indoor air laws. For example, 47.7% of participants in 2011 lived in states and counties that imposed 100% smoke free laws, compared to 1.9% in 2003. Similarly, 44.3% in 2011 lived in states and counties with 100% clean indoor air laws for bars and 53.5% in states and counties with 100% clean indoor air laws for restaurants—compared with 8.5% and 9.0%, respectively, in 2003 (Table 2).

Participants living in states and counties with higher excise taxes had a higher likelihood of quitting (8.9% for those exposed to \geq \$3 taxes compared to 6.6% in those exposed to $<$ \$0.5) and lower likelihood of continuing to smoke (72.7% vs. 79.3%, respectively) (Supplementary Fig. 1). In adjusted logistic regression models, each higher level of excise tax was associated with higher odds of quitting (adjusted odds ratio [aOR] = 1.05, 95% confidence interval [CI] = 1.03–1.07) and lower odds of every-day smoking (aOR = 0.95, 95% CI = 0.94–0.97) among past-year smokers.

Similarly, participants living in states and counties with more stringent laws had a higher likelihood of quitting (8.4%–8.6% for states and counties with 100% smoke-free workplace, bar and restaurant laws vs. 7.0%–7.1% for states and counties with no such laws) and lower likelihood of everyday smoking (71.0%–74% vs. 77.0%–79.5%, respectively) (Supplementary Fig. 2).

In adjusted logistic regression models, each more stringent level of clean indoor air laws for workplace was associated with higher odds of

Table 2

State and county cigarette excise taxes and clean indoor air laws affecting participants of Current Population Survey—Tobacco Use Supplements 2003 and 2011 who had smoked during the past year.

Taxes/laws	2003 surveys		2011 surveys		Comparison
	N	%	N	%	
Cigarette excise taxes, in \$ ^a					
< 0.50	2407	9.4	0	0.0	$\chi^2_{df=1} = 17,876.55, p < .001$
0.50–0.99	18,065	48.3	0	0.0	
1.00–1.49	9192	25.6	4036	18.2	
1.50–1.99	5178	16.7	7241	25.8	
2.00–2.99	0	0.0	9081	33.0	
3.00+	0	0.0	6965	23.0	
State and county workplace clean indoor air laws					
100% smoke free ^b	522	1.9	13,020	47.7	$\chi^2_{df=3} = 7219.82, p < .001$
Qualified 100% smoke free ^c	1190	3.5	1701	5.0	
Some coverage ^d	22,956	62.7	12,255	45.7	
None	10,174	31.9	347	1.6	
State and county bar clean indoor air laws					
100% smoke free ^b	1595	8.5	12,709	44.3	$\chi^2_{df=3} = 20,868.37, p < .001$
Qualified 100% smoke free ^c	426	1.4	0	0.0	
Some coverage ^d	1942	3.9	3070	13.6	
None	30,879	86.2	11,544	42.0	
State and county restaurant clean indoor air laws					
100% smoke free ^b	1899	9.0	15,090	53.5	$\chi^2_{df=3} = 20,250.68, p < .001$
Qualified 100% smoke free ^c	1252	2.6	2000	7.1	
Some coverage ^d	10,522	26.7	3864	15.8	
None	21,169	61.7	6369	23.6	

^a Includes total federal, state and county taxes. The contingency table analysis is based on dichotomized data ($\geq \$1.50$ vs. $< \$1.50$) because of the large number of empty cells when taxes were divided into 6 categories.

^b No smoking on the premises with no exceptions.

^c Premises must be smoke-free with a few exceptions.

^d Some areas of the premises are smoke-free, but with several exceptions.

quitting and lower odds of everyday smoking (aOR = 1.06, 95% CI = 1.04–1.09 and aOR = 0.95, 95% CI = 0.93–0.96, respectively). Similar trends were observed for laws affecting bars (aOR = 1.04, 95% CI = 1.02–1.06 and aOR = 0.95, 95% CI = 0.93–0.96, respectively), and laws affecting restaurants (aOR = 1.04, 95% CI = 1.02–1.06 and aOR = 0.95, 95% CI = 0.94–0.96, respectively). All associations were statistically significant at $p < .001$.

The clean indoor air laws were strongly correlated with each other ($r_{Spearman}$ range = 0.60 to 0.77). Therefore, an average index of clean indoor air laws was computed for the next set of analyses by taking an average of the four categories.

Between 2003 and 2011, the odds of quitting increased by 13% among past-year smokers after adjusting for socio-demographic characteristics and the odds of being an every-day smoker decreased by 10% (Table 3). Both odds ratios were significantly different than 1.

These estimates were attenuated and became statistically non-significant after entering excise taxes and the clean indoor air law summary variables, noted earlier, into the multivariable models (Table 4), suggesting that the changes in smoking behavior over time were mediated by changes in taxes and clean indoor air laws. Based on the assumption of no uncontrolled confounding by other contextual and policy factors, 64.8% of the increase in smoking cessation between 2003 and 2011 could be explained by the indirect effect to changes in cigarette excise taxes and clean indoor air laws based on regression coefficients. Similarly, assuming no omitted variable bias, the reduction in everyday smoking observed between 2003 and 2011 was entirely accounted for by changes in cigarette excise taxes and clean indoor air laws.

The results of sensitivity analyses were very similar to the main analyses. Excise taxes in effect at the time of CPS interviews in 2011 were higher than in 2003 and clean indoor air laws were comprehensive (Supplementary Table 1). Higher taxes and more comprehensive clean indoor air laws in effect at the time of interviews were associated with higher quit rates and lower prevalence of everyday smoking (Supplementary Table 2). Finally, in mediation analyses, excise taxes

and clean indoor air laws in effect at the time of survey interviews explained changes in quit rates and prevalence of everyday smoking between 2003 and 2011 (Supplementary Table 3).

4. Discussion

Despite an increase in clean indoor laws and cigarette excise taxes during the study period (Holmes et al., 2016), little is known about their place in explaining the national trends in smoking. We used state and county data on excise taxes and clean indoor air laws to assess the role of changes in these policies on national trends in smoking behavior. Between 2003 and 2011, there was a modest but significant increase in the rate of quitting cigarette smoking and a decrease in daily smoking. Using census data, the changes between 2003 and 2011 translated into approximately 80,000 more adults quitting every year and 1,600,000 fewer everyday smokers. These changes were mostly mediated by state and county cigarette excise taxes and state and county clean indoor air laws. These findings are important because of the morbidity and mortality associated with tobacco use, as well as uncertainty regarding the impact that clean indoor air laws and cigarette excise taxes have had.

Our work supports findings from prior research that identified associations between taxes and clean indoor air policies, on the one hand, with smoking, on the other hand (U.S. Department of Health and Human Services, 2000; National Cancer Institute, 2000; Fichtenberg and Glantz, 2002; Tauras and Chaloupka, 1999; Centers for Disease C Prevention, 2009; Chaloupka et al., 2011). Our analysis further adds to prior research by identifying how the combined effects of taxes and clean indoor air laws explained national trends in smoking cessation and smoking frequency among smokers in a period of rapid tax and policy change.

The policies we examined are often cost-neutral or, in the case of cigarette taxes, revenue generating. Wider adoption of comprehensive state and local clean indoor air laws and increases in cigarette taxes could help to increase the number of individuals who stop smoking or smoke fewer cigarettes. These policies may also act as a deterrent for

Table 3

Regression analysis of the association of survey year, excise taxes, and clean indoor air laws with quitting in participants of the Current Population Survey—Tobacco Supplements 2003 and 2011 who had smoked during the past year.

Variable	Not adjusting for taxes and clean indoor laws				Adjusting for taxes and clean indoor air laws			
	OR	95% CI	Marginal effect	95% CI	OR	95% CI	Marginal effect	95% CI
Survey year (2010–11 vs. 2003)	1.13	1.07, 1.19	0.009	0.005, 0.012	1.05	0.96, 1.14	0.003	−0.003, 0.009
Total cigarette excise taxes ^a	–	–	–	–	1.04	0.99, 1.09	0.003	−0.001, 0.006
Average of state and county clean indoor air law score ^b	–	–	–	–	1.02	0.99, 1.06	0.002	−0.001, 0.004
Sex								
Male	1.00	Ref.			1.00	Ref.		
Female	1.12	1.07, 1.18	0.008	0.005, 0.012	1.12	1.07, 1.18	0.008	0.005, 0.012
Race/ethnicity								
Non-Hispanic white	1.00	Ref.			1.00	Ref.		
Non-Hispanic black	0.87	0.78, 0.97	−0.010	−0.017, −0.003	0.87	0.78, 0.97	−0.010	−0.017, −0.003
Hispanic	1.00	0.91, 1.10	−0.000	−0.007, 0.007	0.99	0.90, 1.10	−0.000	−0.007, 0.007
Other	0.96	0.85, 1.08	−0.003	−0.012, 0.005	0.95	0.84, 1.08	−0.004	−0.012, 0.005
Age, years								
18–29	1.00	Ref.			1.00	Ref.		
30–49	0.63	0.59, 0.68	−0.036	−0.042, −0.031	0.63	0.59, 0.67	−0.037	−0.042, −0.031
50–64	0.57	0.52, 0.62	−0.043	−0.050, −0.036	0.57	0.52, 0.62	−0.043	−0.050, −0.036
65+	0.69	0.62, 0.78	−0.030	−0.039, −0.021	0.69	0.62, 0.78	−0.030	−0.040, −0.021
Marital status								
Married/living as married	1.00	Ref.			1.00	Ref.		
Divorced/separated	0.82	0.71, 0.93	−0.014	−0.023, −0.005	0.82	0.71, 0.93	−0.015	−0.023, −0.006
Widowed	0.77	0.71, 0.82	−0.018	−0.023, −0.014	0.77	0.71, 0.82	−0.018	−0.023, −0.014
Never married	0.83	0.78, 0.89	−0.013	−0.018, −0.008	0.83	0.77, 0.89	−0.013	−0.018, −0.008
Employment status								
Employed	1.00	Ref.			1.00	Ref.		
Unemployed	0.80	0.71, 0.88	−0.015	−0.022, −0.009	0.80	0.71, 0.89	−0.015	−0.022, −0.009
Not in labor force	0.97	0.91, 1.03	−0.002	−0.006, 0.002	0.97	0.92, 1.03	−0.002	−0.006, 0.002
Region								
Northeast	1.00	Ref.			1.00	Ref.		
Midwest	0.87	0.81, 0.93	−0.010	−0.015, −0.005	0.90	0.84, 0.97	−0.007	−0.013, −0.002
South	0.82	0.76, 0.88	−0.014	−0.019, −0.009	0.87	0.81, 0.95	−0.009	−0.015, −0.004
West	1.13	1.04, 1.23	0.010	0.003, 0.017	1.15	1.05, 1.26	0.011	0.004, 0.018

^a Includes total federal, state and county taxes in \$.

^b Average score was computed by averaging over workplace, bar and restaurant clean indoor policies. Policies were rated as 3 for 100% smoke-free premises, 2 for qualified 100% smoke-free, 1 for partial coverage and 0 for none. Average scores thus range from 0 to 3.

smoking initiation (Song et al., 2015), or promote the use of smoking cessation services. Therefore, our findings may underestimate their net effects on smoking prevalence. The potential effect would be even larger if more states and localities implemented higher taxes and comprehensive clean indoor air laws. Based on data from the American Lung Association (<http://www.lung.org/our-initiatives/tobacco/reports-resources/sotc/state-grades/state-rankings/smokefree-air-laws.html>), many states have not had any increase in cigarette taxes over the past decade or only increased taxes by a small amount; the average state taxes were \$1.72 in 2017. Similarly, based on the American Lung Association grading system, 10 states received a grade of F for clean indoor air laws in 2017, indicating very weak or no laws in this area.

Our study has several limitations. First, we assessed the average annual effect of taxes and clean indoor air laws, while the effect on cumulative rates of quitting over a longer period of time would likely be much larger. At least one study has used a simulation approach to consider this question within a 15-year timeframe (Rhoads, 2012). Second, many individuals who quit smoking may relapse and start smoking again. Third, it may take months or even years for changes in taxes and clean indoor air laws to have their full effect (Hahn et al., 2009), yet our data were limited to past year smoking behavior and we could not track the impact of policies over time. Fourth, we did not examine the methods used for quitting. A recent study using CPS-TUS 2011 found associations between cigarette taxes and the use of smoking cessation treatments (Dahne et al., 2017). It is not clear, however, to what extent the increase in use of these treatments mediated the observed changes in quitting and in frequency of smoking. Fifth, over the years, a number of public and private organizations have mounted various initiatives to combat smoking (Brown and Karson, 2013). Similar to clean indoor air laws and excise taxes, these policies are likely

impacted by political and economic factors such as tobacco revenues and the states' political leaning. It is often not feasible to separate the effects of these policies from the effects of clean indoor air laws and excise taxes (Dahne et al., 2017). The results should be interpreted in light of these and other potential confounders, including change in public attitudes and knowledge, that were not measured in CPS-TUS. Absence of uncontrolled confounding between the independent variable and the outcome and no confounding between the mediator and the outcome are also among assumptions made for mediation analysis. Sixth, this study examined the average effect of policies across all population groups and different states. Policies may have different effects in different populations and settings, but relatively few studies have explored this possibility (Dinno and Glantz, 2009). For example, in further exploratory analyses (not reported) we found that the effect of taxes on smoking cessation fell between OR = 0.61 and 2.00 (interquartile range = 0.97 to 1.34). Examining these variations across states and across smaller counties requires larger sample sizes. Finally, we used FIPS codes at the state and county level, as this is what was available within the data. The local legal environment, however, is more nuanced and legal variations at the city or municipal level – including additional local cigarette excise taxes – were not accounted for in the analyses.

In the context of these limitations, the findings from this study provide further evidence based on nationally representative data regarding the effects of state and county tobacco control policies on smoking cessation and smoking frequency in current smokers. Wider adoption of these policies across state and county governments would likely have a significant impact on smoking cessation in the coming years. It is important to continue monitoring these state and county laws and their impacts as their implementation unfolds.

Table 4

Regression analysis of the association of survey year, excise taxes, and clean indoor air laws with every day smoking in participants of the Current Population Survey—Tobacco Supplements 2003 and 2011 who had smoked during the past year.

Variable	Not adjusting for taxes and clean indoor laws				Adjusting for taxes and clean indoor air laws			
	OR	95% CI	Marginal effect	95% CI	OR	95% CI	Marginal effect	95% CI
Survey year (2010–11 vs. 2003)	0.90	0.87, 0.93	−0.019	−0.025, −0.013	1.06	0.99, 1.13	0.011	−0.001, 0.023
Total cigarette excise taxes ^a	–	–	–	–	0.92	0.88, 0.95	−0.016	−0.024, −0.009
Average of state and county clean indoor air law score ^b	–	–	–	–	0.96	0.94, 0.98	−0.008	−0.012, −0.003
Sex								
Male	1.00	Ref.			1.00	Ref.		
Female	1.00	0.97, 1.03	−0.000	−0.006, 0.006	1.00	0.97, 1.03	−0.000	−0.006, 0.006
Race/ethnicity								
Non-Hispanic white	1.00	Ref.			1.00	Ref.		
Non-Hispanic black	0.63	0.60, 0.67	−0.088	−0.098, −0.077	0.63	0.60, 0.67	−0.087	−0.098, −0.076
Hispanic	0.45	0.43, 0.48	−0.163	−0.176, −0.150	0.46	0.43, 0.48	−0.161	−0.173, −0.148
Other	0.74	0.68, 0.79	−0.057	−0.071, −0.042	0.74	0.69, 0.80	−0.055	−0.069, −0.040
Age, years								
18–29	1.00	Ref.			1.00	Ref.		
30–49	1.37	1.31, 1.42	0.061	0.052, 0.069	1.37	1.31, 1.43	0.062	0.053, 0.070
50–64	1.61	1.52, 1.69	0.089	0.079, 0.099	1.61	1.53, 1.70	0.090	0.080, 0.100
65+	1.30	1.20, 1.41	0.051	0.036, 0.067	1.31	1.20, 1.42	0.053	0.037, 0.068
Marital status								
Married/living as married	1.00	Ref.			1.00	Ref.		
Divorced/separated	0.95	0.88, 1.03	−0.009	−0.024, 0.005	0.95	0.88, 1.03	−0.009	−0.023, 0.005
Widowed	1.16	1.11, 1.21	0.027	0.019, 0.034	1.16	1.11, 1.21	0.027	0.019, 0.034
Never married	0.96	0.92–1.00	−0.008	−0.016, 0.000	0.97	0.93, 1.01	−0.006	−0.014, 0.001
Employment status								
Employed	1.00	Ref.			1.00	Ref.		
Unemployed	1.20	1.12–1.27	0.032	0.022, 0.043	1.19	1.12–1.27	0.032	0.021, 0.043
Not in labor force	1.15	1.11–1.20	0.026	0.019, 0.034	1.15	1.11–1.20	0.026	0.019, 0.033
Region								
Northeast	1.00	Ref.			1.00	Ref.		
Midwest	1.09	1.04–1.15	0.016	0.007, 0.026	1.01	0.96–1.06	0.001	−0.008, 0.011
South	1.13	1.07–1.18	0.021	0.012, 0.030	0.98	0.93–1.04	−0.003	−0.013, 0.007
West	0.76	0.71–0.80	−0.055	−0.066, −0.044	0.72	0.68–0.77	−0.062	−0.073, −0.051

^a Includes total federal, state and county taxes in \$.

^b Average score was computed by averaging over workplace, bar and restaurant clean indoor policies. Policies were rated as 3 for 100% smoke-free premises, 2 for qualified 100% smoke-free, 1 for partial coverage and 0 for none. Average scores thus range from 0 to 3.

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Declaration of Competing Interest

Dr. Alexander is Chair of FDA's Peripheral and Central Nervous System Advisory Committee; serves as a paid advisor to IQVIA; holds equity in Monument Analytics, a health care consultancy whose clients include the life sciences industry as well as plaintiffs in opioid litigation; and is a member of OptumRx's National P&T Committee. This arrangement has been reviewed and approved by Johns Hopkins University in accordance with its conflict of interest policies. Dr. Mojtabai, Dr. Cohen, Dr. Rutkow, and Ms. Riehm have no conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpmed.2019.06.002>.

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