

ORIGINAL ARTICLES

Clean indoor air legislation, taxation, and smoking behaviour in the United States: an ecological analysis

Seth L Emont, Won S Choi, Thomas E Novotny, Gary A Giovino

Abstract

Objective - To examine the association between various indices of state-specific smoking behaviour (smoking prevalence, proportion of quitters, and cigarette consumption per head) and both the strength of legislation for clean indoor air and the amount of taxes levied on tobacco products in the United States.

Methods - State-specific data on smoking from the 1989 Current Population Survey and cigarette consumption per head from the Tobacco Institute were used to evaluate the association between measures of smoking behaviour, excise taxes, and clean indoor air legislation in effect at the time of the survey.

Results - More restrictive clean indoor air laws and higher excise taxes were associated with lower smoking prevalence and cigarette consumption per head and a higher proportion of quitters. States that produced tobacco had a higher average smoking prevalence and cigarette consumption per head and a lower proportion of quitters than did states that did not produce tobacco. Tobacco-producing states also had lower excise taxes and less restrictive clean indoor air laws than states that did not produce tobacco.

Conclusions - Continued surveillance of trends in smoking prevalence and quitting behaviour and their subsequent impact on smoking-related disease will help quantify the importance of smoking-related policies.

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Introduction

Within the past 15 years the number of states that have enacted laws that restrict smoking in public places (smoke-free ordinances or "clean indoor air laws") has increased dramatically.¹ In 1975 Minnesota became the first state to enact a clean indoor air law that covered both public- and private-sector worksites. In the same year 14 other states passed either new or amended clean indoor air laws. In 1987, one year after release of the 1986 Surgeon General's report on passive smoking, 20 states passed either new or amended clean indoor air

laws. The number of states enacting extensive clean indoor air laws has grown, and reflects the significant change in public attitudes and norms regarding environmental tobacco smoke.¹

More attention has also been given to the effects of cigarette tax increases on smoking behaviour. Estimates of price elasticity of demand for cigarettes have ranged from -0.2 to -1.3 with a midpoint of -0.7.¹ A number of econometric studies have shown that as the price of cigarettes increases, cigarette consumption decreases.¹⁻⁶ Thus, differences in tobacco consumption should reflect variation in the price of cigarettes.

Thus, statewide smoking restrictions and increases in cigarette excise taxes represent two potentially powerful public health tools that may influence smoking behaviour. This investigation examined the association of state clean indoor air laws and state excise taxes on cigarettes with three measures of smoking behaviour: current smoking prevalence, proportion of quitters, and consumption of cigarettes per head.

Methods

PREDICTOR VARIABLES

All 50 states and the District of Columbia were categorised according to the scope of their clean indoor air law in 1989 (table 1).¹ Such laws ranged from nominal policies, in which smoking was regulated in three or fewer public places, to extensive policies, in which smoking was regulated in four or more public places

Table 1 Level of restriction by state clean indoor air laws in 1989

Policy	Degree of regulation*	No of states†
None	None	7
Nominal	1-3 public places, excluding restaurants and private workplaces	7
Basic	4 or more public places, excluding restaurants and private worksites	13
Moderate	4 or more public places including restaurants	10
Extensive	4 or more public places including restaurants and private workplaces	14

* Source: Office on Smoking and Health, US Centers for Disease Control, unpublished data updating information in the 1989 Surgeon General's report.¹

† Includes District of Columbia.

Office on Smoking and Health, National Center for Chronic Disease Prevention and Health Promotion, Mail Stop K-50, Centers for Disease Control, 1600 Clifton Road, NE, Atlanta, Georgia 30333, USA
S L Emont
G A Giovino

University of California at San Diego, Cancer Prevention, 2251 San Diego Avenue, Suite B-111, San Diego, California 92110, USA
W S Choi

Office of the Dean, University of California, Berkeley School of Public Health, 19 Warren Hall, Berkeley, California 94720, USA
T E Novotny

Correspondence to: Dr Emont.

plus restaurants and private workplaces. As an example, in 1989 the state of Indiana regulated smoking in schools, hospitals, nursing homes, government buildings, public meeting rooms, and libraries but did not regulate smoking in private worksites or restaurants; thus, this state was categorised as having a "basic" clean indoor air law.

The 16 tobacco-producing states are Connecticut, Florida, Georgia, Indiana, Kentucky, Maryland, Massachusetts, Missouri, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin.

Data on state cigarette excise taxes are reported by the Tobacco Institute.⁷ All states and the District of Columbia had an excise tax on cigarettes in 1989. At that time the average tax on a packet of 20 cigarettes was 20.5 cents (SD 8.8 cents; range 2–40 cents); the average retail price including tax was \$1.44 a packet.⁷

OUTCOME MEASURES

Three measures of smoking behaviour were assessed in this study. We defined state-specific smoking prevalence as the proportion of adult smokers in the population aged 18 and older. A current smoker was defined as a respondent who reported smoking 100 or more cigarettes in his or her lifetime and who was currently smoking. The proportion of quitters was defined as the proportion of former smokers (respondents who were not currently smoking but who reported having smoked 100 or more cigarettes in their lifetimes) among ever smokers (current plus former smokers) in the population.

Estimates of smoking prevalence and the proportion of quitters among adults aged 18 and older were derived from the 1989 Current Population Survey of the US Bureau of the Census.⁸ The Current Population Survey is a household sample survey based on the civilian, non-institutionalised population in the United States (all 50 states and the District of Columbia). The sample, which is continually updated to account for new residential construction, is located in 729 areas comprising 1973 counties, independent cities, and minor civil divisions. About 57000 occupied households containing about 114500 people of 15 years old and older are selected for interview every month.

Although the Current Population Survey primarily collects data on the labour force, in September 1989 it included supplementary questions about smoking and cardiovascular disease. The Cardiovascular Disease Risk Factor Supplement of the Survey was sponsored by the National Heart, Lung, and Blood Institute under the Department of Health and Human Services. Overall response to this supplement was 94%.

Consumption of cigarettes per head in each state was defined as the number of tax-paid sales of packets of cigarettes per person in 1989. Taxes are collected at the wholesale level, and consumption estimates thus do not

include tax-free sales such as those on Indian reservations or military bases.

STATISTICAL ANALYSES

We used the Jonckheere test for ordered alternatives to determine the association between degree of restriction of clean indoor air laws by each measure of smoking behaviour.⁹ The Jonckheere test statistic J^* was used to test the hypothesis that the median values for each measure of smoking behaviour are ordered in magnitude, according to the restrictiveness of the clean indoor air law. The Pearson correlation coefficient was used to determine the association between level of excise taxes per packet and each measure of smoking behaviour.

We used multiple regression analysis to determine the association between clean indoor air laws and taxation and each measure of smoking behaviour. Standardised regression coefficients – that is, standardized Betas – were calculated for each predictor variable. We simultaneously entered four dummy variables, each representing a level of restriction of clean indoor air laws, into the regression model. The seven states without clean indoor air laws in 1989 were included in the reference category. The amount of the state excise tax was entered into the model as a continuous variable.

Results

CLEAN INDOOR AIR POLICIES AND SMOKING BEHAVIOUR

As shown in table 2, smoking prevalence was inversely related to the degree of restriction of the clean indoor air policy. The average smoking prevalence was 28% in states without clean indoor air laws and 24% in states with extensive clean indoor air laws ($J^* = 3.33$, $p < 0.001$). Average cigarette consumption per head, following a pattern similar to that of smoking prevalence, was about 119 packets in states without clean indoor air laws and 105 packets in states with extensive clean indoor air laws ($J^* = 2.79$, $p < 0.005$). The proportion of smokers who had stopped smoking (quitters) was positively associated with the scope of the clean indoor air policies. The average proportion of quitters was 44% in states without clean indoor air policies and 50% in states

Table 2 Association between degree of regulation of state clean indoor air laws and measures of smoking behaviour

Degree of regulation of clean indoor air law	Mean prevalence (%) [*]	Mean no of packets of cigarettes per person [*]	Mean proportion of quitters (%) [*]
None	28.0 [†]	118.6 [‡]	43.5
Nominal	28.1	122.8	43.2
Basic	25.7	105.4	47.0
Moderate	23.5	90.6	49.9
Extensive	24.3	105.3	49.6

^{*} Among people aged 18 and older.

[†] $J^* = 3.33$, $p < 0.001$.

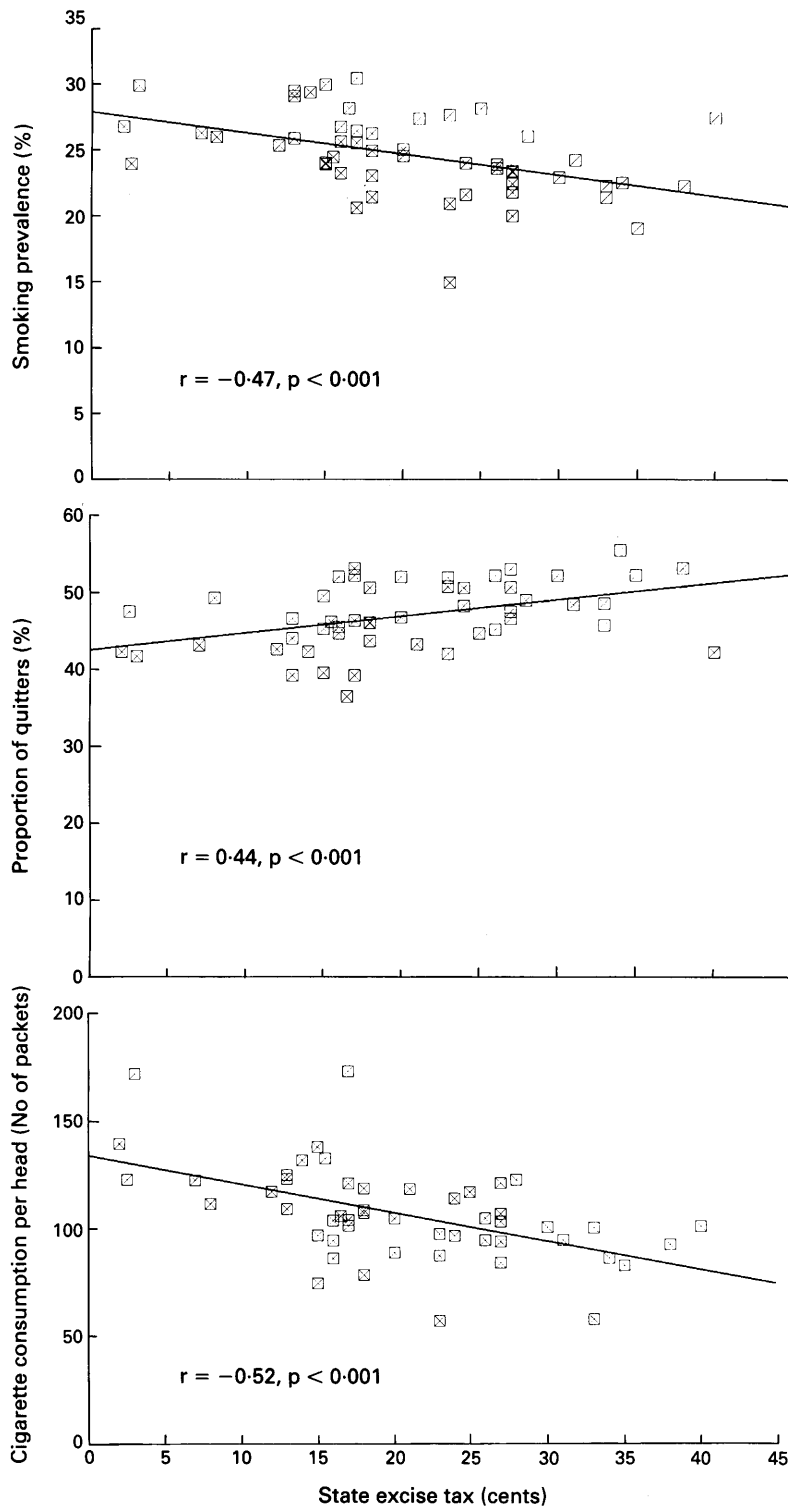
[‡] $J^* = 2.79$, $p < 0.005$.

^{||} $J^* = 3.96$, $p < 0.00005$.

with extensive clean indoor air policies ($J^* = 3.96, p < 0.00005$).

EXCISE TAXES ON CIGARETTES AND RESULTANT SMOKING BEHAVIOUR

The level of the state cigarette excise tax was inversely associated with prevalence ($r = -0.47, p < 0.001$) and consumption per head ($r = -0.52, p < 0.001$). Conversely, the amount of the state cigarette excise tax was positively associated with the proportion of quitters ($r = 0.44, p = 0.001$) (figure).



Association between state-specific cigarette excise taxes and various measures of smoking behaviour

MULTIPLE REGRESSION ANALYSES

The results of the multiple regressions indicated interesting relations between clean indoor air laws and taxation and smoking behaviour. The presence of either moderate or extensive clean indoor air laws was significantly associated with a higher proportion of quitters after we controlled for the effects of excise taxes (moderate laws: Beta = 0.54, $p = 0.01$; extensive laws: Beta = 0.58, $p = 0.01$) and somewhat associated with lower smoking rates, although this did not reach significance at $p < 0.05$ (moderate laws: Beta = -0.43, $p = 0.06$; extensive laws: Beta = -0.39, $p = 0.09$). The overall models accounted for 29% and 23% of the variance in the proportion of quitters and smoking prevalence, respectively. In contrast, higher cigarette excise taxes were associated with lower cigarette consumption per head after we controlled for the effects of clean indoor air laws (Beta = -0.44, $p = 0.01$). The overall model accounted for 24% of the variance in cigarette consumption per head.

STATE TOBACCO PRODUCTION, CLEAN INDOOR AIR LEGISLATION, TAXATION, AND SMOKING BEHAVIOUR

The mean smoking prevalence was 27.2% in states that produced tobacco and 24.8% in states that did not produce tobacco ($F(1, 49) = 7.12, p = 0.01$); the mean cigarette consumption per head was 119.4 packets/day in tobacco-producing states and 100.8 packets/day in states that did not produce tobacco ($F(1, 49) = 8.84, p < 0.01$). Also, the proportion of quitters was significantly lower in tobacco-producing states (45.1%) than in states that did not produce tobacco (48.3%) ($F(1, 49) = 5.95, p < 0.05$). The mean cigarette excise tax was about 7 cents higher in states that did not produce tobacco than in tobacco-producing states (22.6 cents *v* 15.9 cents). In addition, the percentage of states with either moderate or extensive clean indoor air policies was more than three times greater in states that did not produce tobacco than in tobacco-producing states (60.0% *v* 18.8%).

Discussion

Our results indicate that statewide comprehensive clean indoor air laws and higher excise taxes on tobacco are associated with lower smoking prevalence and cigarette consumption and a higher proportion of quitters. Rigotti and Pashos recently reported on the association between local no-smoking laws and smoking prevalence.¹⁰ Their analysis supported the hypothesis that no-smoking laws are more likely to be adopted where there are fewer smokers. Their analysis also indicated fewer city laws both in states with comprehensive state laws and in those with no state smoking laws than in states with non-comprehensive laws.

Although it is possible that community or statewide smoking restrictions can affect smoking behaviour, there have been no controlled trials to evaluate the causality of this

relation.¹ Although we could not test the causal relation between clean indoor air legislation and measures of smoking behaviour in our study, our multivariate analyses indicated that either moderate or extensive clean indoor air laws (but not nominal or basic clean indoor air policies) were associated with a lower smoking prevalence and a higher proportion of quitters. Even though the primary purpose of implementing clean indoor air policies is to protect the non-smoker from exposure to environmental tobacco smoke, such policies – particularly comprehensive policies – may have an impact on smoking behaviour.¹⁰

Our results are also consistent with previous studies showing the effect of cigarette excise taxes on cigarette consumption.^{2-6,11} A recent evaluation of California's Proposition 99, which raised the state's cigarette excise tax by 25 cents a pack in January 1989, showed that the tax increase accelerated the decline in cigarette consumption per head,⁴ although the authors did not control for other anti-smoking activities that occurred during the evaluation period. An ad valorem tax has been recommended to maintain the effect of the tax on cigarette consumption.^{1,4}

A very successful campaign to reduce tobacco consumption is exemplified by Canada's National Strategy to Reduce Tobacco Use. In addition to substantially raising the federal and provincial tax rate per packet of cigarettes to an average of \$2.25 (US dollars), Canada has enacted legislation to ban advertising of tobacco products, to require stringent labelling of tobacco product packages, and to promote clean indoor air.¹² The 30% decline in tobacco consumption observed in Canada between 1980 and 1990 is due primarily to these intensive legislative initiatives.¹²

Rigotti and Pashos also found higher smoking prevalence rates for the six top tobacco-producing states than for all other states.¹⁰ In addition, their multiple logistic regression analysis indicated that smoking prevalence was not independently associated with state laws when tobacco production was included in the model. The fact that tobacco production is strongly associated with smoking behaviour is not surprising because other factors, such as the state's economy,¹³ public sentiment about tobacco control policies,^{14,15} and vigorous opposition to tobacco control activities by the tobacco industry,¹⁶ may account for differences in smoking behaviour between tobacco-producing states and states that do not produce tobacco.

There are several limitations to our study. Because of the cross sectional design of the study, we cannot test the causal relation between clean indoor air laws, excise taxes, and smoking behaviour. However, states with a relatively low smoking prevalence and probably more amenable to adopting more comprehensive clean indoor laws and higher tobacco excise taxes.^{1,3,6,10,17}

The results of the regression analyses should be interpreted with caution. We acknowledge that the effects of taxation or legislation on

smoking behaviour cannot be attributed solely to one variable or the other. Based on our bivariate analyses, both variables are strongly associated with smoking behaviour but also with each other, suggesting the potential for multicollinearity among the predictor variables. This intercorrelation could possibly lead to unreliable regression coefficients.

In addition, other potential confounders were not included in the analyses. These include local (city or county) smoking restrictions and excise taxes, interstate smuggling of cigarettes, and demographic factors, such as income per head and level of education.

Another potential problem arises from the effect of proxy reports on sample estimates from the Current Population Survey. Interviewers recorded the manner in which the supplement interview was given – that is, by self response or proxy response. Interviewers were instructed to make up to two personal or telephone calls before accepting a proxy interview. Of the total sample, 71% were self response interviews and the remaining 29% were proxy interviews. An underreporting bias could result from proxy interviews,¹⁸ although surrogate information on smoking status has been shown to be reliable.^{19,20}

The impact of clean indoor air laws and cigarette excise taxes on smoking behaviour deserves further evaluation. In addition to clean indoor air legislation and excise taxes, there are a number of other public health strategies that can be used to reduce tobacco consumption globally. These include regulating tobacco advertisements and promotions, using mass media in a coordinated anti-smoking campaign, and providing school health education programmes on smoking.²¹ Given current trends in smoking worldwide, it is expected that the annual number of deaths caused by smoking will reach 10 million by the year 2025.²² Continued surveillance of trends in smoking prevalence and its subsequent impact on smoking-related disease will help quantify the importance of antismoking policies. Only through coordinated global tobacco control initiatives will we curtail what is surely expected to be a worldwide epidemic of smoking-related morbidity and mortality.

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