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Original Investigation

Tobacco control policy and adolescent cigarette smoking status in the United States

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Abstract

Introduction: Tobacco policies that limit the sale of cigarettes to minors and restrict smoking in public places are important strategies to deter youth from accessing and consuming cigarettes.

Methods: We examined the relationship of youth cigarette smoking status to state-level youth access and clean indoor air laws, controlling for sociodemographic characteristics and cigarette price. Data were analyzed from the 2001 to 2002 U.S. Health Behavior in School-Aged Children survey, a cross-sectional survey conducted with a nationally representative sample of 13,339 students in the United States.

Results: Compared with students living in states with strict regulations, those living in states with no or minimal restrictions, particularly high school students, were more likely to be daily smokers. These effects were somewhat reduced when logistic regressions were adjusted for sociodemographic characteristics and cigarette price, suggesting that higher cigarette prices may discourage youth to access and consume cigarettes independent of other tobacco control measures.

Discussion: Strict tobacco control legislation could decrease the potential of youth experimenting with cigarettes or becoming daily smokers. The findings are consistent with the hypothesis that smoking policies, particularly clean indoor air provisions, reduce smoking prevalence among high school students.

Introduction

The prevalence of cigarette smoking among youth is a primary public health concern (Centers for Disease Control and Prevention [CDC], 2001; U.S. Department of Health and Human Services [USDHHS], 1994). Recent estimates from the Monitoring the Future Study reveal that in 2005 half of American 12th graders had tried cigarettes and nearly a quarter were current smokers (Johnston, O'Malley, Bachman, & Shulenberg, 2006). Tobacco control initiatives at the national, state, and local levels have been established in recent years to prohibit the distribution, sale, and marketing of tobacco products to minors and to stop youth access to cigarettes (Alciati et al., 1998; Glantz, 1997; Liang, Chaloupka, Nichter, & Clayton, 2003; Luke, Stamatakis, & Brownson, 2000). Notably, the Synar Amendment (Federal Public Law 102-321) stipulates the minimum age for purchase of tobacco products as 18 years and calls for enforcement of this law with random inspections of over-the-counter and vending machine outlets (Forster et al., 1998). Furthermore, to protect nonsmokers from exposure to environmental tobacco smoke, clean indoor air legislation restricts smoking to designated areas (USDHHS, 2000). Levy and Friend (2003) suggest that because clean indoor air laws reduce the opportunity to smoke, comprehensive public indoor air legislation has the potential to reduce population prevalence of cigarette smoking by about 10%.

Despite research on policies to reduce prevalence among adults and youth, little is known about what level of restriction or provision has the most significant effect on the initiation, maintenance, and prevalence of cigarette smoking among school-aged children (Forster & Wolfson, 1998). In addition, the underlying

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mechanisms of these effects are poorly understood. Craig and Boris (2007) suggest that norms that prohibit cigarette smoking among youth but overlook it among adults could increase youth desire to smoke. A multidimensional approach that includes providing merchants with tools to increase their compliance, increasing community support, and performing continuous compliance checks is considered an effective intervention to reduce cigarette smoking among youth (Levy & Friend, 2002). This study examines the prevalence of youth cigarette smoking in relation to state-level youth access and clean indoor air laws.

Youth access laws

The decline in youth cigarette smoking prevalence over the past decade has paralleled the adoption of policies restricting youth access to tobacco products (Johnston, O'Malley, & Terry-McElrath, 2004). Young smokers access tobacco in a variety of ways, including purchasing cigarettes from stores, giving others money to buy cigarettes, getting cigarettes from family members, borrowing cigarettes, using vending machines, and stealing (Ling, Landman, & Glantz, 2002; Robinson, Klesges, & Zbikowski, 1998); only 26% of high school students obtain cigarettes from stores (Ringel, Pacula, & Asserman, 2000). Nevertheless, research has documented the effect of tobacco control laws on cigarette smoking uptake among youth (Wakefield et al., 2000). Wakefield et al. (2000) observed that stringent restrictions reduced by 8% the odds of the transition from early (past or limited current tobacco use with weak or strong intentions not to smoke, respectively) to advanced experimenter (limited current tobacco use with weak intentions to not smoke or moderate lifetime tobacco use). In addition, stringent restrictions reduced by 10% the transition from advanced experimenter to established smoker (smoking 100+ cigarettes in lifetime).

Retailer compliance with laws limiting sales to minors appears to be a significant factor in reducing youth access (Cummings, Hyland, Perla, & Giovino, 2003; Henriksen, Feighery, Wang, & Fortmann, 2007; Klonoff & Landrine, 2004). Cummings et al. (2003) observed a 16% reduction in prevalence of frequent smoking between 1992 and 1996 in communities that achieved a retailer compliance rate of at least 80%. Similarly, Kandel, Kiros, Schaffran, and Hu (2004), with data from the National Longitudinal Study of Adolescent Health, found that banning vending machines had a strong inverse relationship with smoking uptake (odds ratio [*OR*] = 0.65; $p < .001$).

Clean indoor air laws

Smoke-free environment restrictions protect health by limiting nonsmokers' exposure to secondhand smoke (American Lung Association, 2005), which is thought to be the leading cause of specific death for lung cancer, chronic obstructive pulmonary disease, and ischemic heart disease in the United States (CDC, 2005). One possible effect of the clean indoor air laws is a change in community-wide perceptions about acceptable behavior or social norms for tobacco use (Alesci, Forster, & Blaine, 2003; Chaloupka, 2003; Wakefield & Forster, 2005). Siegel, Albers, Cheng, Biener, and Rigotti (2005) found that, compared with youth living in towns with weak local restaurant regulations, youth in towns with strong provisions were half as likely to progress to regular smoking, independent of the time that the regulation had been in effect. Similarly, McMullen, Brownson, Luke, and Chriqui (2005) found that an increase in the clean indoor air score of each state for nine separate categories was significantly inversely related to the proportion of youth who smoke in a state. The present study is the first to investigate the independent effect that each level of clean indoor air provisions has on the prevalence of cigarette smoking among middle and high school students while controlling for significant covariates.

Cigarette price

Higher cigarette prices through increased excise taxes deter smoking initiation and consumption by youth and adults (Liang & Chaloupka, 2001; Tauras & Chaloupka, 1999; Tauras et al., 2005). Furthermore, Tauras and Chaloupka (1999) provided evidence that youth are more responsive to cigarette prices than adults, finding that a 10% increase in the real price of cigarettes would decrease youth smoking prevalence by approximately 7%. Chaloupka (2003) proposed that higher cigarette prices directly affect youth's ability to obtain cigarettes through social sources because youth with cigarettes may be less likely to share. Liang et al. (2003) argued that economic and policy factors influence youth cigarette smoking both directly (by decreasing purchases) and indirectly (by changing smoking norms).

New evidence is needed on the type and level of smoking policy provision or restriction that best deters youth from smoking. Data on smoking status from a national probability sample of 6th- to 10th-grade youth in 39 states provided a unique opportunity to examine the effect of tobacco control legislation on smoking status. The present study examined the prevalence of cigarette smoking among middle and high school students in 39 states with varying state-level tobacco control regulations. It is hypothesized that youth living in a state with minimal restrictions on smoking policies would be more likely to smoke than those living in states with stricter policies.

Methods

Sample design and data collection

The primary data were from the 2001 to 2002 U.S. Health Behavior in School-Aged Children (HBSC) survey, a cross-sectional and school-based survey designed to assess the prevalence of health behaviors and social context influences on young people's well-being (Currie, Samdal, Boyce, & Smith, 2001). The target population for the U.S. HBSC survey was students in grades 6–10. The HBSC survey applied a multistage stratified sampling method, using 22 census regions as the primary strata, with an average stratum size of 674 individuals. The primary sampling units, allocated to each stratum, are 178 school districts, with an average size of 83 individuals (Roberts, François, Batista-Foguet, & King, 2000). The sampling frame achieved population percentages with a precision of ±3% at the 95% confidence level and a design effect factor of 1.2 (Roberts, Tynjälä, Currie, & King, 2004). The design effect of 1.2 suggests that the sample variance is 1.2 times bigger than it would be if the survey were based on the same sample size but selected at random. This design effect was calculated based on the sample size for each age group as reported in analyses of the 1993–1994 and 1997–1998 surveys for the international HBSC protocol (Roberts et al., 2000). The data were weighted to account for unequal probabilities due to the nested sample scheme and for nonresponse. Furthermore, minority students were oversampled to provide reliable estimates for Blacks and Hispanics.

Data collection took place in the classroom under teacher supervision. Questionnaires were completed anonymously and placed in sealed envelopes to ensure confidentiality. The response rate was 81.8%, yielding an overall sample of 14,818 students living in 39 states. The HBSC protocol was approved by the National Institutes of Health/Eunice Kennedy Shriver National Institute of Child Health and Human Development Institutional Review Board, and consent was solicited from parents and assent from students.

Tobacco control policy information was obtained from the National Cancer Institute–State Cancer Legislative Database (Alciati et al., 1998; Chriqui et al., 2002). The State Cancer Legislative Database (SCLD) data measure the extensiveness of state youth access and clean indoor air laws in the 50 states and the District of Columbia. State-level cigarette price came from the ImpacTeen State-Level Tobacco Legislative Database (http://impacteen.org/tobacco.htm). Cigarette price represents the average price of a pack of cigarettes, with generic cigarette brands included. Based on each respondent's state-of-residence identifier, tobacco control policy information and cigarette price were linked with the HBSC survey data. The dataset included respondents' state of residence, cigarette smoking status, sociodemographic characteristics, sampling design variables, state-level youth access laws, clean indoor air laws, and average cigarette price.

Measures

The HBSC survey. The HBSC survey is a standard self-completed questionnaire that included questions about cigarette smoking status and sociodemographic characteristics. Regarding cigarette smoking status, students were asked, "How often do you smoke tobacco at present?". We categorized students who responded "every day" as daily smokers, those who responded "at least once a week, but not every day" or "less than once a week" as experimenters, and those who responded "never smoked" as never-smokers.

Individual sociodemographic characteristics measured included gender (male/female), grade level (high school/middle school), parent education, family affluence scale (FAS), and race/ethnicity (White, Black, Hispanic, and "other" [American Indian, Alaska Natives, and Asian and Pacific Islanders]). Parent education consisted of four categories: less than high school graduate, high school graduate, some education after high school, and college graduate. The FAS is an indicator of socioeconomic status developed for the HBSC survey (Currie, 1997). The FAS measured material wealth by asking about the number of family vacations, cars, and home computers, and whether the respondent had his or her own bedroom. The scale has shown good content validity and external reliability and may be a more reliable affluence indicator than parent education or occupation when asked of adolescents (Spencer, 2006). Consistent with the work of Boyce, Torsheim, Currie, and Zambon (2006), a three-point ordinal scale was created, whereby scores 0–4 were classified as *low*, 5–6 as *moderate*, and 7–9 as *high*.

State-level tobacco control policies. The National Cancer Institute (2000) developed the SCLD to track laws related to youth access restrictions and clean indoor air provisions (Alciati et al., 1998; Chriqui et al., 2002). J. Chriqui (personal communication, 21 March 2006) suggests analyzing at least 2 years after policy initiation to allow time for the policy to have an effect on smoking behavior; thus, the 1999 state-level policies were analyzed. Youth access laws included regulations for minimum age, packaging, clerk intervention, photo identification, vending machines, free distribution, graduated penalties, random inspections, and statewide enforcement. The clean indoor air regulations included government worksites, private worksites, schools, childcare facilities, restaurants, retail stores, recreational and cultural facilities, penalties, and enforcement.

Assigned scores described the extent to which states meet the target public health objectives as outlined in *Healthy People 2010* (USDHHS, 2000). A state received the highest score if it achieved or exceeded the public health objective for the target area (Alciati et al., 1998). An ordinal scale was used for each smoking policy provision based on the approximate percent of target met: 5 = *exceeds target*; 4 = *meets target*; 3, 2, and 1 meet approximately 75%, 50%, and 25% of target, respectively; and 0 indicates no effective provision or restriction. For vending machines, government worksites, private worksites, schools, retail stores, and recreational and cultural facilities, some of the scoring categories were merged due to the small number of states with that score.

Cigarette price. Cigarette pricing information was obtained from the ImpacTeen State-Level Tobacco Legislative Database. This measure represents the average price of 20 cigarettes (generic brands included) based on the prices of single packs, cartons, and vending machine sales for the year 2001, inclusive of state-level excise taxes on cigarettes. The 2001 price variable was not symmetrical (skewness = 0.80 and kurtosis value of −0.60), suggesting a departure from a normal distribution. Therefore, the mean price across states was used as the cutoff to create a dichotomous (high/low) cigarette price variable; "high" price comprised values greater than $3.40 and was used as the referent in the logistic regressions.

Data analyses

Descriptive and bivariate analyses. We examined the distribution of the sociodemographic characteristics, cigarette smoking status, and smoking policies. In addition, Wald's chi-square tests were conducted separately for high schools and middle schools to identify statistically significant differences ($p < .05$) in cigarette smoking status by sociodemographic characteristics and state-level smoking policy score (data not shown).

Multivariate analyses. The SAS version 9.1.3, SURVEYLOGISTIC procedure, was used to perform logistic regressions. This procedure accounts for the stratification, clustering, and unequal weighting in its variance estimation process. Clustering by school districts may lead to biased correlation or interdependence among individuals within the sample district and produces *SEs* that tend to be higher than they would be if the same size of sample was obtained using simple random sampling (Roberts, François, Batista-Foguet, & King, 2000). To address this potential bias, we used the Taylor series linearization to express the estimates, which has been shown to be equivalent to the replication method (Kish & Frankel, 1974).

Logistic regression analyses were conducted to examine the association between cigarette smoking status and smoking policy for daily versus never (referent), experimenter versus never (referent), and daily versus experimenter (referent). Because we anticipated a strong association between cigarette price and cigarette smoking status, we first adjusted the models for sociodemographic characteristics and then ran a second model adding cigarette price. In the analyses, *ORs* greater than 1 signified a

Table 1. Targets for each item in smoking policy variables

Youth access restrictions	Clean indoor air provisions
1. Minimum age Prohibits the sale of tobacco products to those 18 years or younger and requires a warning sign at point of purchase with penalty for failing to post one	1. Government worksites Government worksites are 100% smoke free, no exemptions
2. Packaging Prohibits all cigarette sales other than in a sealed package conforming to federal labeling requirements	2. Private worksites Private worksites are 100% smoke free, no exemptions
3. Clerk intervention Prohibits access to or purchase of tobacco products without the intervention of a sales clerk	3. Schools No smoking permitted in schools during school hours or while school activities are being conducted
4. Photo identification Requires merchants to request photo identification for persons who appear to be under 21 years	4. Childcare facilities No smoking permitted during operating hours in childcare facilities (explicitly including licensed home-based facilities)
5. Vending machines Total ban on sale of all tobacco products through vending machines in all locations	5. Restaurants Restaurants (explicitly including bar areas of restaurants) are 100% smoke free
6. Free distribution Total ban on distribution of free tobacco samples, coupons for free samples, or rebates	6. Retail stores Retail stores or businesses open to the public are 100% smoke free
7. Graduated penalties Establishes a system of graduated penalties applicable to all youth access laws, plus possibility of suspension or revocation of a tobacco retail license for repeated sales to minors	7. Recreational/cultural facilities Recreational and cultural facilities are 100% smoke free
8. Random inspections Establishes random inspections of retailers as part of the enforcement mechanism and does not prohibit use of minors to test compliance	8. Penalties Penalties or fines, applicable to smokers and to proprietors/employers, for any violation of clean indoor air legislation
9. Statewide enforcement Establishes a clearly designated statewide enforcement authority for sales	9. Enforcement Designate an enforcement authority for clean indoor air legislation and require sign posting

Note. Alciati *et al.*, 1998; Chriqui *et al.*, 2002.

higher likelihood of cigarette smoking in students living in states where the policies were less strict. Given the number of logistic regression analyses that were conducted, an alpha level of .01 was selected to control for Type I error inflation in analyses. Thus, statistically significant *OR* in logistic regression will have a nonoverlapping 99% *CI*.

The following sociodemographic categories were used as referents in regression analysis: female, White, college-level parent education, moderate FAS category, and high cigarette price. The FAS and parent education variables were retained in the models, given their small correlation coefficient (rho = .30, $p < .0001$; Cohen, 1988). In addition, because of the magnitude of the majority of the correlations among the youth access and clean indoor air laws variables (rho > .40), separate logistic regressions were performed.

Results

Bivariate analyses: Sociodemographic characteristics and cigarette smoking status

Respondents were excluded from the present study if the cigarette smoking behavior question was not answered (n = 1,479, 10%). The deleted sample was significantly different ($p < .05$) from the analytical sample in all sociodemographic variables. The excluded sample contained more boys than girls (57% vs. 43%); in addition, compared with the analytical sample, proportionately more Blacks (28%) and fewer Whites (49%) were excluded. However, the difference in family affluence was marginally significant ($p = .0485$; data not shown). The analytical sample (n = 13,339) was 47% male and 64% White, 15% Black, 13% Hispanic, and 8% "other" (Table 2). The majority of the sample (85%) never smoked, 10% had experimented, and 5% reported daily smoking. The proportion of experimenters and daily smokers increased with grade ($\chi^2 = 153.61$, $p < .0001$) and was higher among boys than girls for both daily smoking (6% vs. 4%) and experimental smoking (11% vs. 9%; $\chi^2 = 32.40$, $p < .0001$). As shown in Table 2, Whites reported the highest proportion of daily smoking, followed by the "other" category. Children whose parents had less than high school education were more likely to be daily and experimental smokers (13% and 15%, respectively) when compared with children whose parents were college graduates (4% and 8%, respectively; $\chi^2 = 68.83$, $p < .0001$). The proportion of daily smoking was higher among youth from low-affluence families compared with those from high-affluence families (7% and 4%; $\chi^2 = 38.74$, $p < .0001$).

The Spearman rho coefficient showed significant bivariate correlations between smoking policy variables. For example, for

Table 2. Description of the sample sociodemographic characteristics by cigarette smoking status

Characteristic	Sample ($N = 13,339$)	Daily ($n = 616$; 5%)	Experimenter ($n = 1,273$; 10%)	Never ($n = 11,450$; 85%)	χ^2
	Number of subjects (weighted percent)				
Gender					32.40***
Male	6,257 (47)	364 (6)	665 (11)	5,223 (83)	
Female	7,087 (53)	252 (4)	608 (9)	6,227 (87)	
Grade					153.61***
6th	3,300 (20)	35 (1)	135 (4)	3,130 (95)	
7th	2,561 (20)	61 (2)	205 (7)	2,295 (90)	
8th	2,568 (21)	107 (4)	295 (11)	2,166 (85)	
9th	2,436 (20)	184 (9)	307 (12)	1,945 (79)	
10th	2,474 (19)	229 (10)	331 (15)	1,914 (76)	
Race/ethnicity (missing = 138)					22.09**
White	6,892 (64)	392 (6)	609 (9)	5,891 (85)	
Black	2,583 (15)	81 (4)	243 (9)	2,259 (87)	
Hispanic	2,560 (13)	92 (4)	286 (12)	2,182 (84)	
Other	1,166 (8)	46 (5)	123 (11)	997 (84)	
Parent's education (missing = 2,094)					68.83***
<High school	1,164 (8)	117 (4)	163 (8)	884 (88)	
High school	2,438 (21)	125 (6)	253 (12)	2,060 (82)	
>High school	2,430 (22)	128 (6)	276 (10)	2,026 (84)	
College	5,213 (48)	188 (13)	421 (15)	4,604 (72)	
Family affluence scale (missing = 165)					
Low	4,065 (28)	239 (7)	412 (11)	3,414 (82)	38.74***
Moderate	6,603 (52)	265 (4)	632 (10)	5,706 (86)	
High	2,506 (20)	99 (4)	207 (8)	2,200 (88)	
Cigarette price					
Low price	9,043 (71)	506 (6)	969 (11)	7,568 (83)	32.68**
High price	4,296 (29)	110 (3)	304 (7)	3,882 (90)	

Note. "Other" in race/ethnicity refers to Asian American, Pacific Islander, or American Indian.
**$p < .01$; ***$p < .0001$.

middle school students, packaging was correlated with vending machines and free distribution ($r = .75$, for both). For the clean indoor air variables, government worksites was strongly correlated with private worksites ($r = .72$), schools and childcare facilities ($r = .54$, for both), and restaurants ($r = .78$; complete results available from first author).

For middle school students, no youth access variable was associated with smoking status in chi-square analyses. Among the high school sample, the youth access variables found to have significant associations ($p < .05$) with smoking status were packaging, vending machines, and free distribution. For both middle and high school students, clean indoor air laws that target government worksites, private worksites, schools, restaurants, retail stores, and recreational and cultural facilities were associated with cigarette smoking. Penalties was only associated with high school students. The magnitude of the association was greatest for laws targeting private worksites, retail stores, and recreational and cultural facilities for the high school sample ($p < .001$).

Logistic regression analyses

Youth access. Although we found no association between the youth access restrictions and the cigarette smoking for middle school students, regression models were run to explore the possibility of suppression effects. Packing, vending machines, and free distribution were not associated with cigarette smoking status after adjusting for potential confounders in regression models. Despite this lack of association, a consistent trend was noted in the increased probability of smoking in the presence of lax restrictions. This increased probability was not significant within a 99% *CI*.

For high school students, the daily versus never model showed that no restrictions on vending machines was a predictor of daily smoking when compared with youth living in states where vending machines were placed in adult locations only and at least 20 feet from any entry (*OR* = 2.02, 99% *CI* = 1.02–4.01). After adjusting for sociodemographic characteristics and cigarette price, vending machine was not significant (Table 3).

In the experimenter versus never model, high school students were twice as likely to be experimenter smokers if they lived in states with no restrictions on free distribution compared with youth living in states with total bans on distribution (*OR* = 2.16, 99% *CI* = 1.28–3.64; Table 3). This effect was observed even after adjusting for sociodemographic characteristics and cigarette price (*OR* = 2.04, 99% *CI* = 1.10–3.77).

Table 3. Logistic regression models of cigarette smoking status, youth access, and clean indoor air laws for adolescents in middle school and high school

	Daily vs. never		Experimenter vs. never		Daily vs. experimenter	
Law (score)	Model I[a]	Model II[b]	Model I[a]	Model II[b]	Model I[a]	Model II[b]
Youth access			High school			
Packaging						
No provision (0) vs. prohibits all sales; FDA requirements (4)	1.65 (0.94–2.88)		1.07 (0.66–1.76)		1.65 (0.88–3.07)	
Vending machines						
No provision (0) vs. adult locations only, at least 20 feet from any entry (2, 3)	2.02 (1.02–4.01)	NS	1.10 (0.68–1.77)		1.85 (0.84–4.05)	
Free distribution						
No restrictions (0) vs. total ban on distribution (2)	2.22 (0.90–5.49)		2.16 (1.28–3.64)	2.04 (1.10–3.77)	1.06 (0.43–2.61)	
Selected location restrictions (1) vs. total ban on distribution (2)	2.05 (0.72–5.82)		1.95 (0.86–4.45)		1.05 (0.35–3.10)	
Clean indoor air			Middle school			
Government worksites						
No restrictions (0) vs. restrictions in all worksite types (2, 3, 4)	2.57 (1.13–5.81)	NS	1.54 (0.92–2.56)		1.78 (0.76–4.15)	
Schools						
No smoking during school hours (3) vs. no smoking while activities are being conducted or at any time (4, 5)	0.32 (0.08–1.29)		0.35 (0.17–0.71)	0.33 (0.15–0.71)	1.12 (0.25–4.95)	
Retail stores						
No restrictions (0) vs. restricted area or 100% smoke free (2, 4)	2.35 (1.10–5.00)	NS	1.55 (0.88–2.74)		1.58 (0.69–3.61)	
Recreational facilities						
No restrictions (0) vs. restricted areas or 100% smoke free (2)	2.34 (1.01–5.40)	NS	1.51 (0.71–3.22)		1.69 (0.70–4.07)	
Clean indoor air	High school					
Government worksites						
No restrictions (0) vs. restrictions in all worksite types (2, 3, 4)	2.67 (1.22–5.82)	NS	1.47 (0.61–3.56)		1.38 (0.58–3.21)	
Designated areas for some types of worksites (1) vs. restrictions in all worksite types (2, 3, 4)	2.67 (1.30–5.48)	NS	2.23 (1.18–4.22)	NS	1.17 (0.52–2.65)	
Private worksites						
No restrictions (0) vs. restrictions in all worksite types (2, 4)	3.93 (1.52–10.13)	NS	2.37 (1.12–5.00)	NS	1.50 (0.59–3.81)	
Designated areas for some types of worksites (1) vs. restrictions in all worksite types (2, 4)	4.58 (1.74–12.05)	3.63 (1.19–11.10)	2.18 (1.04–4.57)	NS	1.92 (0.69–5.34)	

Table 3. Continued

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Law (score)	Daily vs. never		Experimenter vs. never		Daily vs. experimenter	
	Model I[a]	Model II[b]	Model I[a]	Model II[b]	Model I[a]	Model II[b]
Schools						
Smoking restricted to designated areas (2) vs. no smoking while activities are being conducted or at any time (4, 5)	0.24 (0.08–0.68)	NS	0.44 (0.16–1.21)		0.51 (0.17–1.55)	
Restaurants						
No restrictions (0) vs. enclosed and ventilated areas (2, 4)	4.97 (1.80–13.73)	3.85 (1.21–12.21)	2.80 (1.13–6.89)	NS	1.67 (0.57–4.82)	
Designated areas; restrictions apply to some restaurants (1) vs. enclosed and ventilated areas (2, 4)	5.18 (1.87–14.30)	4.09 (1.29–12.93)	2.35 (0.96–5.76)		2.08 (0.69–6.25)	
Retail stores						
No restrictions (0) vs. restricted area or 100% smoke free (2, 4)	4.53 (1.75–11.72)	3.81 (1.12–13.00)	2.57 (1.23–5.33)	2.59 (1.01–6.64)	1.60 (0.61–4.18)	
Designated areas (1) vs. restricted areas or 100% smoke free (2, 4)	3.81 (1.47–9.88)	3.37 (1.10–10.28)	1.95 (0.92–4.15)		1.76 (0.64–4.81)	
Recreational facilities						
No restrictions (0) vs. restricted areas or 100% smoke free (2)	5.08 (1.85–13.92)	4.08 (1.24–13.38)	2.57 (1.15–5.74)	NS	1.68 (0.55–5.10)	
Designated areas; applied to some types (1) vs. restricted areas or 100% smoke free (2)	4.04 (1.58–10.28)	3.19 (1.07–9.45)	2.24 (1.09–4.63)	NS	1.66 (0.64–4.25)	

Note. –, not applicable; NS, not significant. Score: 0 = *none*, 1 = *minimal*, 2 = *fair*, 3 = *good*, 4 = *excellent*, and 5 = *outstanding*.

[a]Adjusted for sociodemographic characteristics.

[b]Adjusted for sociodemographic characteristics and cigarette price.

For the daily versus experimenter comparison, youth access policies were not significant in logistic regression models. The odds observed for youth living in states with no provision of packaging versus prohibition of all sales indicated an increase of uptake from experimenting to daily smoking (*OR* = 1.65, 99% *CI* = 0.88–3.07; Table 3). Although the probability of daily smoking was increased, compared with experimenting, it was not significant, with a narrower confidence interval. This result suggests that youth access restrictions have the potential to hinder the transition from experimenting to daily smoking.

Clean indoor air laws: Middle school. Lax clean air laws for government worksites, schools, retail stores, and recreational facilities were associated with smoking in middle school students (Table 3). Compared with youth living in states with stricter provisions, youth in states with no restrictions regarding government worksites were more likely to be daily versus never-smokers (*OR* = 2.57, 99% *CI* = 1.13–5.81). No smoking during school hours had a protective effect for the experimenter versus never comparison after adjusting for sociodemographic and cigarette price (*OR* = 0.33, 99% *CI* = 0.15–0.71). Lack of restrictions on retail store regulations was predictive of daily smoking only after adjusting for sociodemographic characteristics (*OR* = 2.35, 99% *CI* = 1.10–5.00). Similarly, for recreational facilities, a middle school youth in a state with no restrictions was twice as likely to smoke daily versus never compared with a youth living in a state in which smoking was at least restricted to certain areas or in which such facilities were 100% smoke free (*OR* = 2.34, 99% *CI* = 1.01–5.40).

Clean indoor air laws: High school. Similar associations were found for high school students (Table 3). Lack of restrictions in government worksites increased the odds of daily versus never smoking (*OR* = 2.67, 99% *CI* = 1.22–5.82), but the effect was not significant when cigarette price was included in the model.

Moreover, a similar effect was observed for daily smoking versus experimenter smoking in states that restrict smoking to designated areas for types of government worksites compared with restrictions in all worksite types. In private worksites, a stronger effect was observed for the daily versus never model (*OR* = 3.93, 99% *CI* = 1.52–10.13) and for the experimenter versus never model after controlling for all the covariates.

Consistent with the findings for middle school youth, less strict school provisions had a protective effect in the daily versus never comparison, which did not remain significant once price

was included (*OR* = 0.24, 99% *CI* = 0.08–0.68). With price and sociodemographic factors controlled, youth in states with no or limited restrictions or where smoking in restaurants was restricted to some areas were approximately four times as likely to be daily smokers than youth in states where smoking was restricted to separate and enclosed areas (*OR* = 3.85, 99% *CI* = 1.21–12.21; *OR* = 4.09, 99% *CI* = 1.29–12.93, respectively).

Regarding retail store provisions, youth living in states with no restrictions versus those in states with 100% smoke-free areas were 3.81 (99% *CI* = 1.12–13.00) times more likely to be a daily smoker than a never-smoker when cigarette price was included in the model. A reduced but significant effect was observed in the experimenter versus never comparison (*OR* = 2.59, 99% *CI* = 1.01–6.64) after controlling for cigarette price and sociodemographics. Compared with those living in states with 100% smoke-free recreational facilities, students living in states with no restrictions were 5.08 (99% *CI* = 1.85–13.92) times more likely to smoke daily, and those where smoking was limited to designated areas were 4.04 (99% *CI* = 1.58–10.28) times more likely to be daily smokers than never-smokers.

Discussion

The present study compared smoking prevalence among adolescents in 39 states with varying smoking control policies. The findings demonstrate that high school students living in states with less strict laws governing youth access and clean indoor air laws are more likely to be daily or experimental smokers than those who live in states with strict policies, after adjusting for sociodemographic variables and cigarette price. These findings support the role of contextual factors on adolescent smoking. Chaloupka (2003) discussed how macrolevel policies affect cigarette smoking behavior directly and indirectly. This study presented evidence that indirect policies, such as the clean indoor air laws, may deter daily smoking among youth. However, these policies may be somewhat limited as deterrents to smoking uptake among youth, given that few experimenter versus never and daily versus experimenter comparison effects were found for clean indoor air policies after adjusting for sociodemographic characteristics and cigarette price. This lack of smoking policy effectiveness in the experimenter group could be related to how adolescents access cigarettes. Previous research has identified the ways in which youth access cigarettes (Robinson et al., 1998; Wakefield et al., 2000). Our findings suggest that experimenter smokers are likely to progress to daily smoking, given the lack of significance observed in the youth access and clean indoor legislation.

Consistent with our findings, other research on clean indoor air provisions has documented that smoking restrictions in public places decrease smoking prevalence among youth (Glantz, 1997; Siegel et al., 2005; Tauras et al., 2005; Wakefield & Forster, 2005; Wakefield et al., 2000). This effect was maintained among high school students when cigarette price was included. We also found some evidence that the stringency of the provisions matters. In government and private worksites, as well as in retail stores and recreational facilities, having designated smoking areas, compared with 100% smoke-free policies, increased the odds of daily and experimenter smoking. Thus, partial restrictions do little more to reduce the likelihood of youth smoking daily than having no restriction. Strict laws would limit smoking by reducing opportunities to smoke among youth and by influencing attitudes and social norms of smoking (Levy & Friend, 2003). Siegel et al. (2005) proposed that strong local restaurant smoking regulations had an effect on social acceptability among youth. Thus, the enactment and vigorous enforcement of clean indoor air laws should reduce youth smoking by changing social norms. This may be particularly effective as this enactment and enforcement establishes restrictions, thereby norms, applied not only to youth, but to adults as well. As argued by Craig and Boris (2007), age restrictions may not be effective if they reflect social norms that condemn the use of cigarettes by youth but not among adults, thereby enhancing the desire of youth to smoke. Intervention research is needed that identifies policies that consistently and effectively control youth access to tobacco products.

Interestingly, no effects for middle school students were found for provisions regarding youth access, which were enacted to directly reduce or deter youth smoking. For high school students, free distribution might reflect fewer opportunities for cost-free cigarettes or impulsive smoking. Similar to the findings of Kandel et al. (2004) on state-level vending machines, we observed that state-level banning of vending machines was associated with cigarette smoking. Nonetheless, the findings reported here did not examine the association of vending machines with the initiation and progression of cigarette smoking.

Surprisingly, having broader prohibitions on smoking at school was not found to be protective for middle or high school students. In fact, we observed the inverse, less strict school policies restricting smoking to designated areas had a protective effect for middle school and high school students. The majority of schools surveyed had a policy prohibiting cigarette smoking on school grounds by students and staff, which might have influenced the associations. In addition, it could be that adolescent smoking occurs as part of their socialization context. We speculate that removing smokers from the rest of the student population creates a social distance for smokers, making being a smoker socially undesirable. More research is needed to examine this idea.

Limitations of the present study should be addressed. Other potential mechanisms at the family, peer, and policy levels might have influenced the present findings. The HBSC survey did not measure important family-level characteristics, such as parent smoking status, family bonding, parental structure (living with two biological parents), and home smoking bans. Youth whose parents smoke are likely to have easier access to cigarettes than youth whose parents do not smoke (Robinson et al., 1998; Tyas & Pederson, 1998). In addition, family bonding was found to decrease the odds of smoking initiation and adverse transition from adolescence to young adulthood (Kim & Clark, 2006). The lack of family-level data may limit the interpretations of our findings as to their level of influence on youth smoking prevalence. Wakefield et al. (2000) found beneficial effects of smoking bans, which reduce the odds of smoking among youth and also have an impact on the smoking norms in the home environment. These restrictions on smoking in public places may translate into less social acceptance of smoking at home. However, if youth perceive that their parents approve of smoking, they are more likely to socialize with prosmoking peers (Tucker, Martinez, Ellickson, & Edellen, 2008).

Peer influences represent a robust predictor of adolescent cigarette smoking (Iannotti, Bush, & Weinfurt, 1996; Simons-Morton, Chen, Abroms, & Haynie, 2004), yielding a stronger

smoking identity among youth (Jones, Schroeder, & Moolchan, 2004). Proximal peer influences would be expected to be more powerful than more distal smoking policy effects unless policy effects alter social norms regarding smoking (Turner, Mermelstein, & Flay, 2004). However, parental influences on smoking remain important into middle adolescence (Iannotti et al., 1996; Simons-Morton, 2004; Simons-Morton et al., 2004), and state-level smoking policies would exert more powerful influences on smoking behavior when parents also engage in smoking prevention behavior.

More research is needed to explain all these levels of influence on cigarette smoking status among youth. At the policy level, these smoking policies likely need more time to have an effect than the 2-year timeframe used in this study. This could be related to tobacco industry opposition regarding the adoption and implementation of these laws (Andersen, Begay, & Lawson, 2003). Another study limitation is the absence of information on the enforcement of these laws. Instead, a rating score indicates that the law is in place in the state; strict laws that are not enforced may not deter smoking. Thus, the impact of state-level measures of tobacco control, as reflected by clean indoor air and youth access laws, needs to be interpreted with caution. Nevertheless, the policy scores presented are nonpreemptive and therefore capture to some extent the implementation of local policies. More evidence is needed to account for local ordinances in conjunction with state-level smoking policies to determine their effect on cigarette smoking status among youth.

Because of the study's cross-sectional design, causality cannot be established. It could be that stronger policies will be implemented in states where antismoking feelings are high and smoking prevalence is low. Conversely, states in which youth smoking prevalence is not a public health concern might implement smoking policies less aggressively. More research is needed to address the mechanisms by which smoking policy can reduce cigarette smoking behavior among youth. An issue related to the generalizability of our findings is the low prevalence of cigarette smoking reported in the present study; only 5% were daily smokers and 15% were experimenters. Although these percentages are lower than those reported in other nationally representative studies, the prevalence of cigarette smoking status follows trends similar to the rates reported in earlier prevalence studies (Johnston et al., 2006).

Another methodological issue is the clustering of observations at the state level, which could bias the accuracy of the effects reported. As discussed in the Methods section, the analyses used for the present study controlled for the interdependence and the nesting structure of the data. Our sample design has a design effect of 1.2, which means that the sample variance is 1.2 bigger than it would be if the survey were based on the same sample size but selected randomly (Roberts et al., 2000; Shackman, 2001). Moreover, the *OR*s were estimated using Taylor's series expansion so as to fully account for the complex survey design.

Despite these limitations, the findings of the present study suggest that stronger tobacco control policies are effective in reducing the prevalence of daily cigarette smoking and experimenting among high school students. A distinctive contribution of this study is that it identifies the levels of provisions that have an effect on cigarette smoking status for middle and high school students. To our knowledge, this is the first study to use this methodology. These findings could inform tobacco control advocates in promoting effective legislation to deter cigarette smoking among youth. Given the political, economic, and social costs associated with the maintenance of legislation, more emphasis is needed on enforcing tobacco control policies that are effective and on evaluating and identifying those that are not. This paper provides a better understanding of the effectiveness of state-level youth access and clean indoor air laws on the prevalence of cigarette smoking among school-aged children.

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Declaration of Interests

None declared.

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