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State-level tobacco control policies and youth smoking cessation measures

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ABSTRACT

Objective: Research on the effects of state-level tobacco control policies targeted at youth has been mixed, with little on the effects of these policies and youth smoking cessation. This study explored the association between state-level tobacco control policies and youth smoking cessation behaviors from 1991 to 2006.
Methods: The study design was a population-based, nested survey of students within states. Study participants were 8th, 10th, and 12th graders who reported smoking "regularly in the past" or "regularly now" from the Monitoring the Future study. Main cessation outcome measures were: any quit attempt; want to quit; non-continuation of smoking; and discontinuation of smoking.
Results: Results showed that cigarette price was positively associated with a majority of cessation-related measures among high school smokers. Strength of sales to minors' laws was also associated with adolescent non-continuation of smoking among 10th and 12th graders.
Conclusions: Findings suggest that increasing cigarette price can encourage cessation-related behaviors among high school smokers. Evidence-based policy, such as tax increases on tobacco products, should be included as an important part of comprehensive tobacco control policy, which can have a positive effect on decreasing smoking prevalence and increasing smoking cessation among youth.

1. Introduction

Cigarettes continue to be the most common type of tobacco used by youth, and data from the 2007 Youth Risk Behavior Surveillance System (YRBSS) estimate current nationwide smoking prevalence among 9th to 12th graders at 20% [1]. Trends in cigarette smoking prevalence among youth increased in the early to mid 1990s, but have shown a decreasing trend since 1997. Smoking rates among 12th graders dropped from a high of 37% in 1997, to 20.4% in 2008; while among 8th and 10th graders, trends in 30-day cigarette smoking prevalence have been similar, with 2008 prevalence rates of 6.8% and 12.3%, respectively [2].

In 2007, 50% of currently smoking high school students had tried to quit at least once during the past 12

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months [1]. Adolescent smokers face difficult withdrawal symptoms and failed quit attempts, with many reporting relapse within six months of their initial quit attempt; however, many are motivated to quit and successful adolescent smoking cessation has been associated with student-level variation across social and psychological factors such as parental and peer support, healthy lifestyles, and psychosocial coping skills [3–8].

A variety of tobacco control policies were enacted over the past two decades that aim to prevent smoking initiation and encourage cessation among adolescents. Popular policies include: cigarette tax increases; smoke-free air laws; and youth access laws, including sales to minors' laws and possession, use, and purchase laws [9]. In 1998, the Master Settlement Agreement (MSA) focused even more attention on tobacco control policies, as settlement dollars were allocated to state tobacco control programs; however, few studies have focused on the relationship between multiple tobacco control policies and youth smoking cessation [10–12]. Research on policy effects related to youth and young adult tobacco cessation is one of the four main goals for the Youth Tobacco Cessation Collaborative (YTCC) to help meet its 10-year goal of ensuring that every young tobacco user has access to appropriate and effective cessation interventions by the year 2010 [13].

State-level tobacco control policy research has been limited, with somewhat mixed findings for associations with youth smoking behavior. Rohrbach et al. analyzed the effects of the California Tobacco Control Program on adult and 10th grade tobacco-related attitudes and behaviors and found a decrease in smoking prevalence among adults in California, but no significant program effects for 10th grade adolescents [14]. In contrast, Ross and Chaloupka reported that higher cigarette prices reduced the probability of youth smoking, and that the teen-specific perceived price of cigarettes had a negative impact on demand [15]. Chaloupka and Warner reported that in developed countries, increasing cigarette price by 10% reduces cigarette consumption among youth smokers, with the decline in consumption due to both reduced consumption among continuing smokers and cessation [16]. Similar findings have been reported by other researchers, who have found price or tax increases to be effective in decreasing current smoking prevalence or the number of cigarettes smoked per day among youth or young adult smokers [17–19].

Smoke-free air laws, which are tobacco control policies designed to protect non-smokers and discourage smoking as an acceptable norm in public places and work places, have also been studied. Some research has reported a favorable association of smoke-free air laws with decreases in adult smoking behavior, including cigarettes per day [20]. Other researchers have reported a possible relationship between reduced adolescent smoking and restrictions on smoking at home, more extensive bans on smoking in public places, and enforced bans on smoking at school [21,22]. Analyzing longitudinal data, Tauras and Chaloupka reported that stronger smoke-free air restrictions in private worksites and public places, other than restaurants, increased the probability of smoking cessation among young adults [12]. A recent study in Minnesota by Klein et al. reported no significant association between local clean indoor air policies and past-month smoking among youth over time; however, home smoking bans were significantly associated with reduced past-month smoking among youth [23].

Youth access laws are tobacco control policies restricting minors' access to tobacco, with goals of decreasing availability and reducing the supply to youth, ultimately decreasing youth smoking prevalence. These include sales to minors' (STM) laws, which penalize merchants and retailers for selling tobacco to youth; and possession, use, and purchase (PUP) laws, which penalize youth themselves for possessing, using, and/or purchasing tobacco products [24]. While some studies have reported an association between youth access STM laws and decreased availability of tobacco from retail sales to youth, a sustained relationship between these laws and decreased youth smoking prevalence has been questioned, with reports of social sources replacing commercial tobacco sources [25–31]. Youth access PUP laws have been controversial, with arguments both for and against their usefulness to discourage youth tobacco use [32,33]. Although some studies have found enforcement of local possession laws to be effective in curbing smoking rates among targeted communities; previous research has failed to support a long-term relationship between state-level youth access possession laws and a sustained decrease in youth smoking prevalence [34–36].

The effects of comprehensive state-level tobacco control programs have also been studied. Siegel and Biener compared statewide tobacco control efforts of both Massachusetts and California, and found that youth programs in either state were not related to decreased smoking initiation [37]. However, Luke et al. reported that states with more extensive tobacco control policies had significantly lower youth smoking rates and that comprehensive state tobacco control policies could increase prevention and encourage youth smoking cessation [38]. Wakefield and Chaloupka studied comprehensive statewide tobacco control programs, with various policy components, and found that different strengths and combinations of these program components could lead to reductions in youth smoking [39]. Similarly, Tauras et al. found that greater funding for comprehensive state tobacco control programs was associated with reductions in youth smoking prevalence [40].

Taken together, past research suggests that state-level tobacco control policies and programs can influence adolescent smoking behaviors; however, little research has focused specifically on multiple state-level policies and adolescent cessation behaviors. Therefore, using a nationally representative combined sample of 10th and 12th grade regular smokers from 1991 to 2006, this paper explores the association between adolescent tobacco cessation behaviors and state-level tobacco control policies. This study will assess cessation behaviors among regular youth smokers using cross-sectional measures; therefore, respondents may differentially report regular smoking and relate to quitting variables in each nationally representative sample.

2. Methods

2.1. Study design and population

This study incorporates cross-sectional student and state-level data from 1991 to 2006. Hierarchical linear modeling was used to link student and state-level data. Student-level data were taken from the Monitoring the Future (MTF) study, which is supported by the National Institute on Drug Abuse. MTF is an ongoing study of nationally representative samples of secondary school students in the coterminous United States, which includes 48 states and Washington DC, conducted by the Institute for Social Research at the University of Michigan since 1975. While MTF is not a state-specific survey, samples are drawn separately at each grade level to be representative of students in that grade in public and private secondary schools across the coterminous United States. Schools are selected with probability proportionate to their estimated class size. The sampling design of the MTF study has been described extensively elsewhere [41,42].

Analyses include a combined sample of 10th and 12th grade 'regular smokers', which are students who describe themselves as smoking "regularly now" or "regularly in the past". MTF respondents are included in the 'regular smoking' category by self-identifying as a regular smoker based on their own interpretation and self-selection into this category at the time of survey. Analyses were restricted to regular smokers to include respondents with the potential to be most influenced by policy measures, as opposed to occasional smokers who often times do not self-identify as 'smokers', and who may also be less likely to have smoking behavior influenced by tobacco control policies. During 1991–2006, self-administered questionnaires were collected from 39,876 and 50,608 10th and 12th grade regular smokers, respectively.

Data on state-level tobacco control policies were collected, organized, and reviewed by tobacco control researchers at the Roswell Park Cancer Institute and University at Buffalo, State University of New York, as part of the tobacco component for the ImpacTeen study (funded by the Robert Wood Johnson Foundation). State policies across all US states, including Washington DC, were collected and documented by researching and coding enacted and effective dates of state laws for tobacco control statutes and regulations [43]. Laws were coded and included in analyses based upon the effective date of the legislation. Effective date means that the law was effective before July 1 of the calendar year, to be coded and included for that respective year. If the effective date was on or after July 1, the law was coded for the following calendar year. State-level policy data were matched to student-level data by state and year based on the effective date of the legislation, thus capturing any changes in the laws over the years of interest.

2.2. Outcome measures

Main outcome measures were binary variables for: any quit attempt (tried to quit one or more times); want to quit (want to quit smoking now); non-continuation of smoking (ever-regular smokers who have not smoked in the past 30 days); and discontinuation of smoking (ever-regular smokers who have made at least one quit attempt and have not smoked in the past 30 days). These outcome measures are described in detail below.

Any quit attempt was defined as tried to quit smoking one or more times and was based on the MTF survey question, "How many times, if any, have you tried to stop smoking?". The original variable was re-coded into "no attempts to quit" versus "any attempts to quit" because adolescent smokers were primarily divided into two groups: those without quit attempts, and those with one or more quit attempts. Want to quit smoking was defined as want to quit smoking now, and was measured by the MTF question, "Do you want to stop smoking now?". We compared adolescent smokers who responded "yes" versus "no" to this question.

Non-continuation of smoking was defined as ever-regular smokers who have not smoked in the past 30 days. From the subset of 10th and 12th grade students who described themselves as smoking "regularly in the past" or "regularly now," non-continuation of smoking was defined as "the percentage of those who say they ever smoked 'regularly' who also reported not smoking at all during the past 30 days" [44]. The term "non-continuation" does not necessarily imply "quitting" because the latter implies intentionally and permanently ceasing an established pattern of smoking. The operational definition of non-continuation focused on not smoking within the past 30 days. The 'non-continuation' smoking measure has been used in MTF to describe a group of smokers with smoking abstinence for a defined time period during the past 30 days that did not report making a quit attempt in the past 30 days. Therefore, they have most likely quit smoking due to situational or circumstantial factors (e.g. summer vacation with parents; sports participation; a temporary change in living arrangements). This measure has been validated through its repeated use in MTF surveys to measure temporary smoking cessation during a 30-day time period.

Discontinuation of smoking was defined as ever-regular smokers who have made at least one quit attempt and have not smoked in the past 30 days. Specifically, among the subsample of adolescent smokers who made one or more quit attempts, we compared those adolescents who were abstinent from smoking for at least the 30 days immediately preceding the survey (those who discontinued smoking) versus those who were not abstinent during the previous 30 days (those who did not discontinue smoking). Therefore, discontinuation provides a measure of intentional smoking abstinence in the 30 days preceding the MTF survey by including youth who have made at least one quit attempt. This measure of quitting intention distinguishes between those abstinent from smoking due to situational or circumstantial reasons versus those who have made a conscious effort to quit smoking, realizing that policy may differentially affect these two groups of smokers.

While our study focuses on cessation behaviors, we also investigated smoking behaviors such as frequency (e.g. how many cigarettes were smoked in the past 30 days). In reviewing the residuals, the frequency variable showed a non-linear positively skewed distribution, where we would

need to create a binary variable of low frequency or high frequency. From a policy perspective, we decided to focus analytic efforts on cessation behaviors of these self-defined regular smokers, rather than frequency of smoking.

2.3. State-level tobacco control policies

The following state-level tobacco control policies were included for this study: cigarette price; smoke-free air laws; youth access sales to minors' (STM) laws; and youth access possession laws. In preliminary analyses, we also examined the impact of youth access purchase and use laws, in addition to tobacco control expenditures, in our models. These variables were excluded from the final models because they were not significant predictors of our cessation outcome measures.

Cigarette price data were taken from *The Tax Burden on Tobacco*, as state-specific estimates for price, and constructed as the average price of a pack of cigarettes, excluding generic cigarettes, for the first six months of the year. The price variable was constructed by subtracting both federal and state excise taxes from average price, weighting tax clear prices, and adding these average weighted federal and state excise taxes for the first half of year to the weighted average price for the first half of the year. [45]. Therefore, the average price of a pack of cigarettes was an estimate of the first two quarters of each year, representing a yearly average that accounted for state and federal excise tax changes, but was exclusive of local cigarette taxes, and was adjusted for inflation to the consumer price index (CPI) average for 1982–1984.

Smoke-free air data were compiled from state-specific legislation to construct a smoke-free air (SFA) index, using a multi-step process. State-specific SFA index values, ranging from 0 = no provision/does not meet a restriction to 3 = ban at all times, were constructed from ratings given to each state. The ratings were based upon the levels of restriction provided for the following locations considered to be most reflective of states with strong smoke-free air legislation: private worksites, restaurants, and free-standing bars. SFA ratings were assigned based on strength of protection at each location and summed to arrive at the final SFA index value, ranging from 0 to 9 [46].

Youth access sales to minors' (STM) laws were analyzed using an Alciati Index value, which is a composite score representing the strength of state youth access laws focusing on sales to minors' legislation for state-specific years, and has nine components: minimum age of purchase; packaging; clerk intervention; photo identification; vending machine availability; free distribution; graduated penalties; random inspections; and statewide enforcement. Alciati index scoring, ranging from 0 to 31, is based upon the National Cancer Institute's (NCI) Decision Criteria For Rating state youth access laws, and detailed decision rules and scoring information can be found on the NCI's State Cancer Legislative Database Program website: http://www.scld-nci.net/ [47,48]. Youth access possession laws were binary variables coded for the presence or absence (1/0) of a given law in a given state for a specific year [43].

2.4. Student-level controls

Student characteristics previously shown to have strong relationships to adolescent tobacco cessation were used as control variables. Student measures of race/ethnicity (African American, Hispanic, or Other Race) and gender were binary variables, where the comparison groups were Caucasian and female. Parental educational attainment, a proxy for family socioeconomic status (SES), was a binary variable for whether either parent had any education beyond high school or not, where the comparison group was parental education of high school or less. Total income was a sum based on money earned from a paid or unpaid job, other work, and other sources (such as allowances), with a range of $0 to $184 per week, and was adjusted for inflation to the CPI average for 1982–1984. Work status was a binary variable taken from the question, "On average, how many hours per week do you work in a paid/unpaid job?". We included both student income and work status in the same model since working youth may be subjected to an additional environment where others are smoking or not smoking. Student age was also included in the models as a covariate.

2.5. Analysis strategy

Because of the multilevel design, where students are nested within states, hierarchical generalized linear modeling (HGLM) was used to account for student-level variance and state-level variance [49]. We chose a random-effects model (e.g. HGLM) over the fixed-effects model because with a nested design, a random-effects model can account for unobservable variables at both the state and student levels, and therefore, allows for a parsimonious model. For each binary outcome, a two-level Bernoulli distribution, logit-link function HGLM was performed for 10th and 12th grade regular smokers separately. For the analyses, we included year dummies in the models and pooled data from 1991 to 2006. Therefore, at level-2 (state level), we included year as indicator variables to account for cohort effects, where 1991 was the referent year. Inclusion of the year indicator variables to control for cohort effects, are optimal for taking into account other state policies (e.g. the Master Settlement Agreement in 1998).

For the HGLM models at level-1 (student level), we have the following control variables to account for student characteristics: student age, gender, race/ethnicity, parental education (proxy for SES), total income, and work status. At the state-level, level-2, we have 19 variables that include state policies of interest and year indicator variables. The HGLM equation is as follows:

$$\begin{aligned}\eta_{ij} = {} & \gamma_{00} + \gamma_{01}(1992) + \gamma_{02}(1993) + \gamma_{03}(1994) \\ & + \gamma_{04}(1995) + \gamma_{05}(1996) + \gamma_{06}(1997) + \gamma_{07}(1998) \\ & + \gamma_{08}(1999) + \gamma_{09}(2000) + \gamma_{010}(2001) + \gamma_{011}(2002) \\ & + \gamma_{012}(2003) + \gamma_{013}(2004) + \gamma_{014}(2005) \\ & + \gamma_{015}(2006) + \gamma_{016}(\text{PossessionLaw}) \\ & + \gamma_{017}(\text{SFAIndex}) + \gamma_{018}(\text{CigarettePrice})\end{aligned}$$

Table 1
Results of HGLM analyses—multilevel models for high school regular smokers and smoking cessation outcome measures (1991–2006 combined).

	Any quit attempt[a]			Want to quit smoking[b]		
	β	se	Odds ratio (CI)	β	se	Odds ratio (CI)
Intercept, γ_{00}	1.228**	0.399	3.415 (1.560,7.475)	−1.718***	0.404	0.179 (0.081,0.396)
State level						
1992, γ_{01}	0.037	0.213	1.038 (0.684,1.574)	0.112	0.219	1.118 (0.728,1.718)
1993, γ_{02}	−0.020	0.220	0.980 (0.636,1.509)	−0.126	0.206	0.882 (0.589,1.322)
1994, γ_{03}	0.125	0.187	1.133 (0.785,1.637)	0.076	0.190	1.079 (0.743,1.566)
1995, γ_{04}	−0.251	0.180	0.778 (0.546,1.109)	0.308	0.173	1.361 (0.968,1.913)
1996, γ_{05}	−0.244	0.240	0.784 (0.490,1.254)	−0.160	0.210	0.852 (0.564,1.288)
1997, γ_{06}	−0.016	0.167	0.985 (0.710,1.366)	−0.031	0.168	0.969 (0.697,1.348)
1998, γ_{07}	0.022	0.169	1.022 (0.733,1.424)	0.001	0.173	1.001 (0.713,1.407)
1999, γ_{08}	0.049	0.174	1.050 (0.746,1.478)	−0.008	0.171	0.992 (0.709,1.388)
2000, γ_{09}	0.051	0.175	1.052 (0.746,1.484)	0.027	0.179	1.027 (0.723,1.459)
2001, γ_{010}	−0.033	0.186	0.967 (0.672,1.392)	−0.050	0.184	0.951 (0.663,1.365)
2002, γ_{011}	0.079	0.193	1.082 (0.741,1.579)	0.122	0.182	1.130 (0.791,1.615)
2003, γ_{012}	−0.032	0.196	0.969 (0.659,1.424)	−0.207	0.200	0.813 (0.549,1.204)
2004, γ_{013}	−0.243	0.196	0.785 (0.535,1.151)	0.192	0.192	0.798 (0.548,1.163)
2005, γ_{014}	−0.230	0.193	0.795 (0.545,1.160)	−0.221	0.206	0.802 (0.536,1.200)
2006, γ_{015}	−0.353	0.197	0.703 (0.478,1.034)	−0.349	0.194	0.706 (0.482,1.032)
Possession Law, γ_{016}	0.003	0.046	1.001 (0.915,1.096)	−0.074	0.050	0.929 (0.843,1.024)
SFA Index, γ_{017}	0.002	0.011	1.002 (0.979,1.024)	−0.002	0.012	0.998 (0.975,1.022)
Cigarette Price, γ_{018}	0.002	0.001	1.001 (1.000,1.003)	0.003*	0.001	1.003 (1.001,1.005)
Youth access STM, γ_{019}	0.003	0.003	1.003 (0.996,1.009)	−0.004	0.003	0.996 (0.989,1.002)
Student level						
Male, γ_{10}	−0.215***	0.043	0.806 (0.741,0.877)	−0.158***	0.043	0.854 (0.785,0.929)
Black, γ_{20}	−0.295**	0.098	0.745 (0.615,0.902)	0.184	0.114	1.202 (0.962,1.501)
Hispanic, γ_{30}	−0.222**	0.079	0.801 (0.686,0.935)	−0.026	0.090	0.975 (0.817,1.162)
Other Race, γ_{40}	0.101	0.076	1.107 (0.953,1.285)	0.147	0.077	1.158 (0.995,1.347)
Age, γ_{50}	−0.025	0.020	0.976 (0.937,1.015)	0.079***	0.020	1.082 (1.040,1.126)
Total Income, γ_{60}	−0.002**	0.001	0.998 (0.996,0.999)	−0.001*	0.001	0.999 (0.997,1.000)
Parental Education, γ_{70}	−0.001	0.040	0.999 (0.924,1.080)	−0.169***	0.043	0.844 (0.776,0.918)
Work Status, γ_{80}	0.110**	0.050	1.116 (1.012,1.230)	0.166**	0.054	1.181 (1.062,1.313)

* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$.
[a] 'Any quit attempt' is defined as tried to quit smoking one or more times. There were 16,742 high school regular smokers included in this sample (1991–2006).
[b] 'Want to quit smoking' is defined as want to quit smoking now. There were 12,073 high school regular smokers included in this sample (1991–2006).

$$+\gamma_{019}(\text{AlciatiIndex})+\gamma_{10}(\text{Male})+\gamma_{20}(\text{Black})$$
$$+\gamma_{30}(\text{Hispanic})+\gamma_{40}(\text{OtherRace})+\gamma_{50}(\text{Age})$$
$$+\gamma_{60}(\text{TotalIncome})+\gamma_{70}(\text{ParentalEducation})$$
$$+\gamma_{80}(\text{WorkStatus})+u_{0j.}$$

These HGLM models were run for each smoking cessation outcome measure, where η_{ij} is the log odds of: tried to quit one or more times; want to quit smoking now; ever-regular smokers who have not smoked in the past 30 days (non-continuation); and ever-regular smokers who have not smoked in the past 30 days and have made at least one quit attempt (discontinuation).

3. Results

High school sample sizes for cessation outcome measures ranged from 12,073 students for 'want to quit smoking' to 78,584 students for 'non-continuation of smoking'. Mean age for the high school sample was 16.7 years, and approximately 80% were White with 47% male and 53% female students.

HGLM results for cessation outcomes measures are shown in Tables 1 and 2. Table 1 shows the results among high school regular smokers for smoking cessation outcome measures: 'any quit attempt' and 'want to quit smoking'. 'Any quit attempt' was not significantly associated with any state-level tobacco control measure. 'Want to quit smoking' was significantly associated with cigarette price, as a state-level tobacco control policy ($\beta = 0.003$; se = 0.001; $p = .012$). The reported odds ratio for cigarette price in this model was 1.003 (1.001–1.005), which indicates that there is a 0.3% increase in the odds that a high school regular smoker will want to quit smoking for a one-unit (i.e. one cent) increase in cigarette price. This shows a significant and positive association between cigarette price and a smoking cessation outcome measure. A price increase of $1.00 per pack would be associated with a 30% increase in the odds of wanting to quit smoking now among youth, which becomes more notable.

Table 2 shows the results among high school regular smokers for smoking cessation outcome measures: 'non-continuation of smoking' and 'discontinuation of smoking'. 'Non-continuation of smoking' was significantly associated with the following state-level tobacco control policies: cigarette price ($\beta = 0.002$; se = 0.001; $p = .002$) and

Table 2
Results of HGLM analyses—multilevel models for high school regular smokers and smoking cessation outcome measures (1991–2006 combined).

	Non-continuation of smoking[a]			Discontinuation of smoking[b]		
	β	se	Odds ratio (CI)	β	se	Odds ratio (CI)
Intercept, γ_{00}	0.660**	0.194	1.936 (1.324,2.829)	−0.262	0.509	0.769 (0.284,2.088)
State level						
1992, γ_{01}	0.009	0.078	1.009 (0.867,1.175)	−0.074	0.224	0.929 (0.599,1.441)
1993, γ_{02}	−0.120	0.078	0.887 (0.761,1.034)	0.157	0.195	1.170 (0.799,1.713)
1994, γ_{03}	−0.103	0.076	0.902 (0.776,1.048)	0.004	0.188	1.004 (0.695,1.451)
1995, γ_{04}	−0.279**	0.082	0.756 (0.645,0.888)	0.070	0.203	1.073 (0.721,1.597)
1996, γ_{05}	−0.314***	0.081	0.730 (0.623,0.856)	−0.501*	0.235	0.606 (0.382,0.960)
1997, γ_{06}	−0.330***	0.078	0.719 (0.616,0.838)	−0.331	0.174	0.719 (0.511,1.010)
1998, γ_{07}	−0.267**	0.086	0.765 (0.646,0.906)	−0.314	0.170	0.730 (0.523,1.020)
1999, γ_{08}	−0.200*	0.087	0.819 (0.690,0.971)	−0.252	0.170	0.777 (0.557,1.084)
2000, γ_{09}	−0.258**	0.085	0.772 (0.654,0.913)	−0.247	0.187	0.781 (0.542,1.127)
2001, γ_{010}	−0.126	0.090	0.882 (0.739,1.051)	−0.141	0.189	0.869 (0.599,1.259)
2002, γ_{011}	−0.170	0.098	0.844 (0.696,1.023)	−0.264	0.200	0.768 (0.519,1.136)
2003, γ_{012}	−0.295**	0.105	0.745 (0.606,0.915)	−0.326	0.211	0.722 (0.477,1.091)
2004, γ_{013}	−0.356**	0.103	0.700 (0.573,0.856)	−0.605**	0.215	0.546 (0.358,0.833)
2005, γ_{014}	−0.291**	0.108	0.747 (0.604,0.924)	−0.430*	0.209	0.651 (0.432,0.981)
2006, γ_{015}	−0.231*	0.103	0.793 (0.649,0.971)	−0.397	0.211	0.672 (0.444,1.017)
Possession Law, γ_{016}	0.005	0.032	1.005 (0.945,1.069)	−0.009	0.055	0.991 (0.890,1.104)
SFA Index, γ_{017}	0.001	0.010	1.001 (0.982,1.021)	0.001	0.015	0.997 (0.968,1.027)
Cigarette Price, γ_{018}	0.002**	0.001	1.002 (1.001,1.003)	0.003*	0.001	1.003 (1.000,1.005)
Youth Access STM, γ_{019}	0.006*	0.002	1.006 (1.001,1.011)	0.004	0.004	1.005 (0.996,1.014)
Student level						
Male, γ_{10}	0.013	0.022	1.013 (0.969,1.059)	0.024	0.048	1.024 (0.933,1.125)
Black, γ_{20}	0.612***	0.052	1.843 (1.665,2.040)	0.445***	0.113	1.560 (1.249,1.948)
Hispanic, γ_{30}	0.545***	0.043	1.725 (1.587,1.876)	0.223*	0.090	1.250 (1.047,1.491)
Other Race, γ_{40}	0.177***	0.041	1.193 (1.100,1.294)	0.160	0.097	1.174 (0.972,1.418)
Age, γ_{50}	−0.131***	0.011	0.877 (0.859,0.895)	−0.092**	0.027	0.912 (0.865,0.962)
Total Income, γ_{60}	−0.007***	0.000	0.993 (0.993–0.994)	−0.007***	0.001	0.994 (0.992,0.995)
Parental Education, γ_{70}	0.030	0.022	1.030 (0.980–1.082)	0.075	0.053	1.078 (0.972,1.196)
Work Status, γ_{80}	0.064*	0.025	1.066 (1.014,1.120)	0.046	0.064	1.047 (0.923,1.188)

* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$.
[a] 'Non-continuation of smoking' is defined as ever-regular smokers who have not smoked in the past 30 days. There were 68,584 high school regular smokers included in this sample (1991–2006).
[b] 'Discontinuation of smoking' is defined as ever-regular smokers who have not smoked in the past 30 days and have ever made a quit attempt. There were 16,709 high school regular smokers included in this sample (1991–2006).

youth access STM laws ($\beta = 0.006$; se = 0.002; $p = .011$). The odds ratio for cigarette price in this model was 1.002 (1.001–1.003), which indicates that there is a 0.2% increase in the odds that a high school regular smoker will have not smoked in the past 30 days (non-continuation of smoking) for a one-cent increase in cigarette price. This odds ratio represents an increased likelihood of an ever-regular smoker not smoking in the past 30 days, and a $1.00 increase in cigarette price would be associated with a 20% increase in this likelihood. Again, these findings show a significant and positive relationship between cigarette price and non-continuation of smoking (Table 2). The odds ratio for strength of youth access STM laws in this model was 1.006 (1.001–1.011), which indicates that there is a 0.6% increase in the odds that a high school regular smoker will not have smoked in the past 30 days for a one-unit increase in strength of sales to minors' laws, which would translate to a 1-point increase in the Alciati Index value. These findings show that there is a significant positive relationship between strength of youth access STM laws and smoking non-continuation among high school regular smokers in this sample.

'Discontinuation of smoking' was significantly associated with cigarette price ($\beta = 0.003$; se = 0.001; $p = .018$). The odds ratio for cigarette price in this model was 1.003 (1.000–1.005), which indicates that a $1.00 price increase would be associated with a 30% increase in the odds of a high school ever-regular smoker, who has made at least one quit attempt, not smoking in the past 30 days. These findings show a consistent significant positive association between cigarette price and smoking cessation outcome measures.

Other state-level tobacco control policy variables (smoke-free air laws and youth access possession laws) were not significantly associated with any of the smoking cessation outcome measures among this sample of high school regular smokers.

4. Discussion

This study focused on the association between state-level tobacco control policies and adolescent smoking cessation behaviors from 1991 through 2006. Cigarette price had a positive association with three of the

four cessation-related outcome measures studied among high school regular smokers, suggesting that increasing cigarette price is a successful tobacco control policy to encourage smoking cessation, particularly among youth who are often more price-sensitive.

Other studies have reported positive relationships between increasing cigarette price and decreasing youth smoking prevalence, including decreasing cigarettes per day smoked among youth [15–18]. Tauras has also reported a positive association between increasing cigarette price and young adult smoking cessation [19]. This study expands upon previous literature to report a positive association between increasing cigarette price and specific youth smoking cessation-related behaviors among high school regular smokers. Carpenter and Cook used national data from 1991 to 2005 Youth Risk Behavior Surveys (YRBS), which also included state and local YRBS versions, and reported that large state tobacco tax increases over the past 15 years were associated with significant decreases in smoking and frequent smoking among youth [50]. In a longitudinal study using 1992 and 2000 data from the National Educational Longitudinal Study, DeCicca and colleagues examined the effect of cigarette price on smoking among youth and young adults. Their longitudinal findings also suggest some evidence that higher cigarette taxes are associated with increased smoking cessation [51].

Stronger youth access sales to minors' laws were associated with increased non-continuation among high school regular smokers. STM laws reflect the Alciati index, comprising multiple youth access components. The effectiveness of enforcing sales to minors' laws to prevent youth initiation and encourage cessation has been a subject of debate in tobacco control literature [25–31]. Chen and Forster conducted a community-based randomized intervention study among 14 communities and reported that restricting commercial access to tobacco through local ordinances is effective to reduce adolescent smoking both immediately and in 5-year post-intervention follow-up; however, longer-term results were inconclusive because control communities adopted ordinances similar to intervention communities [52]. Our study suggests that stronger STM laws may be associated with cessation outcome measures, and this relationship warrants further study.

A study by Botello-Harbaum et al. examined state-level youth access and clean indoor air laws, controlling for sociodemographic characteristics and cigarette price, and found that these policies decreased the potential of youth experimenting with cigarettes or becoming daily smokers [53]. Other studies, such as Tauras, did observe a positive association between smoke-free air laws and young adult smoking cessation behavior [19]. Further evaluation may be necessary to better understand the complex relationship between youth smoking cessation behaviors and multiple tobacco control policies.

While our study's emphasis is on state-level cessation policies, it is interesting to note that across our analytic models, student characteristics such as gender and race/ethnicity were strong predictors of cessation behaviors. This is common among the adolescent development literature, where behavior is related strongly to their immediate, or proximal, influences (such as peers and parents), rather than distal influences (such as schools, communities, and states) [54,55]. In fact, researchers have consistently found that schools have between 2% and 5% variance in influencing at-risk youth behaviors such as smoking [56,57]. Clearly, a key component to impacting changes in youth cessation behaviors is addressing their proximal environment, in addition to providing a distal environment that supports these positive changes.

Our study has several limitations. First, the data are cross-sectional among each nationally representative sample, rather than longitudinal. Since these data are reported among different students in each study year, youth may differentially report regular smoking and relate to quitting variables, which may also be mediated by addictiveness and frequency of smoking among adolescents in each nationally representative sample. This limitation may also result in environmental and social factors, such as social norms or social acceptability of smoking, affecting self-identification as a regular smoker, self-reported quitting measures, and inclusion of varying smoking behaviors among each nationally representative sample.

Second, some within-state samples and lack of variance for a given outcome measure required that the 10th and 12th grade student samples be combined to allow convergence of HGLM cessation outcomes analyses. An additional limitation relates to available data for outcome measures, since several youth cessation outcome measures were asked on a limited number of MTF forms. Therefore, the available student sample size for analyses for the 'any attempt to quit', 'want to quit' and 'discontinuation of smoking' measures was reduced. Non-continuation was the only youth cessation outcome measure assessed for all grades on all forms for all survey years. Students in grade 12 who were no longer considered to be minors (based upon the legal age of purchase for cigarettes) were also excluded from analyses.

We recognize that other factors, such as duration and enforcement of a law, in addition to the presence, duration, and enforcement of other tobacco control policies or a comprehensive tobacco control program, which may be correlated with tax increases or other policies, may affect the impact of policy on smoking behavior and cessation. While our analyses used effective date of legislation and matched state-level data to student-level data by state and year, we recognize these study limitations. We also recognize that states enacting comprehensive tobacco control programs may also be implementing school-based prevention programs, school-based tobacco cessation programs, and/or anti-tobacco media campaigns. These factors could not be specifically controlled for as independent predictors in our analysis models, which is another limitation related to possible effects of these programs or media campaigns on youth cessation measures and state-level tobacco control policies.

Despite these limitations, this study is the first to specifically address the relationship between multiple state-level tobacco control policies and specific adolescent smoking cessation outcome measures. HGLM techniques were also used to account for the variance between states and students over these 16 years of nationally representative data.

5. Conclusion

Findings support earlier evidence that cigarette price influences youth smoking; such influence is not only in the uptake of tobacco, but also in smoking cessation behaviors among adolescents. Comprehensive tobacco control policies should be evidence-based and include policies that can have a maximum positive effect, to both decreased smoking initiation and increased smoking cessation among youth.

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