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Impact of E-cigarette Minimum Legal Sales Age Laws on Current Cigarette Smoking

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Abstract

Introduction—Research using state-level data suggests e-cigarette minimum legal sale age (MLSA) laws are positively associated with cigarette smoking among U.S. adolescents; research using individual-level data suggests a negative association. Existing studies have not controlled for e-cigarette use.

Methods—In 2016 and 2017, we regressed (logistic) current (past 30-day) cigarette smoking (from 2009–2014 National Youth Tobacco Surveys [NYTS]) on lagged (laws enacted each year counted for the following year) and unlagged (laws enacted January–June counted for that year) state e-cigarette MLSA laws prohibiting sales to youth aged <18 or <19 years (depending on the state). Models were adjusted for year and individual- (e-cigarette and other tobacco use, sex, race/ethnicity, and age) and state-level (smokefree laws, cigarette taxes, medical marijuana legalization, income, and unemployment) covariates.

Results—Cigarette smoking was not significantly associated with lagged MLSA laws after adjusting for year (OR=0.87, 95% CI:0.73–1.03; $p=0.10$) and covariates (OR=0.85, 0.69–1.03; $p=0.10$). Unlagged laws were significantly and negatively association with cigarette smoking

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(OR=0.84, 0.71–0.98, $p=0.02$), but not after adjusting for covariates (OR=0.84, 0.70–1.01, $p=0.07$). E-cigarette and other tobacco use, sex, race/ethnicity, age, and smokefree laws were associated with cigarette smoking ($p<0.05$). Results unadjusted for e-cigarette use and other tobacco use yielded a significant negative association between e-cigarette MLSA laws and cigarette smoking (lagged: OR=0.78, 0.64–0.93, $p=0.01$; unlagged: OR=0.80, 0.68–0.95, $p=0.01$).

Conclusions—After adjusting for covariates, state e-cigarette MLSA laws did not affect youth cigarette smoking. Unadjusted for e-cigarette and other tobacco use, these laws were associated with lower cigarette smoking.

Keywords

cigarettes; e-cigarettes; youth

INTRODUCTION

During 2011–2014, marked changes in tobacco use occurred among U.S. middle and high school students; most notably, e-cigarette use increased considerably, and conventional cigarette (hereafter “cigarette”) use continued to decline[1]. The observed increase in e-cigarette use has been attributed to multiple factors, including curiosity, flavors that appeal to youth, and widespread advertising[2]. Some have argued that the observed decrease in cigarette smoking may be attributed to the marked increase in e-cigarette use[3,4] as opposed to tobacco control measures, such as smoke-free laws[5]. However, according to an analysis of repeated cross-sectional data from the 2004–2014 National Youth Tobacco Survey (NYTS), the observed increase in e-cigarette use during this period did not significantly affect the declining trend in cigarette smoking[6]. According to analyses of cross-sectional data from national and California-based samples of adolescents, in addition to dual users of cigarettes and e-cigarettes, many adolescents became e-cigarette-only users during this period, many of whom had risk profiles that made them unlikely to initiate tobacco product use with cigarettes[6,7]. Moreover, the U.S. Surgeon General concluded that youth e-cigarette use is strongly associated with tobacco product use, including cigarettes[2]. In addition, multiple longitudinal studies found that youth and young adults who use e-cigarettes (compared to those that do not) have more than twice the odds of initiating cigarette smoking or being current (past 30-day) cigarette smokers at follow-up (6–18 months later)[8,9,10,11].

Through authority granted by the Family Smoking Prevention and Tobacco Control Act, the U.S. Food and Drug Administration (FDA) finalized its “deeming rule” in May 2016 that prohibited the sale of e-cigarettes to individuals younger than age 18[12]. In addition, as of October 2017, five states (California, Hawaii, Maine, New Jersey, and Oregon) and the District of Columbia had instituted minimum legal sale age (MLSA) laws of 21 for e-cigarettes[13].

Based on the theory that cigarettes and e-cigarettes are economic substitutes, studies published in 2014[14] and 2015[15] raised concern that limiting access to e-cigarettes could lead to increases in population-level cigarette smoking. This concern was heightened by a 2015 analysis of U.S. state-level data on adolescent cigarette smoking that found that

between 2002 and 2013, states that had passed e-cigarette MSLA laws had 0.9% higher smoking prevalence than states without such laws[16]. As of April 2017, two additional analyses using state-level data found significantly higher cigarette smoking among youth covered by e-cigarette MSLA laws[17,18]. In contrast, a subsequent study using individual-level data from high school students in the Monitoring the Future study found significantly lower smoking among youth covered by e-cigarette MSLA laws[19]. None of these analyses adjusted for youth e-cigarette or other tobacco product (hereafter “other tobacco”) use, which are highly associated with cigarette smoking[2]. In addition, all but one[19] used state-level data, rather than individual-level data, therefore not accounting for key covariates for the association between e-cigarette MSLA laws and cigarette smoking.

To address this gap in the scientific literature, the present study used individual-level data from the 2009–2014 NYTS to assess the relationship between e-cigarette MSLA laws and cigarette smoking among youth, adjusting for e-cigarette and other tobacco use, as well as other individual and state-level covariates. The relationship between e-cigarette MSLA laws and youth e-cigarette use was also assessed.

METHODS

Sample

NYTS is a cross-sectional, pencil-and-paper, school-based survey of U.S. middle and high school students in grades 6 through 12[20,21,22,23,24]. NYTS started in Fall 1999, and has been conducted in the spring of 2000, 2002, 2004, 2006, 2009, 2011, and annually thereafter. This analysis was restricted to the five NYTS waves conducted 2009–2014 (2009, 2011, 2012, 2013, and 2014) because respondents’ state of residence, a restricted use variable, first became available in 2009, and at the time of submission, state cigarette tax information was available through 2014. Response rates for the surveys and sample sizes were 84.8% (N=17,855) [2009], 72.7% (N=15,008) [2011], 73.6% (N=19,488) [2012], 67.8% (N=14,074) [2013], and 73.3% (N=16,952) [2014]. To align with the published literature[16], the analysis only included youth aged 12–17, resulting in a restricted sample size of 85,861 of 101,561 potential participants (84.5%). Respondents with missing values for any variable of interest were also excluded, resulting in an analytic sample of 83,026 of 85,861 (96.7%) participants.

Dependent Variable

The primary dependent variable was dichotomized current (30-day) cigarette smoking (“0” for 0 days and “1” for 1 day). Current (past 30-day) e-cigarette use was also assessed as a dichotomous dependent variable (“0” for 0 days and “1” for 1 day).

Independent Variables

Individual-level—Adjusted models included individual-level correlates of cigarette smoking, including sex (male and female [reference]), race/ethnicity (non-Hispanic white [reference], Hispanic, non-Hispanic black, and non-Hispanic other), age (in years, centered at 12), current (past 30-day) e-cigarette use, and current (past 30-day) other tobacco use (“0” for 0 days and “1” for 1 day)[2]. We also included these variables to account for potential

differences in e-cigarette MLSA coverage by demographics[25] and the potential impact of e-cigarette MLSA laws on e-cigarette use and other tobacco use[2]. To ensure comparability across years, other tobacco use was restricted to products assessed every year in the 2009–2014 NYTS: chewing tobacco/snuff/dip, cigars/cigarillos/little cigars, pipes, and bidis. E-cigarette prevalence was assumed to be zero in 2009 because e-cigarettes entered the U.S. marketplace around 2007[2], and current adolescent e-cigarette use was only 1.1% in 2011, the first year that NYTS included questions on e-cigarette use[1].

State-level—The State Tobacco Activities Tracking & Evaluation (STATE) System was used to create a dichotomized variable and a continuous variable[16] for e-cigarette MLSA laws prohibiting sales to youth aged 18 or 19 or younger (depending on the state)[26]; state e-cigarette MLSA laws prohibiting sales to those aged 21 or younger were not included in the analysis because no such law existed during the assessment period (i.e., 2009–2014). The dichotomized variable was coded as “0” for no law and “1” for a law. The continuous variable was the number of months the MLSA was in place during the survey period (2009–2014) divided by the total number of months of the survey period. The resulting values ranged from “0” for no e-cigarette MLSA law enacted to “1” for e-cigarette MLSA law enacted during the entire study period. Either the dichotomized or continuous e-cigarette law variable was included in each model, but never both. State-level covariates that did not vary over time included median household income (in thousands of 2014 dollars to adjust for inflation), and unemployment rate, both obtained from 2014 American Communities Survey 5-year estimates. The remaining state-level covariates were included for each year of the survey period (2009–2014), including medical marijuana legalization (“0” for no law and “1” for a law)[27], percentage of state population covered by a 100% state or local smokefree law (ranging from “0” for no 100% smokefree law to “1” for 100% of state population covered by 100% smokefree law) for public (non-governmental) workplaces and bars[28]; and average state per-pack cigarette tax in 2014 dollars[29]. Smokefree workplace and bar laws, but not restaurant laws, were included because bar and restaurant laws are highly collinear. Moreover, bar laws have as large or larger effects on cigarette smoking behavior among adolescents and young adults as smokefree restaurant laws[5]. In addition, smoke-free bar laws represent a greater shift in social norms because these laws generally face greater resistance than other types of smoke-free laws[30]. Household income, unemployment rate, medical marijuana legalization, smoke-free laws, and cigarette taxes were included because they are correlates of cigarette smoking[5,31]. These variables are also likely to be associated with e-cigarette MLSA laws because tobacco control policy coverage varies by income and education[25] and state-level policies tend to coexist (e.g., comprehensive smoke-free laws and high cigarette taxes).

Based on previous research[5,32], we used enactment date (the date that the policy changes occurred) for all policies to create lagged and unlagged versions of all tobacco control policies (e-cigarette MLSA laws, marijuana laws, smokefree laws, and cigarette taxes) to ensure that these policies went into effect before NYTS data collection occurred (January to June of each year). It may take one year or longer for policies to meaningfully affect social norms, and for those social norms to have a measurable effect on behavior[5,32]. Lagging variables is a scientifically established approach that allows time for this effect to take place,

thereby decreasing the likelihood of inaccurately concluding that a policy has no effect. Lagged policies were created by applying the prior year's policy to the following year, regardless of the month in which the policy was enacted[5]. Unlagged laws were created by applying laws that passed by June 30 of a given year (i.e., the end of NYTS data collection) to the year in which they were passed, with two exceptions. Since smokefree laws were continuous, unlagged laws were created by applying average coverage for the first two quarters of a given year to that year, and lagged laws were created by applying percentage coverage averaged across all four quarters of the previous year to the following year. Unlagged continuous e-cigarette laws were created by leaving the variable as originally coded for a given year since it already accounted for time the law was in place, and lagged laws were created by applying this value for a given year to the following year.

Because we had individual-level data, we did not include state-level smoking prevalence for 18- to 25-year-olds or the percentage of the state population younger than age 18 as covariates[19]. (Friedman[16], Pesko et al.[17], and Pesko and Currie[18] did so because they used state-level data.)

Statistical Analysis

Using individual-level data, logistic regression models were created to examine the relationship between e-cigarette MLSA laws and current cigarette smoking prevalence, both adjusted for survey year only and then fully adjusted for all covariates (including survey year). To create comparability with previous analyses[16,17,18,19], we also used logistic regression models to examine the relationship between e-cigarette MLSA laws and cigarette smoking prevalence, unadjusted for e-cigarette use and other tobacco use. Unlike previous analyses[16,17,18], we did not adjust for state-level fixed effects because we used individual-level data. In addition, including these terms created model instability and collinearity.

All analyses were conducted using SAS-Callable SUDAAN version 11.0.0, adjusting for NYTS stratification variables and weights that adjust for clustered sampling techniques and render the sample comparable to the U.S. population of adolescents attending middle or high school[20,21,22,23,24]. Logistic regression was also used to assess the relationship between e-cigarette MLSA laws and current e-cigarette use, adjusting for all covariates. The publicly available data were analyzed in 2016 and 2017.

RESULTS

The percentage of NYTS participants whose states had e-cigarette MLSA laws increased from 0.0% in 2009 to 49.9% in 2014 ($p<0.05$) (Table 1). The percentage of the sample covered by 100% smokefree laws increased from 57.5% in 2009 to 70.7% in 2014 for workplace laws and from 55.0% in 2009 to 59.1% in 2014 for bar laws ($p<0.05$). State per-pack cigarette tax increased from \$1.61 per pack in 2009 to \$1.67 in 2014 (2014 dollars) ($p<0.05$). The percentage of participants living in a state with legalized medical marijuana sales increased from 20.1% in 2009 to 38.8% in 2014 ($p<0.05$).

E-cigarette MLSA Laws and Cigarette Smoking

Lagged Models—Accounting for survey year, but no other covariates, lagged dichotomous e-cigarette MLSA laws were not significantly associated with cigarette smoking (OR=0.87, 95% CI: 0.73–1.03; $p=0.10$) (Table 2). Adjusting for all covariates, the effect remained unchanged, but the magnitude of the estimate continued to trend downward (OR=0.85, 0.69–1.03; $p=0.10$). Following adjustment, participants who used e-cigarettes (OR=8.17, 6.92–9.64) and other tobacco products (OR=19.37, 17.64–21.27) in the past 30 days and who were older (OR=1.35, 1.31–1.39) had higher odds of smoking cigarettes in the past 30 days. In contrast, students who were male (OR=0.75, 0.69–0.81), non-Hispanic black (OR=0.52, 0.44–0.62), and covered by (lagged) smokefree workplace laws (OR=0.74, 0.61–0.91) had lower odds of cigarette smoking. Similarly, continuous e-cigarette MLSA laws were not significant after adjusting for year alone (OR=0.79, 0.61–1.03, $p=0.08$) or all covariates (OR=0.81, 0.58–1.14; $p=0.22$). All variance inflation factors were less than 2.5.

Without current e-cigarette use and other tobacco use in the model, we found a significant negative association (OR=0.78, 0.64–0.93) between lagged categorical e-cigarette laws and cigarette smoking. Similarly, lagged continuous e-cigarette laws were significant (OR=0.73, 0.54–0.99).

Unlagged Models—Adjusting for survey year only, unlagged dichotomous e-cigarette MLSA laws were significantly associated with lower odds of smoking (OR=0.84, 0.71–0.98, $p=0.02$) (Table 3). Adjusting for covariates, the association was no longer statistically significant (OR=0.84, 0.70–1.01, $p=0.07$). Students who currently used e-cigarettes (OR=8.21, 6.98–9.75) and other tobacco products (OR=19.35, 17.62–21.24) and who were Hispanic (OR=1.11, 1.00–1.22), older (OR=1.35, 1.31–1.39), and covered by smoke-free bar laws (OR=1.24, 1.03–1.48) had greater odds of current cigarette smoking. In contrast, students who were male (OR=0.75, 0.69–0.81), non-Hispanic black (OR=0.51, 0.43–0.61), lived in states with legalized medical marijuana (OR=0.82, 0.70–0.96), and were covered by smoke-free workplace laws (OR=0.76, 0.63–0.92) had lower odds of cigarette smoking. Continuous unlagged e-cigarette MLSA laws were not significant after adjusting for year alone (OR=0.84, 0.66–1.07, $p=0.15$) or all covariates (OR=0.96, 0.70–1.33; $p=0.82$). All variance inflation factors were less than 2.5.

Without current e-cigarette use and other tobacco use in the model, we found a significant negative association (OR= 0.80, 0.68–0.95) between unlagged categorical e-cigarette laws and cigarette smoking. However, unlagged continuous e-cigarette laws were not significant (OR=0.84, 95% CI: 0.63–1.13).

E-cigarette MLSA Laws and E-cigarette Use

Unadjusted for covariates, no significant association was observed between either lagged (OR=0.87, 0.67–1.13; $p=0.40$) or unlagged (OR=0.93, 0.72–1.19; $p=0.54$) e-cigarette MLSA laws and current e-cigarette use. Following adjustment for covariates, the relationship remained non-significant: lagged (OR=1.09, 0.78–1.53; $p=0.60$) and unlagged (OR=0.91, 0.78–1.07; $p=0.26$).

DISCUSSION

Accounting for individual-level factors, including e-cigarette use, this analysis found no statistically significant association between e-cigarette MLSA laws and current cigarette smoking among U.S. middle and high school students. When we did not adjust for e-cigarette and other tobacco use, these laws were associated with significantly lower cigarette smoking prevalence. These findings are consistent with previous research based on individual data[19], but differ from findings from research based on state-level data[16,17,18]. The finding that e-cigarette use, other tobacco use, demographics, year, and smoke-free workplace laws were all significantly associated with current smoking among adolescents is consistent with previous analyses[5,6]; the latter finding corroborates the utility of smoke-free workplace laws for reducing youth cigarette smoking rates[5]. Like a previous analysis of state and national data from the Youth Risk Behavior Surveys from 2005–2013[33], we did not detect an association between tobacco taxes and youth smoking, likely due to very small changes in cigarette taxes during this period.

The lack of an association between e-cigarette MLSA laws and cigarette smoking among youth is consistent with the only other analysis of individual-level data[19]. Abouk and Adams[19] found that current cigarette smoking among U.S. high school students declined approximately 2% after e-cigarette MLSA laws were enacted, which is generally consistent with the downward, although non-significant, trend observed in the present analysis. The lack of statistical significance in the present analysis is likely due to adjusting for current e-cigarette and other tobacco use because the exclusion of these variables from the model resulted in a significant negative association between lagged and unlagged e-cigarette MLSA laws and youth smoking, suggesting that these laws may help reduce e-cigarette use.

Unfortunately, because this is a cross-sectional analysis, we could not assess whether e-cigarette use mediates or confounds the relationship between e-cigarette MLSA laws and cigarette use. We adjusted for this variable because this was the most scientifically cautious approach to the analyses.

In contrast, the present analysis was not consistent with three analyses using state-level data[16,17,18], all of which found a significant positive relationship between e-cigarette MLSA laws and youth cigarette smoking. Friedman[16] found a 0.9% increase in current cigarette smoking in states that passed e-cigarette MLSA laws, compared to states that did not, using 2002–2003 and 2013–2014 National Survey on Drug Use and Health data. Similarly, using 2007–2014 national birth records, Pesko and Currie[18] found that e-cigarette MLSA laws were associated with a 2% increase in current cigarette smoking among pregnant teens younger than age 18; however, these laws were also associated with a decline in very premature births and better birth outcomes among nonsmokers. Finally, using 2007–2013 Youth Risk Behavior Surveillance System data, Pesko et al.[17] found that e-cigarette MLSA laws were associated with a 0.8% increase in cigarette smoking. The present findings likely differ from the aforementioned analyses, which used aggregate data, because the current analysis used individual-level data[19]; however, it was not possible to test this hypothesis because the NYTS sampling frame does not allow for the calculation of state-representative estimates. Of note, the lack of association observed in the present

analysis is likely not due to the lack of statistical power; a post-hoc power calculation revealed that, with 80% power, it was possible to detect an OR of 0.90 or lower, which includes the observed effect sizes for cigarette smoking.

The present analysis suggests that e-cigarette MLSA laws covering youth under age 18 or 19 do not impact e-cigarette use. One potential reason for this finding is a lack of enforcement of e-cigarette MLSA laws[34]. We were only able to locate one study (from 2002) that contradicted this hypothesis by finding no association between cigarette MLSA law enforcement and youth cigarette smoking[35]. It is important to emphasize that all of these analyses involve laws covering youth under age 18 or 19; raising MLSA laws for all tobacco products, including e-cigarettes, to 21 is likely to increase their efficacy for reducing all types of youth tobacco use [2,36,37]. In addition to its direct effect on e-cigarette use, increasing the age of legal purchase for e-cigarettes to 21 has the potential to reduce cigarette smoking because longitudinal analyses suggest that adolescent e-cigarette use is a predictor of future cigarette smoking[8,9,10].

We could find no explanation for our finding that bar laws, when unlagged (but not when lagged), were associated with higher odds of cigarette smoking. However, previous analyses have shown that the true effect of policy variables may take one year or more to accurately detect[5,32]. For example, a telephone survey conducted 3 and 8 months after California enacted a 100% smokefree bar law (January 1, 1998) found that 25% of California smokers reported smoking during their most recent visit to a bar[38]; this figure did not drop significantly to 14% ($p<0.01$) until 2.5 years after the policy was enacted.

Limitations

This study has at least five limitations. First, NYTS data cannot be used to produce state representative estimates, which prevented exact replication of previous state-level analyses. Second, NYTS e-cigarette questions varied slightly over time; changes in terminology and the e-cigarette brands included in the survey item likely contributed, in part, to 2013–2014 increases in e-cigarette use [39]. Third, only “other” tobacco products measured in all waves of NYTS data were included, therefore excluding roll-your-own cigarettes, snus, or hookah/waterpipe, the latter of which became increasingly popular among adolescents during 2011–2014. Fourth, because only participants’ state of residence (and not city or county) was available, some misclassification of smokefree law coverage may have occurred, which would bias the result toward the null. Also because of the lack of city or county of residence, this analysis did not account for local e-cigarette MLSA laws; we also did not adjust for cigarette MLSA laws that increased to age 21 during this time. Finally, because the NYTS does not sample the same schools every year or every state every year, the average observed state policy coverage may not reflect levels for the United States overall; however, adjustment by weights and stratification variables increases the accuracy of these figures. Although not necessarily a limitation of the present analysis, it is important to note that e-cigarette MLSA laws were still relatively new in 2014, and thus, the impact of these laws may change over time. Although one potential critique of this analysis is the utility of 30-day measures of tobacco use for adolescents, a 2016 analysis suggests that this is an effective measure of adolescent cigarette smoking[40].

Conclusion

In summary, this study found that e-cigarette MLSA laws did not affect youth cigarette smoking after adjusting for survey year and covariates, while results unadjusted for e-cigarette and other tobacco use suggest e-cigarette MLSA laws may have contributed to lower cigarette smoking. The U.S. Surgeon General has concluded that adolescent exposure to nicotine in any form is unsafe[2]. Accordingly, fully enforced youth MLSA strategies that address the full scope of tobacco products used by youth represent an important component of a comprehensive tobacco prevention and control effort.

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Abbreviations

CI	confidence interval
NYTS	National Youth Tobacco Survey
OR	odds ratio

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IMPLICATIONS AND CONTRIBUTION

After adjusting for covariates, e-cigarette minimum legal sale age laws covering youth under age 18 or 19 did not affect current (30-day) cigarette smoking among adolescents in the National Youth Tobacco Survey between 2009 and 2014. Workplace smoke-free indoor air laws were negatively associated with current cigarette smoking.

Table 1
Individual and state-level characteristics of middle and high school students age 12 to 17 years old—National Youth Tobacco Survey, 2009–2014

	2009		2011		2012		2013		2014	
N	17,855	% (SE)	15,008	% (SE)	19,488	% (SE)	14,074	% (SE)	16,952	% (SE)
State-level variables										
Mandatory legal sales age for e-cigarettes	0.00	% (SE)	12.93 (4.08)	% (SE)	23.76 (4.84)	% (SE)	42.83 (6.34)	% (SE)	49.91 (6.57)	% (SE)
Medical marijuana legal	20.14 (5.52)	Mean (SE)	30.97 (5.84)	Mean (SE)	30.12 (5.00)	Mean (SE)	38.28 (6.15)	Mean (SE)	38.75 (5.42)	Mean (SE)
% state population (youth and adults) covered by 100% smoke-free workplace laws	57.54 (6.14)	Mean (SE)	67.68 (4.99)	Mean (SE)	56.72 (5.00)	Mean (SE)	65.74 (5.31)	Mean (SE)	70.72 (4.37)	Mean (SE)
% state population (youth and adults) covered by 100% smoke-free bar laws	55.03 (6.69)	Mean (SE)	65.35 (6.21)	Mean (SE)	69.39 (4.22)	Mean (SE)	68.01 (5.38)	Mean (SE)	59.06 (5.49)	Mean (SE)
Average state per-pack cigarette tax ^{a,c}	1.61 (0.16)	Mean (SE)	1.62 (0.11)	Mean (SE)	1.51 (0.10)	Mean (SE)	1.73 (0.15)	Mean (SE)	1.67 (0.13)	Mean (SE)
Median household income ^{a,b}	54.70 (0.98)	Mean (SE)	54.00 (1.08)	Mean (SE)	55.31 (0.92)	Mean (SE)	56.02 (1.12)	Mean (SE)	54.92 (0.47)	Mean (SE)
Unemployment rate ^b	9.01 (0.13)	Mean (SE)	9.25 (0.16)	Mean (SE)	9.33 (0.17)	Mean (SE)	9.31 (0.17)	Mean (SE)	9.21 (0.08)	Mean (SE)
Individual-level variables										
Past 30-day cigarette smoking	11.43 (0.65)	Mean (SE)	10.09 (0.78)	Mean (SE)	8.65 (0.53)	Mean (SE)	7.58 (0.47)	Mean (SE)	5.76 (0.33)	Mean (SE)
Past 30-day e-cigarette use	0.00	Mean (SE)	1.09 (0.14)	Mean (SE)	1.90 (0.19)	Mean (SE)	2.78 (0.26)	Mean (SE)	2.88 (0.19)	Mean (SE)
Past 30-day other tobacco use ^d	9.94 (0.69)	Mean (SE)	10.60 (0.67)	Mean (SE)	10.09 (0.51)	Mean (SE)	9.59 (0.56)	Mean (SE)	9.43 (0.25)	Mean (SE)
Sex										
Female	49.72 (0.74)	Mean (SE)	49.54 (0.54)	Mean (SE)	49.87 (0.42)	Mean (SE)	49.78 (0.67)	Mean (SE)	49.82 (0.31)	Mean (SE)
Male	50.28 (0.74)	Mean (SE)	50.46 (0.54)	Mean (SE)	50.13 (0.42)	Mean (SE)	50.22 (0.67)	Mean (SE)	50.18 (0.31)	Mean (SE)
Race										
White	57.54 (3.08)	Mean (SE)	56.43 (2.41)	Mean (SE)	54.97 (2.07)	Mean (SE)	52.55 (2.69)	Mean (SE)	53.95 (1.92)	Mean (SE)
Hispanic	18.73 (1.87)	Mean (SE)	19.90 (1.74)	Mean (SE)	21.07 (1.30)	Mean (SE)	21.39 (1.83)	Mean (SE)	20.51 (0.72)	Mean (SE)
Non-Hispanic black	14.78 (2.16)	Mean (SE)	13.85 (1.39)	Mean (SE)	13.35 (1.35)	Mean (SE)	14.71 (1.82)	Mean (SE)	14.16 (0.74)	Mean (SE)
Non-Hispanic other	8.95 (0.73)	Mean (SE)	9.81 (0.65)	Mean (SE)	10.61 (0.94)	Mean (SE)	11.36 (0.91)	Mean (SE)	10.20 (0.36)	Mean (SE)
Age (years)	14.54 (0.10)	Mean (SE)	14.50 (0.09)	Mean (SE)	14.51 (0.07)	Mean (SE)	14.53 (0.06)	Mean (SE)	14.51 (0.09)	Mean (SE)

Note: All analyses adjusted by NYTS weights and stratification variables. Abbreviation: SE=standard error

^aIn 2014 inflation-adjusted thousands of dollars.

^bObtained from 2014 5-year estimates from American Community Survey (U.S. Census Bureau)

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^cFrom Tax Burden of Tobacco 2014 (in 2014 inflation-adjusted dimes).

^dIncludes all tobacco products other than cigarettes or e-cigarettes that were measured in all years of NYTS data collection between 2011 and 2014: smokeless tobacco, cigars, pipes, and bidis.

Table 2

Odds of current (past 30 day) conventional cigarette smoking of middle and high school students age 12 to 17 years old in relation to individual and state-level predictors, including *lagged* (by 1 year) e-cigarette MLSA laws—National Youth Tobacco Survey, 2009–2014

	OR (95% CI)	p-value	AOR (95% CI)	p-value
State-level variables				
Mandatory legal sales age for e-cigarettes ^a	0.87 (0.73–1.03)	0.1041	0.85 (0.69–1.03)	0.1025
Medical marijuana legal ^a			0.91 (0.78–1.06)	0.2507
% state population (youth and adults) covered by 100% smoke-free workplace laws ^a			0.74 (0.61–0.91)	0.0039
% state population (youth and adults) covered by 100% smoke-free bar laws ^a			1.16 (0.96–1.40)	0.1152
Per-pack average state cigarette tax (per 10¢) ^{a,b,d}			1.00 (0.92–1.09)	0.9608
Median household income per \$1000 ^{c,d}			0.99 (0.98–1.00)	0.0652
Unemployment rate ^c			1.01 (0.97–1.05)	0.6368
Individual-level variables				
30-day e-cigarette use			8.17 (6.92–9.64)	<.0001
30-day other tobacco use			19.37 (17.64–21.27)	<.0001
Male (Female=Referent)			0.75 (0.69–0.81)	<.0001
Race			Referent	
White				
Hispanic			1.10 (0.99–1.22)	0.0684
Non-Hispanic black			0.52 (0.44–0.62)	<.0001
Non-Hispanic other			0.96 (0.84–1.10)	0.5303
Age (years) ^f			1.35 (1.31–1.39)	<.0001
Year survey conducted ^g	0.88 (0.85–0.91)	<.0001	0.80 (0.77–0.83)	<.0001

Note: All analyses adjusted by NYTS weights and stratification variables. Abbreviations: AOR= adjusted odds ratio; CI=confidence interval; OR=odds ratio

^aLagged 1 year to ensure that policy change went into effect before data collection occurred (e.g., law enacted in 2009 is coded as a 2010 law).

^bFrom Tax Burden of Tobacco 2014 (in 2014 cents).

^cObtained from 2014 5-year estimates from American Community Survey (U.S. Census Bureau).

^dIn 2014 dollars.

^eIncludes all tobacco products other than cigarettes or e-cigarettes that were measured in all years of NYTS data collection between 2009 and 2014: smokeless tobacco (chew, dip, snuff), cigars/cigarillos/little cigars, pipes, and bidis.

^fCentered at age 12.

^gCentered at 2009.

Table 3

Odds of past 30-day conventional cigarette smoking of middle and high school students age 12 to 17 years old in relation to individual and state-level predictors, including *unlagged* e-cigarette MLSA laws—National Youth Tobacco Survey, 2009–2014

	OR (95% CI)	p-value	AOR (95% CI)	p-value
State-level variables				
Mandatory legal sales age for e-cigarettes ^a	0.84 (0.71–0.98)	0.0246	0.84 (0.70–1.01)	0.0650
Medical marijuana legal			0.82 (0.70–0.96)	0.0136
% state population (youth and adults) covered by 100% smoke-free workplace laws			0.76 (0.63–0.92)	0.0054
% state population (youth and adults) covered by 100% smoke-free bar laws			1.24 (1.03–1.48)	0.0212
Per-pack average state cigarette tax (per 10¢) ^{b,d}			1.00 (0.91–1.07)	0.7303
Median household income per \$1000 ^{c,d}			0.99 (0.98–1.00)	0.0684
Unemployment rate ^c			1.02 (0.98–1.06)	0.3946
Individual-level variables				
30-day e-cigarette use			8.25 (6.97–9.75)	<.0001
30-day other tobacco use			19.35 (17.63–21.24)	<.0001
Male (Female=referent)			0.75 (0.69–0.81)	<.0001
Race			Referent	
White				
Hispanic			1.11 (1.00–1.22)	0.0534
Non-Hispanic black			0.52 (0.44–0.62)	<.0001
Non-Hispanic other			0.96 (0.84–1.10)	0.5688
Age ^f			1.35 (1.31–1.39)	<.0001
Year survey conducted ^g	0.89 (0.86–0.92)	<.0001	0.81 (0.78–0.84)	<.0001

Note: All analyses adjusted by NYTS weights and stratification variables. Abbreviations: AOR= adjusted odds ratio; CI=confidence interval; OR=odds ratio

^aUnlagged; smokefree laws passed between January and June of a given year (NYTS data collection period) were counted as in effect for that year.

^bFrom Tax Burden of Tobacco 2014 (in 2014 cents).

^cObtained from 2014 5-year estimates from American Community Survey (U.S. Census Bureau).

^dIn 2014 dollars.

^eIncludes all tobacco products other than cigarettes or e-cigarettes that were measured in all years of NYTS data collection during 2009–2014: smokeless tobacco (chew, dip, snuff), cigars/cigarillos/little cigars, pipes, and bidis.

^fCentered at age 12.

^gCentered at 2009.