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Original Investigation

Local Tobacco 21 Policies are Associated With Lower Odds of Tobacco Use Among Adolescents

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Abstract

Introduction: Tobacco 21 (T21) policies have shown promise in reducing cigarette use among adolescents. This study examined whether local T21 policies affected adolescent use of a variety of tobacco products and whether results differed by grade level.

Methods: We used repeated cross-sectional data from eighth, ninth, and eleventh-grade respondents to the 2016 (n = 107 981) and 2019 (n = 102 196) Minnesota Student Surveys. Generalized estimating equations modeled eight adolescent tobacco use outcomes in 2019 (past 30-day use of any tobacco, cigarettes, cigars, e-cigarettes, hookah, chewing tobacco, flavored tobacco, and multiple products) by T21 exposure, defined as respondents' attendance at a school within a jurisdiction with T21 policy implementation between the two surveys. Models controlled for demographic characteristics and product-specific baseline tobacco use at the school level in 2016 and were stratified by grade.

Results: After adjusting for baseline tobacco use and other demographics, T21-exposed eighth and ninth-grade students had significantly lower odds of tobacco use than unexposed peers in five of eight models, i.e. any tobacco (aOR = 0.80, 95% CI: 0.74, 0.87), cigarettes (aOR = 0.81, 95% CI: 0.67, 0.99), e-cigarettes (aOR = 0.78, 95% CI: 0.71, 0.85), flavored tobacco (aOR = 0.79, CI: 0.70, 0.89), and dual/poly tobacco (aOR = 0.77, 95% CI: 0.65, 0.92). T21-exposed eleventh-grade students did not differ significantly in their odds of any tobacco use outcomes relative to their unexposed peers.

Conclusions: T21 exposure is associated with lower odds of multiple forms of tobacco use, particularly among younger adolescent populations, supporting the implementation of T21 policies to reduce tobacco use in this population.

Implications: T21 policy exposure was associated with lower odds of using tobacco products in younger (eighth and ninth grade) adolescents, but these policies were not associated with less use among older (eleventh grade) adolescents. Findings support T21 policies as a strategy to reduce adolescent tobacco use, especially among younger populations.

Introduction

Despite historically low levels of adolescent cigarette use in the United States (U.S.), a dramatic rise in e-cigarette use has driven increasing rates of overall use of nicotine or tobacco products, hereafter referred to as tobacco use, among middle- and high-school youth in recent years.[1,2] Flavored tobacco products, particularly e-cigarettes,[3] frequently represent adolescents' first experiences with tobacco products and have been implicated in the rise in overall tobacco use.[2,4,5]

Raising the minimum legal sales age of all tobacco products to 21 years through Tobacco 21 or 'T21' policies is one approach to reducing adolescent tobacco use, most of which is initiated before 21 years of age.[6] Previous research has found that T21 policies limit youth access to tobacco products, reduce tobacco product circulation among 18- to 20-year-old peers who often serve as the source of tobacco products for younger adolescents,[7] and are likely to alter the social acceptability of tobacco use among adolescents.[8] Simulation models summarized in the Institute of Medicine's (IOM) 2015 report predicted reductions in smoking initiation, smoking prevalence, and long-term morbidity and mortality for individuals born between 2000 and 2019.[8] By disrupting potential social sources of tobacco distribution among the 15–17 year age group, these models projected that T21 policies would reduce smoking initiation by 25% and result in an estimated 250,000 fewer premature deaths in this cohort.[8]

Evidence from the IOM report propelled policy momentum at the community[9] and state levels[10] that ultimately culminated in the passage of federal T21 legislation in December 2019.[11] As of January 1, 2020, 19 states and numerous localities had passed T21 legislation.[12] While early evaluations of T21 laws demonstrated a decrease in adolescent[9] and young adult cigarette smoking,[13,14] effects on a broader range of tobacco products have not been well-delineated.[10,15] Furthermore, though models projected greater T21 impact among 15 to 17-year-olds relative to adolescents both younger and older than this range,[8] few previous studies have empirically evaluated T21 policy effects in adolescents younger than 18 years.[9,10] Given the rising prevalence of adolescent e-cigarette and flavored tobacco product use,[3] a clearer understanding of how T21 laws influence the use of these products and age-related differences in effects are important to inform future enforcement.

In Minnesota, T21 legislation was first implemented at the local level in July 2017 in one locality; subsequently 28 additional localities implemented T21 laws between July 2017 and the first half of 2019.[16] Only two localities in Minnesota had implemented separate flavored tobacco sales restrictions by the end of 2016, though by June 2019 eleven localities had such restrictions or bans in place for flavored tobacco sales, including menthol.[16] The heterogeneity of Minnesota's tobacco legislation preceding the recent passage of a statewide T21 bill in May 2020[17] presented an ideal opportunity to study the effects of T21 exposure on a broad range of adolescent tobacco use behaviors. We used repeated cross-sectional, statewide surveys of Minnesota adolescents in 2016 and 2019 to determine how exposure to T21 policies related to adolescent tobacco use behaviors across a range of tobacco products and ages. We hypothesized that adolescents living in locations that instituted T21 policies between 2016 and 2019 would report lower levels of all forms of tobacco use in 2019 than their counterparts in locations without such policies.

Methods

Data Source

This study used data from the 2016 and 2019 Minnesota Student Survey (MSS). The MSS is offered every three years to all fifth, eighth, ninth, and eleventh-grade students in all school districts to assess risk behaviors such as tobacco use and potential risk and protective factors. While schools are not required to administer the survey, participation rates at the school level were high—85% and 81% in 2016 and 2019, respectively. This yielded a total of 168 733 students in 2016 and 170 128 students in 2019, or 68% and 64% of total enrollment in the selected grades statewide.[18,19] Our analytic sample excluded fifth graders because they were not asked comprehensive tobacco use questions. Participating schools allowed parents to opt their child out of the MSS in accordance with federal laws. All surveys were administered online in schools during school hours by school officials to students who assented between January and May in each year. The University of Minnesota's Institutional Review Board determined that this secondary analysis of existing anonymous data was exempt from review.

Measures

Outcome Variables

We examined past 30-day tobacco use among respondents in 2019 that spanned a range of five products and three composite measures—flavored tobacco (menthol and others), dual/poly tobacco (2 or more products), and any tobacco product use—as detailed in Table 1. Given the skewed data towards no past 30-day use, all outcomes were dichotomized as any (i.e., at least one day of use in the past 30 days) vs. no past 30-day use. The percent of our sample that was missing one tobacco outcome variable was 11.2% and, of these, 88.7% of respondents with one missing tobacco outcome variable were missing all outcome variables (or 10.0% of the sample). We therefore excluded all those individuals missing one or more of the tobacco outcome variables from our analysis (n = 14 063).

Independent Variables

The exposure of interest was a binary indicator of whether the student attended a school in a locality (city or county) that implemented a T21 policy between the 2016 and 2019 MSS survey administrations. Implementation of any T21 policy was included in the analysis irrespective of variability in policy details and enforcement. All T21 policies implemented during this study period were inclusive of all tobacco products. Data from Minnesota's Office of Statewide Health Improvement Initiatives were used to develop the T21 exposure variable. Students attending schools in localities that implemented a T21 policy 30 or more days prior to the 2019 survey administration were classified as T21 exposed for the purposes of this analysis (n = 10,544 students in 41 schools). Students attending schools in localities that had not implemented a T21 policy before the 2019 survey administration were classified as unexposed (n = 91 652 students in 421 schools). Students attending schools in localities that implemented a T21 policy within one to 29 days before the 2019 survey administration were excluded from this study (n = 1413 at 4 schools). We also excluded students who were missing the exposure variable (n = 8) and who attended online schools (n = 179), for a total of 1600 excluded students. According to our exposure definition, 12.0% of respondents (10 544 of 102 196) were classified as exposed to T21 policies in this analysis.

Demographic controls included biological sex (0.2% missing) and grade (0% missing). The blended race/ethnicity variable (0.6% missing) combined responses to race and ethnicity questions to create a seven-component variable (Hispanic or Latino and six non-Hispanic categories including multiple race [defined as one or more race categories and non-Hispanic ethnicity]) as previously described (Table 1).[20] Our indicator of economic hardship included two categories:

Table 1. Respondent characteristics by T21 policy exposure[a]

	2016			2019		
	T21 policy?			T21 policy?		
	No *N* = 96 210	Yes *N* = 11 771		No *N* = 91 652	Yes *N* = 10 544	
	%	%	*p*[b]	%	%	*p*[b]
Grade			<0.001			<0.001
8	35.3	35.2		36.9	38.2	
9	35.4	38.6		35.0	36.3	
11	29.3	26.2		28.1	25.6	
Biological sex			0.01			0.01
Male	49.8	48.5		48.6	47.1	
Female	50.2	51.5		51.3	52.8	
Race/ethnicity			< 0.001			< 0.001
Hispanic or Latino	8.8	11.3		5.4	9.1	
Non-Hispanic						
American Indian or Alaska Native	1.3	0.4		1.3	0.4	
Asian	5.1	8.0		6.0	9.3	
Black, African, or African American	4.7	8.3		5.8	9.2	
Native Hawaiian or other Pacific Islander	0.1	0.2		0.2	0.1	
White	72.2	62.8		72.4	61.2	
Multiple race[c]	7.2	8.2		8.3	9.9	
Economic hardship[d]			<0.001			<0.001
No	90.9	92.3		91.7	93.0	
Yes	9.1	7.7		8.3	7.0	
School location[e]			<0.001			<0.001
Urban	7.8	30.4		7.5	36.1	
Suburban	47.0	61.0		46.9	53.5	
Small town	27.2	1.7		27.5	2.4	
Rural	18.1	7.0		18.1	8.0	
Past 30-day tobacco use						
Any tobacco[f]	13.4	9.2	<0.001	18.2	13.6	<0.001
Cigarette[g]	5.1	3.1	<0.001	3.4	2.4	<0.001
Chew[h]	2.9	1.4	<0.001	1.9	1.0	<0.001
Cigar[i]	3.2	2.3	<0.001	2.1	1.6	0.001
Hookah[j]	2.5	2.0	0.003	1.4	1.3	0.17
E-cigarette[k]	10.7	7.7	<0.001	17.3	12.9	<0.001
Flavored tobacco[l]	8.1	5.4	<0.001	9.4	6.7	<0.001
Dual/poly tobacco[m]	6.1	4.0	<0.001	4.6	3.1	<0.001

[a]Tobacco 21 (T21) policy exposure defined at the school level and indicates student attendance at a school in a locality (city or county) with a T21 policy in effect at the time of 2019 survey completion.
[b]X^2 tests of association were used to examine differences in demographic factors.
[c]Multiple race defined as one or more race categories and non-Hispanic ethnicity.
[d]Economic hardship defined as any (housing insecurity *or* skipped meals for economic reasons in the past 30 days) or none.
[e]School location as defined by the National Center for Education Statistics[21].
[f]Any past 30-day use of the tobacco products listed below.
[g]Any past 30-day use of combustible cigarettes.
[h]Any past 30-day use of chewing tobacco, snuff, or dip.
[i]Any past 30-day use of cigars, cigarillos, or little cigars.
[j]Any past 30-day use of hookah or waterpipe.
[k]Any past 30-day use of e-cigarettes, e-hookah, or vaping pen.
[l]Any past 30-day use of cigarettes or other tobacco products that were flavored to taste like mint, menthol, or some other flavor.
[m]Any past 30-day use of 2 or more tobacco products.

any (defined as answering yes to either housing insecurity in the past 12 months or skipped meals for economic reasons in the past 30 days) and none (answering no to both of these items). Respondents who answered no to one item and who did not respond to the other item, as well as those who were missing responses to the two items, were classified as missing (2.0% missing). Finally, school location (0% missing) was classified as urban, suburban, small town, and rural according to the National Center for Education Statistics classifications.[21]

Statistical Analysis

Chi-squared and *t*-tests were used to compare demographic factors and individual-level tobacco outcomes in 2016 and 2019. We used generalized estimating equations (GEE) to model adolescent tobacco use behaviors in 2019, using school buildings as the clustering variable. Analyses adjusted for demographic characteristics detailed above. To account for the influence of secular trends on observed differences in tobacco use prevalence among students in 2019, baseline tobacco use

prevalence at the school building level in 2016 was included in analytic models. Tobacco use prevalence for each tobacco outcome in 2016 was calculated by school building and grade and matched to 2019 participating schools. Overall, 7516 respondents in 538 buildings could not be matched to 2016 data and were excluded from regression models. Surveys that were not complete on the other covariates included in the model were excluded from analysis. A total of 1570 (2.13%) of eighth and ninth-grade respondent surveys and 522 (1.84%) of eleventh-grade respondent surveys were excluded in this manner.

Given age-related differences in tobacco use and a priori anticipated differences in policy effects by age,[8] we examined interaction terms between grade level and T21 policy exposure in the models. We found a significant interaction between grade level and T21 exposure for most tobacco products and therefore stratified our models by grade. Stratified models revealed empirically similar results for eighth and ninth-grade students, so we therefore combined eighth and ninth-grade students to compare to eleventh-grade students.

All analyses were conducted in R (version 4.0.2).[22] Statistical tests were deemed significant at the 0.05 significance level.

Results

Table 1 describes respondent characteristics by survey year and T21 policy exposure. Compared with unexposed students, T21-exposed students were significantly more racially and ethnically diverse (with 62.8% reporting white non-Hispanic race/ethnicity relative to 72.2% of unexposed students in 2016, $p < 0.001$) and more likely to attend schools in urban (30.4% vs. 7.8%) or suburban locations relative to small town or rural locations (61.0% vs. 47.0%, $p < 0.001$) in 2016, with similar differences in the 2019 sample. Overall past-30 day use of any tobacco products rose dramatically between 2016 and 2019 in both the T21 exposed and unexposed groups, a change that was largely driven by increases in e-cigarette use. E-cigarettes were the predominant form of tobacco use among both T21-exposed and unexposed students in both 2016 and 2019. In 2016, past 30-day tobacco use was lower among T21-exposed students relative to unexposed students (9.2% vs. 13.4%, $p < 0.001$) and remained significantly lower in 2019 among T21-exposed students relative to unexposed students (13.6% vs. 18.2%, $p < 0.001$). In both 2016 and 2019, T21-exposed students reported significantly lower past 30-day use of all tobacco products, except for hookah in 2019.

In our GEE models stratified by grade level and adjusted for all covariates (Table 2), T21-exposed eighth and ninth-grade students in 2019 had significantly lower odds than unexposed students for five of eight tobacco outcomes, including use of any tobacco (aOR: 0.80, 95% CI: 0.74, 0.87), cigarettes (aOR: 0.81, 95% CI: 0.67, 0.99), e-cigarettes (aOR: 0.78, 95% CI: 0.71, 0.85), flavored tobacco (aOR: 0.79, 95% CI: 0.70, 0.89), and dual/poly tobacco (aOR: 0.77, 95% CI: 0.65, 0.92). There were non-significant differences between T21-exposed and unexposed eighth and ninth-grade students in 2019 for chew (aOR: 0.80, 95% CI: 0.62, 1.05), cigars (aOR: 0.86, 95% CI: 0.68, 1.09), and hookah (aOR: 0.87, 95% CI: 0.68, 1.11). Eleventh grade students exposed to T21 policies did not differ significantly in their odds of any tobacco product use relative to their unexposed peers. Complete GEE models are available in Supplementary Appendix Tables A1 and A2.

Table 2. Adjusted odds ratios (95% CI) of tobacco use by product for students exposed to T21 policy[a]

	8th & 9th grade	11th grade
	aOR (95%CI)	aOR (95%CI)
Any tobacco	0.80*(0.74, 0.87)	1.00(0.90, 1.10)
Cigarettes	0.81*(0.67, 0.99)	1.20(0.97, 1.48)
Chew	0.80(0.62, 1.05)	0.80(0.58, 1.10)
Cigars	0.86(0.68, 1.09)	1.08(0.84, 1.40)
Hookah	0.87(0.68, 1.11)	1.07(0.77, 1.48)
E-cigarettes	0.78*(0.71, 0.85)	0.98(0.89, 1.09)
Flavored tobacco	0.79*(0.70, 0.89)	1.03(0.91, 1.17)
Dual/poly tobacco[b]	0.77*(0.65, 0.92)	1.08(0.91, 1.30)

[a]Models stratified by 8/9th and 11th grades. Controls include female sex, race/ethnicity, economic hardship, school geographic location, and product specific tobacco use prevalence at the school building level in 2016.
[b]Any past 30-day use of 2 or more tobacco products.
*Denotes statistical significance at the 0.05 level.

Discussion

This study of T21 policy effects across a range of tobacco products in a statewide survey of youth during a time of dramatic changes in adolescent e-cigarette use found that students from all grade levels did not benefit equally from exposure to T21 policies. While eighth and ninth grade students exposed to T21 policies demonstrated significantly lower odds of most forms of tobacco use relative to their unexposed peers, T21 exposure among eleventh grade students was not associated with any significant differences in tobacco use.

Most previous evaluations of local and state-level T21 policies have focused on identifying policy-related reductions in cigarette use or sales and have demonstrated that community-level T21 implementation may reduce adolescent[9] and young adult[13,14] cigarette use. Our study expands on previous work on local T21 effects[15] by examining multiple types of tobacco use pre- and post-policy implementation and demonstrating a significant interaction with grade level. In contrast to the IOM models, which projected the greatest policy benefits of T21 laws among 15- to 17-year-olds,[8] our findings suggest that locally implemented T21 policies are more likely to reduce tobacco use behaviors among younger adolescents (8th and 9th grades—typically age 13–15) relative to their older (11th grade—typically age 16–17) peers.

There are several potential explanations for our observed age-related differences in T21 policy effects. First, poor compliance with proof-of-age identification checks at point-of-sale purchases[23,24] and other documented T21 enforcement challenges may help to explain our demonstrated lack of T21 policy effect on older adolescents' tobacco product use. Adolescents most commonly purchase tobacco products in specialty tobacco or vaping shops and gas stations,[25,26] which represent three retail locations with previously demonstrated low levels of compliance with proof-of-age identification checks and high levels of tobacco sales to underage customers even after T21 implementation.[24,26] Previous policies aimed at limiting flavored tobacco product sales to minors that moved product availability from convenience and grocery stores to age-restricted specialty tobacco and vape shops[27] with higher tobacco sales violation rates[24] may be contributing to the lack of observed T21 policy effects in older adolescents, especially for flavored tobacco products including e-cigarettes. Efforts to raise tobacco retailer awareness of T21 policy components[28] and to increase regular compliance checks[29,30] will be important enforcement components to reduce illegal tobacco sales to underage populations as T21 implementation expands. The more recent implementation of federal[11] and statewide T21 legislation in Minnesota as of August 1, 2020, should strengthen local governments' abilities to conduct compliance checks and enforce the legislation.[31]

The heterogeneous nature of T21 policy coverage resulting from implementation at the local rather than at the state or federal levels could also be contributing to our observed age differences in T21 effects. That is, adjacent localities with discrepant minimum legal sales age policies may permit older adolescents (typically of driving age) to more easily circumvent T21 restrictions by purchasing products in nearby, less restrictive locations—analogous to previously described border crossings to evade tobacco tax increases at the state level.[32,33] Furthermore, older adolescents are also more likely to be socially connected to older peers who would be able to legally obtain tobacco products in nearby localities without T21 policies, which aligns with previous work demonstrating that friends,[25,34] especially those over the age of 18 years,[35] are common sources of tobacco products for underage adolescent populations. Notably, this circumvention of local T21 policies has not manifested in previous research among young adults.[14]

Finally, the timing of effects from T21 implementation may be contributing to age-related differences in policy effects. While some studies have demonstrated early impacts on cigarette sales in the first six months post-T21 implementation,[36] changes in reported tobacco use may not be apparent until two years post-implementation,[9] likely reflecting slower changes in adolescent social norms.[30] Slower changes in tobacco use behaviors would be anticipated then among older adolescents, who are more likely than their younger peers to be established tobacco users[2] and thus less susceptible to short-term T21 policy effects.[26]

Our study also demonstrated that baseline tobacco use was lower in locations where T21 policies were subsequently implemented compared with other parts of the state that did not implement these policies by 2019. This observation suggests that early T21 policy adopters may represent more progressive localities with stronger preexisting tobacco prevention policies and control norms at baseline. These findings, if they apply to a broader range of geographies,[37] speak to the promising impacts that the recent implementation of state and national level T21 policies[11,31] may have on reducing adolescent tobacco use as policies extend to areas with higher adolescent tobacco use prevalence. Furthermore, this finding underscores the utility of T21 policies as one tool in a broader set of tobacco prevention and reduction strategies, such as smoke-free laws, tobacco taxes, tobacco cessation programs, and tobacco retail licensing, that work in concert to effectively reduce adolescent tobacco use.[29,30,38]

Strengths and Limitations

This study is among the first to assess how T21 policy implementation influences a broad range of adolescent tobacco use behaviors. By doing so in a large statewide survey of adolescents, we were also able to tease out how T21 effects differ by grade level, indicating a significantly greater benefit for younger adolescents. However, we must also note several limitations of this study. First, this study used a dichotomized measure of self-reported past 30-day use of tobacco products to represent current tobacco use. While this is a reliable measure of current tobacco use that correlates with tobacco outcomes in young adulthood,[39] these measures may underestimate true levels of adolescent tobacco use due to social desirability and recall bias. Furthermore, our approach to dichotomizing this variable may have masked underlying changes in the frequency of tobacco product use with exposure to T21 policies. Second, our use of the school attended as a proxy for T21 exposure may have resulted in misclassification of an individual student's exposure if a student lives and attends school in different localities with heterogeneous T21 exposure, thereby biasing effects towards the null. However, we excluded online schools and schools with addresses and licensing jurisdictions that did not match to mitigate this effect. Third, we were not able to assess for potential confounding effects of parental smoking in our models because this variable was not included in the survey.

Fourth, this study was not equipped to evaluate how local differences in preexisting adolescent tobacco prevention policies and norms may have affected both the implementation and enforcement of T21 policies and/or adolescent tobacco use itself via another mechanistic pathway. Though we did have local policy information on separate local flavored tobacco restriction policy implementation, our models were not adequately powered to assess the concurrent effects of flavored tobacco point-of-sale restrictions due to the small number of localities (eleven Minnesota localities) where flavored tobacco policies were implemented between 2016 and survey data collection in 2019. These flavored tobacco policies, as well as other local differences in policies or norms, may have contributed to some of our observed differences in tobacco use between T21-exposed and unexposed adolescents. Additionally, we did not evaluate differences in T21 policy components such as phase-in age restrictions (i.e., excepting current 18–20 year olds) and inclusion of purchase, use, and possession penalties which target the user as opposed to retailers, or retailer responses to T21 policies such as discounted prices or marketing campaigns. It is possible that these variations might affect implementation, enforcement, and, ultimately, adolescent tobacco use outcomes. Given the documented variation in T21 legislation,[40] future work should examine how differences in policy components, implementation, and enforcement influence policy effectiveness. Finally, the findings in this statewide, repeated cross-sectional sample may not be generalizable to other geographic locations and are not able to establish a causal link between T21 policy exposure and adolescent tobacco behaviors.

Conclusions

This study demonstrates that local T21 policy exposure is associated with lower levels of a broad range of adolescent tobacco use behaviors, particularly among younger adolescent populations. These findings support the implementation of T21 policies as an effective strategy to reduce adolescent tobacco use and underscore the potential public health benefits of broader T21 policy implementation at the state and federal levels.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

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Declaration of Interests

None declared.

Data Availability

Data are managed by the MSS Interagency Team, who can be contacted at mde.studentsurvey@state.mn.us.

References

1. Cullen KA, Gentzke AS, Sawdey MD, et al. e-Cigarette use among youth in the United States, 2019. *JAMA*. 2019;322(21):2095–2103.
2. Gentzke AS, Creamer M, Cullen KA, et al. Tobacco use among middle and high school students—United States, 2011 - 2016. *Morb Mortal Wkly Rep*. 2019;68(6):157–164. doi:10.15585/mmwr.mm6623a1
3. Dai H. Changes in flavored tobacco product use among current youth tobacco users in the United States, 2014-2017. *JAMA Pediatr*. 2019;173(3):282–284.
4. Ambrose BK, Day HR, Rostron B, et al. Flavored tobacco product use among us youth aged 12-17 years, 2013-2014. *JAMA*. 2015;314(17):1871–1873.
5. Singh T, Arrazola RA, Corey CG, et al. Tobacco use among middle and high school students—United States, 2011–2015. *Morb Mortal Wkly Rep*. 2016;65(14):361–367. doi:10.2307/24858013
6. U.S. Department of Health and Human Services. *Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General: Executive Summary*. Rockville, MD: Office of the Surgeon General; 2012.
7. Forster J, Chen V, Blaine T, Perry C, Toomey T. Social exchange of cigarettes by youth. *Tob Control*. 2003;12(2):148–154.
8. Institute of Medicine. *Public Health Implications of Raising the Minimum Age of Legal Access to Tobacco Products*. Washington, DC: The National Academies Press; 2015. doi:10.17226/18997
9. Kessel Schneider S, Buka SL, Dash K, Winickoff JP, O'Donnell L. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tob Control*. 2016;25(3):355–359.
10. Oregon Health Authority. Oregon's Tobacco 21 Law: Impact Evaluation; 2019. Accessed May 5, 2020. https://www.oregon.gov/oha/PH/PREVENTIONWELLNESS/TOBACCOPREVENTION/Documents/Oregon-Tobacco-21-Impact-Evaluation-Report.pdf
11. *Rules Committee Print 116–44 Text of the House Amendment to the Senate Amendment to H.R. 1865*. Washington, DC: 116th Congress; December 16, 2019. https://docs.house.gov/billsthisweek/20191216/BILLS-116HR1865SA-RCP116-44.PDF
12. Tobacco 21 statement on federal law - Tobacco 21. Accessed May 27, 2020. https://tobacco21.org/tobacco-21-statement-on-federal-law/
13. Friedman AS, Buckell J, Sindelar JL. Tobacco-21 laws and young adult smoking: quasi-experimental evidence. *Addiction*. 2019;114(10):1816–1823.
14. Friedman AS, Wu RJ. Do local tobacco-21 laws reduce smoking among 18 to 20 year-olds? *Nicotine Tob Res*. 2020;22(7):1195–1201.
15. Macinko J, Silver D. Impact of New York City's 2014 increased minimum legal purchase age on youth tobacco use. *Am J Public Health*. 2018;108(5):669–675.
16. Minnesota - Tobacco 21. Published 2020. Accessed June 2, 2020. https://tobacco21.org/state/minnesota/
17. Minnesotans for a Smoke Free Generation. Governor Walz Signs Tobacco 21 into Law. Published 2020. Accessed June 2, 2020. https://www.smokefreegenmn.org/pr/governor-walz-signs-tobacco-21-into-law/
18. Minnesota Student Survey Interagency Team. *2016 Minnesota Student Survey Statewide Tables*. St Paul, MN; 2016. Accessed April 7, 2020. https://www.health.state.mn.us/data/mchs/surveys/mss/docs/statewidetables/statetablesbygender16.pdf
19. Minnesota Student Survey Interagency Team. *2019 Minnesota Student Survey Statewide Tables*. St. Paul, MN; 2019. Accessed April 10, 2020. https://www.health.state.mn.us/data/mchs/surveys/mss/docs/statewidetables/statetablesbygender19.pdf
20. Rider GN, Mcmorris BJ, Gower AL, Coleman E, Eisenberg ME. Health and care utilization of transgender and gender nonconforming youth: a population-based study. *Pediatrics*. 2018;141(3):e20171683. doi:10.1542/peds.2017-1683
21. Geverdt D. *Education Demographic and Geographic Estimates (EDGE) Program: Locale Boundaries User's Manual*. Washington, DC: National Center for Education Statistics; 2015.
22. R Core Team. R: A language and environment for statistical computing. Published online 2020. Accessed January 19, 2020. https://www.r-project.org
23. Muralidharan N, Ferketich AK, Keller-Hamilton B, Roberts ME. Tobacco advertising and ID checks in Columbus, Ohio, in advance of tobacco 21. *Am J Health Promot*. 2019;33(7):1077–1080.
24. Roeseler A, Vuong TD, Henriksen L, Zhang X. Assessment of underage sales violations in tobacco stores and vape shops. *JAMA Pediatr*. 2019;173(8):795–797.
25. Meyers MJ, Delucchi K, Halpern-Felsher B. Access to tobacco among California high school students: the role of family members, peers and retail venues. *J Adolesc Heal*. 2017;61(3):385–388. doi:10.1016/j.jadohealth.2017.04.012
26. Schiff S, Liu F, Cruz TB, et al. E-cigarette and cigarette purchasing among young adults before and after implementation of California's tobacco 21 policy. *Tob Control*. 2020;0:1–6. doi:10.1136/tobaccocontrol-2019-055417
27. Brock B, Carlson SC, Leizinger A, D'Silva J, Matter CM, Schillo BA. A tale of two cities: exploring the retail impact of flavoured tobacco restrictions in the twin cities of Minneapolis and Saint Paul, Minnesota. *Tob Control*. 2019;28(2):176–180.
28. Zhang X, Vuong TD, Andersen-Rodgers E, Roeseler A. Evaluation of California's 'Tobacco 21' law. *Tob Control*. 2018;27(6):656–662.
29. Astor RL, Urman R, Barrington-Trimis JL, et al. Tobacco retail licensing and youth product use. *Pediatrics*. 2019;143(2):e20173536. Accessed November 5, 2019. www.aappublications.org/news
30. Winickoff JP. Maximizing the impact of tobacco 21 laws across the United States. *Am J Public Health*. 2018;108(5):594–595.
31. Minnesota Department of Health. News release: statewide tobacco 21 goes into effect. Published 2020. Accessed August 4, 2020. https://www.health.state.mn.us/news/pressrel/2020/tobacco080320.html
32. Barker DC, Wang S, Merriman D, Crosby A, Resnick EA, Chaloupka FJ. Estimating cigarette tax avoidance and evasion: Evidence from a national sample of littered packs. *Tob Control*. 2016;25(Suppl 1):i38–i43.
33. Nicholson A, Turner TM, Alvarado E. Cigarette taxes and cross-border revenue effects: evidence using retail data. *Public Financ Rev*. 2014;44(3):311–343. doi:10.1177/1091142114548265
34. Wolfson M, Forster JL, Claxton AJ, Murray DM. Adolescent smokers' provision of tobacco to other adolescents. *Am J Public Health*. 1997;87(4):649–651.
35. DiFranza JR, Coleman M. Sources of tobacco for youths in communities with strong enforcement of youth access laws. *Tob Control*. 2001;10(4):323–328.
36. Glover-Kudon R, Gammon DG, Rogers T, et al. Cigarette and cigar sales in Hawaii before and after implementation of a Tobacco 21 Law. *Tob Control*. 2021;30(1):98–102. doi:10.1136/tobaccocontrol-2019-055248
37. Patel M, Donovan E, Czaplicki L, et al. Examining Tobacco 21 policies and the relationships to tobacco use prevalence and intentions to use tobacco among a nationally representative sample of young adults. Poster presented at: *Society for Research on Nicotine and Tobacco*. Annual Meeting; February 20–23, 2019; San Francisco, CA.
38. Huang J, Chaloupka FJ. *The Impact of the 2009 Federal Tobacco Excise Tax Increase on Youth Tobacco Use*. Cambridge, MA: National Bureau of Economic Research; 2012. doi:10.3386/w18026
39. Dutra LM, Glantz SA. Thirty-day smoking in adolescence is a strong predictor of smoking in young adulthood. *Prev Med*. 2018;109:17–21.
40. Dobbs PD, Chadwick G, Ungar KW, et al. Development of a tobacco 21 policy assessment tool and state-level analysis in the USA, 2015-2019. *Tob Control*. 2019;0:2015–2019. doi:10.1136/tobaccocontrol-2019-055102