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E-cigarette-inclusive smoke-free policies, excise taxes, tobacco 21, and changes in youth e-cigarette use: 2017–2019

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Abstract

Background: We examined whether the implementation of e-cigarette policies at the state level [e-cigarette-inclusive smoke-free (ESF) policies, excise taxes on e-cigarettes, and raising tobacco legal purchasing age to 21 years (T21)] affected recent upward trends in youth e-cigarette use.

Methods: Data were from participants from 34 US states who completed the Youth Risk Behavior Survey (YRBS) state surveys in 2017 and 2019 ($n=278,271$). States were classified as having or not having ESF policies, any e-cigarette excise tax, and T21 policies by January 1, 2019. Participants reported ever, past-30-day, and frequent (≥ 20 days) e-cigarette use; past-30-day combustible cigarette smoking; and age, sex, and race/ethnicity. Weighted multivariable logistic regression models assessed whether changes in e-cigarette use over time differed by policy status, adjusting for participants' demographics and combustible cigarette smoking.

Results: Prevalence of ever and past-30-day youth e-cigarette use in states with ESF policies decreased during 2017–2019, while the prevalence of these measures in states without ESF policies increased. States with T21 policies showed non-significant changes in prevalence of ever and past-30-day youth e-cigarette use, whereas states without T21 policies showed significant increases in ever and past-30-day youth e-cigarette use. States with ESF and T21 policies showed slower increases in youth frequent e-cigarette use. E-cigarette excise taxes were not associated with decreasing prevalence of youth e-cigarette use.

Conclusions: State-level ESF and T21 policies could be effective for limiting growth of youth e-cigarette use despite an overall national increase. Higher e-cigarette excise tax rates may be needed to effectively reduce youth e-cigarette use.

Keywords

Smoke-free policies; tax; tobacco 21; e-cigarettes; youth

INTRODUCTION

Electronic cigarette (e-cigarette) use is increasingly prevalent among US youth [1, 2] and young adults [3] while holding steady among older adults in recent years. This is in part due to their modern designs of e-cigarette devices, variety of flavor options, and lower perceived harm compared to combustible cigarette smoking [4, 5]. E-cigarette use poses health risks to the users [6–8] as well as bystanders [9].

Consequently, a growing number of states in the US have passed regulations related to e-cigarettes. Specifically, on December 20, 2019, the federal minimum age of sales of all tobacco products (including e-cigarettes) was raised to 21 years (T21), following Hawaii and Maine (enacted in 2016 and 2018, respectively). T21 policies have been associated with lowering youth combustible cigarette smoking [10]. Furthermore, as of December 31, 2019, 14 states, the District of Columbia, and Puerto Rico enacted e-cigarette-inclusive smoke-free [ESF] policies; and 20 states, the District of Columbia, Puerto Rico, and the US Virgin Islands have imposed excise taxes on e-cigarettes [11]. Previous studies showed mixed results of the impact of setting e-cigarette minimum legal sales age at 18 years on youth cigarette smoking and substance use [12–16]. Additionally, prior research suggests that ESF policies and e-cigarette excise taxes are associated with lower prevalence of e-cigarette use among adults [17, 18]. However, evidence on how these policies affect youth e-cigarette use is lacking. Therefore, the current study aims to examine how these policies are associated with trends in youth e-cigarette use in the US.

METHODS

Study Population

The Youth Risk Behavior Survey (YRBS) is sponsored by the US Centers for Disease Control and Prevention, and is conducted every two years as part of the Youth Risk Behavior Surveillance System (YRBSS) to collect data related to various health behaviors among a representative sample of 9th through 12th grade students. Additional to the nationally representative sample, states can opt for state representative samples, these data were pooled in the YRBS combined state dataset (<https://www.cdc.gov/healthyyouth/data/yrbs/data.htm>). Specific details of the YRBSS methodology can be found elsewhere [19]. The present analysis uses data from 34 states that opted for state-representative samples in 2017 and 2019 with information on e-cigarette and combustible cigarette use ($n=278,271$) including: Alaska, Arizona, Arkansas, Colorado, Hawaii, Idaho, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, West Virginia, and Wisconsin (see supplementary figure 1 for details on sample inclusion process).

Measures

State policy statuses as of January 1, 2019 were ascertained through internet searches (e.g., Campaign for Tobacco-Free Kids and state health department websites). States were classified into having ESF policies (Hawaii, New York, North Dakota, Rhode Island, Utah, and Vermont), having T21 policies (Hawaii, Maine), and having e-cigarette excise taxes (Kansas, Louisiana, North Carolina, Pennsylvania, and West Virginia), versus not having each of these policies (see supplementary table 1 for policy implementation dates). We were unable to further develop the excise tax measure for several reasons. First, some states tax e-cigarettes by their nicotine capacity. Since capacities of pods vary by brand, we are unable to determine the percent of tax proportion to price. Second, without accurate pricing information on e-cigarettes, calculating tax-to-price ratios very challenging. Third, some states tax e-cigarettes at the wholesale instead of retail level. The lack of information on e-cigarette wholesale prices hindered us from calculating the proportion of price due to tax.

In the surveys, students were asked if they ever used an electronic vapor product (yes/no) and the number of days they used an electronic vapor product during the 30 days prior to the survey. Students who used e-cigarettes for 1 day were categorized as being past-30-day e-cigarette users, and students who did not use e-cigarettes during the same time period were categorized as non-users. Additionally, students who used e-cigarettes on 20 days were classified as frequent past-30-day users. Students also reported the number of days they smoked combustible cigarettes during the 30 days prior to the survey. Those who reported 1 day were categorized as past-30-day combustible cigarette smokers (vs. non-smokers). Information on age, sex, and race/ethnicity was also ascertained.

Statistical analysis

Data were weighted to be representative of the participating states and to account for sampling methodology. Weighted prevalence of e-cigarette use behaviors were estimated by year (2017 vs. 2019) and policy statuses, and relative percent change (R%) over time were calculated. Weighted logistic regression models were used to compare differences in youth e-cigarette use (ever, past-30-day, frequent) by each policy status using year*policy interaction terms. These models controlled for age, sex, race/ethnicity, and past-30-day combustible cigarette smoking. All analyses were conducted in SAS® version 9.3 (SAS Institute: Cary, NC, USA).

RESULTS

Overall, 37.1% of US youth in the participating states were 12–15 years old (versus 16–18 years old); 49.4% were female; 22.3% were Hispanic/Latino, 53.0% were non-Hispanic White, 14.0% were non-Hispanic Black or African American, 3.3% were non-Hispanic Asian, 1.4% were non-Hispanic American Indian/Alaskan Native, 0.5% were non-Hispanic Native Hawaiian/Pacific Islander, 3.3% were non-Hispanic multi-race, and 2.3% unspecified; and 7.8% reported past-30-day combustible cigarette smoking. In 2019, 13.9% of US youth were covered by ESF policies, 17.6% by e-cigarette excise tax, and 1.3% by T21 policies.

Between 2017 and 2019, prevalence of ever and past-30-day youth e-cigarette use in states with ESF policies decreased, while the prevalence of these measures in states without ESF policies increased (Table 1). States with T21 policies showed non-significant changes in prevalence of ever and past-30-day youth e-cigarette use, whereas states without T21 policies showed significant increases in ever and past-30-day youth e-cigarette use. States with ESF and T21 policies also showed slower increase in youth frequent e-cigarette use than states without these policies. Further analysis of the YRBS 2017–2019 data showed that fewer youth bought their e-cigarettes in retail stores in states with T21 policies (from 14.3% in 2017 to 6.5% in 2019) compared to states without T21 policies (20.3% in 2017 and 20.2% in 2019). However, more youth had someone else purchase e-cigarettes for them in states with T21 policies (from 10.2% in 2017 to 19.3% in 2019). Compared to states without e-cigarette excise tax, states with e-cigarette excise taxes showed similar increasing trends in youth ever e-cigarette use, but faster upward trends in youth past-30-day and frequent e-cigarette use.

DISCUSSION

Given the dearth of research in the impact of state-level e-cigarette policies among US youth e-cigarette use, our findings provided insights that may further guide the adoption and implementation of these policies in protecting youth from e-cigarette use. It is noteworthy that despite the dramatic increase in youth e-cigarette use during 2017–2019, [1, 2] states with ESF and T21 policies showed either a decline or no changes in prevalence of youth ever and past-30-day e-cigarette use, and slower increases in frequent e-cigarette use compared to states without these policies. Our findings suggest that ESF and T21 policies could be effective in combating the youth e-cigarette epidemic. As the US implemented a federal T21 policy at the end of 2019, ensuring high retailer compliance and discouraging proxy purchases will be important to ensure the effectiveness of the policy over time.

We did not find an association between e-cigarette excise taxes and declines in youth e-cigarette use from 2017 to 2019. While youth are known to be price sensitive to e-cigarettes [20], state e-cigarette taxes may not be high enough to achieve their intended effect. Currently, Kansas, Louisiana and North Carolina have e-cigarette tax rates at US\$0.05/ml of e-liquid, West Virginia at US\$0.075/ml of e-liquid, and Pennsylvania at 40% wholesale price [21]. Given that JUUL e-liquid cartridges (commonly known as “pods”) have a 0.7ml capacity, the e-cigarette excise taxes in these states are much less than combustible cigarettes (e.g., US\$1.29/pack in Kansas). Therefore, higher e-cigarette tax rates will be needed to reduce youth e-cigarette use.

Several limitations of our study should be considered. First, the data only cover 34 states and therefore may not be generalizable to states outside of this sample. Second, our analysis did not account for local jurisdictions that adopted these policies in states that did not. Third, we did not control for socioeconomic status because relevant measures were unavailable in YRBS. Fourth, we were unable to assess how different tax rates may influence youth e-cigarette use because of lack of e-cigarette pricing information. Despite these limitations, our findings suggest that e-cigarette policies at the state level (e-cigarette-inclusive smoke-free policies and raising legal tobacco sales age to 21 years) could reduce youth e-cigarette

use despite the national increasing trend [1, 2]. Further state-level and individual-level research is needed to understand why these policies do not reduce youth frequent e-cigarette use and to determine effective e-cigarette excise tax rates to further strengthen these policies and combat the youth e-cigarette use epidemic.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

- [1]. Cullen KA, Ambrose BK, Gentzke AS, et al. Notes from the Field: Use of Electronic Cigarettes and Any Tobacco Product Among Middle and High School Students - United States, 2011–2018. *MMWR Morb Mortal Wkly Rep* 2018;67(45):1276–1277. [PubMed: 30439875]
- [2]. Cullen KA, Gentzke AS, Sawdey MD, et al. e-Cigarette Use Among Youth in the United States, 2019. *JAMA* 2019.
- [3]. Dai H, Leventhal AM. Prevalence of e-Cigarette Use Among Adults in the United States, 2014–2018. *JAMA* 2019.
- [4]. Barrington-Trimis JL, Leventhal AM. Adolescents' Use of "Pod Mod" E-Cigarettes - Urgent Concerns. *N Engl J Med* 2018;379(12):1099–1102. [PubMed: 30134127]
- [5]. Palazzolo DL. Electronic cigarettes and vaping: a new challenge in clinical medicine and public health. A literature review. *Front Public Health* 2013;1:56. [PubMed: 24350225]
- [6]. Yang I, Sandeep S, Rodriguez J. The oral health impact of electronic cigarette use: a systematic review. *Crit Rev Toxicol* 2020;50(2):97–127. [PubMed: 32043402]
- [7]. Buchanan ND, Grimmer JA, Tanwar V, et al. Cardiovascular risk of electronic cigarettes: a review of preclinical and clinical studies. *Cardiovasc Res* 2020;116(1):40–50. [PubMed: 31696222]
- [8]. Chun LF, Moazed F, Calfee CS, et al. Pulmonary toxicity of e-cigarettes. *Am J Physiol Lung Cell Mol Physiol* 2017;313(2):L193–L206. [PubMed: 28522559]
- [9]. Bayly JE, Bernat D, Porter L, et al. Secondhand Exposure to Aerosols From Electronic Nicotine Delivery Systems and Asthma Exacerbations Among Youth With Asthma. *Chest* 2019;155(1):88–93. [PubMed: 30359612]
- [10]. Kessel Schneider S, Buka SL, Dash K, et al. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tob Control* 2016;25(3):355–359. [PubMed: 26071428]
- [11]. U.S. Centers for Disease Control and Prevention. STATE System E-Cigarette Fact Sheet Atlanta, GA: U.S. Centers for Disease Control and Prevention 2020.
- [12]. Friedman AS. How does electronic cigarette access affect adolescent smoking? *J Health Econ* 2015;44:300–308. [PubMed: 26583343]
- [13]. Dave D, Feng B, Pesko MF. The effects of e-cigarette minimum legal sale age laws on youth substance use. *Health Econ* 2019;28(3):419–436. [PubMed: 30648308]
- [14]. Pesko MF, Hughes JM, Faisal FS. The influence of electronic cigarette age purchasing restrictions on adolescent tobacco and marijuana use. *Prev Med* 2016;87:207–212. [PubMed: 26971853]
- [15]. Abouk R, Adams S. Bans on electronic cigarette sales to minors and smoking among high school students. *J Health Econ* 2017;54:17–24. [PubMed: 28349865]

- [16]. Dutra LM, Glantz SA, Arrazola RA, et al. Impact of E-Cigarette Minimum Legal Sale Age Laws on Current Cigarette Smoking. *J Adolesc Health* 2018;62(5):532–538. [PubMed: 29422436]
- [17]. Lee B, Lin HC, Seo DC. Inclusion of electronic nicotine delivery systems in indoor smoke-free air policies and associated vaping behavior. *Addict Behav* 2019;98:106061. [PubMed: 31377449]
- [18]. Du Y, Liu B, Xu G, et al. Association of Electronic Cigarette Regulations With Electronic Cigarette Use Among Adults in the United States. *JAMA Netw Open* 2020;3(1):e1920255. [PubMed: 32003818]
- [19]. Brener ND, Kann L, Shanklin S, et al. Methodology of the Youth Risk Behavior Surveillance System—2013. *MMWR Recomm Rep* 2013;62(RR-1):1–20.
- [20]. Pesko MF, Huang J, Johnston LD, et al. E-cigarette price sensitivity among middle- and high-school students: evidence from monitoring the future. *Addiction* 2018;113(5):896–906. [PubMed: 29193537]
- [21]. Boonn A. STATE EXCISE TAX RATES FOR NON-CIGARETTE TOBACCO PRODUCTS Washington, DC: Campaigns for Tobacco-Free Kids 2020.

WHAT THIS PAPER ADDS:

- The current analysis shows that state e-cigarette-inclusive smoke-free policies that included e-cigarettes and raising tobacco legal sales age to 21 years, but not e-cigarette excise taxes, were associated with either declines or no changes in trends in youth e-cigarette ever use and past-30-day use, and slower increases in youth frequent e-cigarette use, despite national increases.
- Implementing state e-cigarette-inclusive smoke-free policies, reducing commercial and social sources for e-cigarette acquisition, and raising e-cigarette excise taxes have potential to reduce youth e-cigarette use.

Table 1.

Weighted prevalence estimates, relative percent changes, and trends in youth e-cigarette use by e-cigarette policies, 2017–2019 Youth Risk Behavior Surveys.

	2017	2019	Relative % change	2017–2019	
	Weighted %	Weighted %		AOR (95% CI)	Time*policy interaction <i>p</i>
Ever use					
E-cigarette-inclusive smoke-free policies					
Enacted	48.9%	37.6%	–23.1%	0.76 (0.63, 0.91)	<0.01
Not Enacted	35.7%	42.3%	18.7%	1.46 (1.38, 1.55)	
Raising legal tobacco sales age to 21 years					
Enacted	42.2%	44.3%	4.9%	0.96 (0.78, 1.18)	0.32
Not enacted	36.3%	41.6%	14.7%	1.40 (1.32, 1.48)	
E-cigarette excise tax					
With state tax	38.2%	46.5%	21.9%	1.54 (1.38, 1.71)	0.09
Without state tax	35.9%	40.6%	13.2%	1.36 (1.27, 1.46)	
Past-30-day use					
E-cigarette-inclusive smoke-free policies					
Enacted	37.6%	20.5%	–45.4%	0.53 (0.41, 0.68)	<0.01
Not Enacted	14.1%	23.7%	68.1%	2.60 (2.37, 2.87)	
Raising legal tobacco sales age to 21 years					
Enacted	29.8%	29.9%	0.5%	0.83 (0.62, 1.15)	<0.01
Not enacted	15.2%	23.2%	52.6%	2.26 (2.05, 2.49)	
E-cigarette excise tax					
With state tax	15.1%	28.2%	86.4%	2.94 (2.45, 3.52)	<0.01
Without state tax	15.4%	22.2%	44.5%	2.07 (1.84, 2.32)	
Frequent use					
E-cigarette-inclusive smoke-free policies					
Enacted	7.0%	6.3%	–10.7%	1.56 (1.21, 2.01)	<0.01
Not Enacted	3.0%	8.8%	197.0%	4.42 (3.85, 5.09)	
Raising legal tobacco sales age to 21 years					
Enacted	5.3%	9.7%	84.4%	2.29 (1.78, 2.95)	0.02
Not enacted	3.2%	8.4%	167.6%	4.07 (3.56, 4.64)	
E-cigarette excise tax					
With state tax	2.8%	10.3%	272.6%	5.45 (4.09, 7.24)	0.02
Without state tax	3.3%	8.1%	146.2%	3.75 (3.21, 4.38)	

Models adjusted for age, sex, race/ethnicity, combustible cigarette smoking, and e-cigarette policies. Bolded estimates are statistically significant ($p < 0.05$).