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Tobacco 21's Impact Amid the E-Cigarette Surge

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Abstract

Objectives: Nationwide implementation of Tobacco 21 (raising the legal sales age for all tobacco products to 21) is occurring against the backdrop of an electronic cigarette (e-cigarette) epidemic among young people, which makes Tobacco 21 evaluation difficult. To address this issue, we examined young adult use of e-cigarettes separately from use of other tobacco products. Our objective was to determine whether use changed after Tobacco 21 implementation and whether those changes differed by product.

Methods: In Columbus, Ohio, which began enforcing Tobacco 21 in 2017, we surveyed incoming first-year undergraduates at a large, public university in 2016 (Cohort 1; n = 529) and re-contacted them in 2018. We surveyed a new sample of incoming first-year students in 2018 (Cohort 2; n = 611). Survey items assessed tobacco use, sources for obtaining tobacco, and attitudes surrounding Tobacco 21.

Results: Both cross-sectional (Cohort 1 vs Cohort 2) and prospective (pre–post Tobacco 21 in Cohort 1) analyses indicated a slight decline in most tobacco use from 2016 to 2018, but e-cigarette use more than doubled during the same period. Students enrolled throughout the transition to Tobacco 21 (Cohort 1) perceived little effect of Tobacco 21 on peer use. The largest proportions (35.3%-43.5%) of combustible tobacco were obtained outside Columbus; 61.8% of e-cigarette users reported obtaining e-cigarettes through borrowing.

Conclusions: Tobacco 21 was associated with reductions in combustible and smokeless tobacco use, but its impact was not sufficient to curb the surge in e-cigarette use. Tobacco 21 should be contextualized as part of a broader network of tobacco control efforts, including additional youth-access regulations, that may be needed to address e-cigarette use among young people.

Keywords
e-cigarettes, Tobacco 21, prevention

Among the latest wave of tobacco control approaches, Tobacco 21 is a policy that raises the minimum legal age for selling tobacco to 21. The goal of Tobacco 21 is to prevent or delay tobacco initiation among young people, both by prohibiting sales to older adolescents and by limiting underage youths' access to legal purchasers (such as older peers in high school). Beginning in 2005 with the first local ordinance and later spreading to state laws, Tobacco 21 became a federal law in 2019. Expert opinion[1,2] and early evidence[3] suggest that, when well-enforced, Tobacco 21 has the potential to be widely effective at curbing tobacco initiation among young people.

The national implementation of Tobacco 21 is now occurring against the backdrop of an electronic cigarette (e-cigarette) epidemic[4] among youth. Since 2014, e-cigarettes have been the most commonly used tobacco product among adolescents, surpassing other products such as cigarettes, smokeless tobacco, and cigarillos.[5] In 2018, there was a particularly marked surge, with the prevalence of current e-cigarette use reaching 20.8% among high school students (an increase of 77.8% from the previous year).[6] Since that time, current e-cigarette use among high school students has remained near 20%.[7] Rates of current e-cigarette use have risen similarly among young adults, with national data from 2019 indicating a prevalence of 9.3%[8] (nearly double the prevalence of 2017[9]).

Because of the simultaneous surge in e-cigarette use among young people and implementation of Tobacco 21 across the United States, the effects of Tobacco 21 on tobacco use are unclear. Therefore, the objective of this study was to

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evaluate changes in young people's use of both e-cigarettes and other tobacco products, separately, from 2016 to 2018: a period of concurrent Tobacco 21 enforcement and e-cigarette use escalation. We used data from undergraduate students in Columbus, Ohio, which began enforcing Tobacco 21 in 2017—shortly before the recent surge in e-cigarette use. These data allowed us to assess trends in the initiation and prevalence of use and examine the sources where young people were obtaining tobacco products. We hypothesized that the use of combustible and smokeless tobacco products would decrease after implementation of Tobacco 21 but that the use of e-cigarettes would increase.

Methods

Study participants were from a prospective cohort study that examined tobacco use among undergraduate students in Columbus, Ohio. In August 2016, we emailed 1000 incoming first-year students aged ≥18. The Office of the University Registrar provided the list of students, which was a random sample of the incoming class, stratified by sex/gender, first-generation college status, and whether the student's family residence was in state or out of state. Five-hundred twenty-nine participants completed our baseline online survey (Cohort 1). Participants completed follow-up online surveys in September and December of that year (2016).

In August 2018, we re-contacted the original 529 Cohort 1 students (then primarily third-year students). At the same time, we contacted a new random sample of 1000 incoming first-year students applying the methods used in August 2016, which produced a sample of 611 new first-year participants (Cohort 2). The first-year students in Cohort 2 completed follow-up online surveys in September and December of that year (2018), and third-year students (Cohort 1) completed a follow-up survey in December 2018. In both cohorts, among the 1000 students invited to participate in the study, enrollment (vs nonenrollment) was not related to sex/gender or first-generation college status; in Cohort 2, enrolled students were more likely than nonenrolled students to have in-state family residence. The institutional review board at The Ohio State University approved this study, and all participants provided informed consent.

Measures

Each survey asked participants about their ever and past-30-day use of various tobacco products, including e-cigarettes, cigarettes, cigars, cigarillos, smokeless tobacco, and hookah. We calculated dual/poly use as ever or past-30-day use of ≥2 products. In 2018, additional items assessed awareness and perceptions surrounding Tobacco 21, including attitudes about Tobacco 21 (on a scale of 1 to 5, with 1 = very negative and 5 = very positive) and agreement that the legal age to purchase tobacco products should be 21 (on a scale of 1 to 7, with 1 = strongly disagree and 7 = strongly agree). Third-year students in Cohort 1, who experienced the change to Tobacco 21 in Columbus, were also asked to respond to statements about the effect of Tobacco 21 on tobacco use among peers and friends (on a scale from 1 to 7, with 1 = strongly disagree and 7 = strongly agree). In December 2018, the survey asked tobacco users how they usually got their product, as well as the frequency with which clerks in Columbus check identification during one's tobacco purchases (response options were "always," "sometimes," and "never"). We assessed age, sex/gender, race and ethnicity, and socioeconomic status when participants were first-year students. We used 3 indicators of socioeconomic status: social class growing up, current social class,[10] and parent education (assessed separately for mother and father). We *z*-scored and aggregated responses to these 4 indicators to create our measure of socioeconomic status.

Analyses

Analyses began with descriptive statistics to characterize the sample's sociodemographic characteristics, awareness and perceptions surrounding Tobacco 21, and sources for obtaining tobacco products. We then conducted prospective and cross-sectional comparisons to examine pre–post Tobacco 21 changes in tobacco use. Prospective analyses of Cohort 1 examined pre–post changes from 2016 to 2018. Because this examination involved repeated measures of categorical data, we used McNemar tests. Cross-sectional analyses examined changes between first-year students in 2016 (Cohort 1) and first-year students in 2018 (Cohort 2). Because this examination involved independent categorical data, we used the Pearson χ^2 test. For all analyses, we considered $P < .05$ to be significant. We used SPSS version 27 (IBM Corp).

Results

First-year students in Cohort 1 (n = 529) had an average age of 18.6 years (SD, 0.7); 51.6% were female, 76.1% were non-Hispanic White, and 13.9% were first-generation college students. The second cohort of first-year students, enrolled in 2018 (n = 611), had an average age of 18.6 years (SD, 0.6); 52.9% were female, 68.9% were non-Hispanic White, and 13.7% were first-generation college students (Table 1). Of the 529 first-year students in Cohort 1, 388 (73.3%) completed a survey in fall 2018. Third-year students who completed the fall 2018 survey were less likely than third-year students who did not complete the survey to be male and to have used tobacco in 2016; attrition was not associated with age, racial and ethnic minority status, or socioeconomic status.

Awareness of Tobacco 21 was more prevalent among third-year students in Cohort 1 (61.5%) than among first-year students in Cohort 2 (28.4%) (Table 1). However, we found no significant differences between cohorts in attitudes or agreement with Tobacco 21—which, on average, were in

Table 1. Awareness and perceptions regarding Tobacco 21 (T21) among undergraduate cohorts, Columbus, Ohio, August 2018[a]

Characteristic	Cohort 1: third-year students in 2018 (n = 529)	Cohort 2: first-year students in 2018 (n = 611)
Age, mean (SD), y	18.6 (0.7)	18.6 (0.6)
Gender		
% Female	51.6	52.9
% Male	48.0	46.8
% Other response	0.4	0.3
Race and ethnicity		
% Non-Hispanic White	76.1	68.9[b]
% Other[c]	23.8	31.1
Socioeconomic status score, mean (SD)[d]	0 (0.7)	0 (0.8)
Awareness of T21, % aware	61.5	28.4[b]
Attitude about T21, mean (SD), 1-5 scale	3.1 (1.31)	3.3 (1.22)
Agreement with T21, mean (SD), 1-7 scale	4.1 (2.09)	4.5 (2.03)
Impact of T21,[e] mean (SD), 1-7 scale		
People under 21 have been using tobacco less often or not at all	2.76 (1.54)	—
Students at the university have been using less often or not at all	2.63 (1.42)	—
My friends at the university who use tobacco have been using less often or not at all	2.60 (1.49)	—
My friends who use tobacco products have switched products	2.66 (1.51)	—
I have used tobacco less often	3.23 (2.09)	—
Clerks in Columbus always check identification,[e] %	46	—

[a]Tobacco 21 is a policy that raises the minimum legal age for selling tobacco to 21. Data were collected by the study team via online surveys. When enrolled in 2016, there were 529 students in Cohort 1; there were 388 students in Cohort 1 by the 2018 follow-up. When enrolled in 2018, there were 611 students in Cohort 2.

[b]Significant difference in prevalence between 2016 first-year students (Cohort 1) and 2018 first-year students (Cohort 2). Determined by Pearson χ^2 test; $P < .05$ considered significant.

[c]Included all racial and ethnic responses except for non-Hispanic White.

[d]Three indicators of socioeconomic status were used: social class growing up, current social class,[10] and parent education (assessed separately for mother and father). Responses were z-scored and aggregated.

[e]Items were asked only of third-year students who were enrolled at the Columbus campus during the change to Tobacco 21.

the middle range of the scales. Third-year students tended to perceive little effect of Tobacco 21, and only 46% reported that clerks in Columbus always check identification during tobacco purchases.

In terms of sources of tobacco products, e-cigarettes stood out from the other products by being most commonly obtained from borrowing (61.8%; Figure). The most frequently reported source of purchase among cigarette users (41.7%), cigar users (35.3%), and cigarillo users (43.5%) was through purchase outside Columbus.

Prospective analyses of Cohort 1 indicated significant increases in prevalence of ever use and past-30-day use for nearly all tobacco products from 2016 to 2018; the only exception was no change in past-30-day hookah use (Table 2). The largest of these increases was for e-cigarettes: ever use increased from 18.5% to 49.0%, and past-30-day use increased from 7.4% to 32.6%. Increases for other tobacco products were more modest. For example, past-30-day cigarette use increased from 6.6% to 8.2%.

Cross-sectional analyses between cohorts indicated several changes between the 2016 to 2018 first-year students, although the direction of these changes differed by product (Table 1). Whereas ever use of e-cigarettes significantly increased between Cohort 1 and Cohort 2 (past-30-day use increased from 7.4% among first-year students in 2016 to 34.5% among first-year students in 2018), use of other tobacco products either declined or had no significant change. In follow-up analyses, to account for cohort differences in race and ethnicity, logistic regressions that controlled for race and ethnicity indicated the same pattern of results.

Discussion

The simultaneous rise of Tobacco 21 and youth e-cigarette use leaves us with a difficult question: How do we evaluate Tobacco 21 amid a youth e-cigarette crisis? To address this problem, we examined changes in e-cigarette use separately from changes in other tobacco product use. Findings indicated that, for combustible and smokeless tobacco products, there may have been some benefit of Tobacco 21: First-year students in 2018 were using less of this tobacco than first-year students in 2016, and the small rise in smoking during college (from first year to third year) in our study was lower

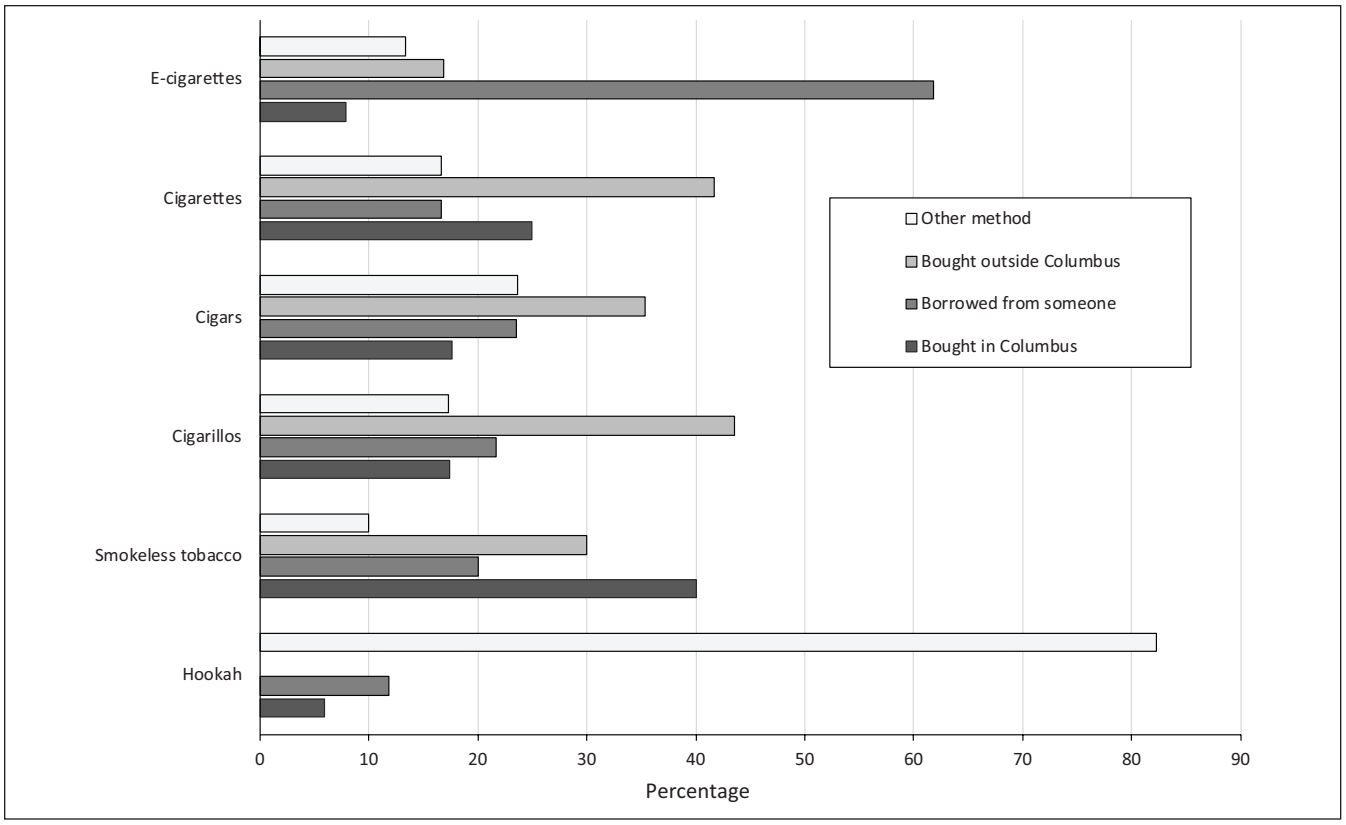

Figure. Usual source of tobacco products reported among undergraduate students in the sample, Columbus, Ohio, December 2018. For each product, questions were asked only of past-30-day users of that product. "Other methods" includes the following response options: "I got them on the internet," "I gave someone else money to buy them for me," "A person 18 years old or older gave them to me," "I took them from a store or family member," "I got them some other way," and (for hookah only), "I got it at a hookah café." Data were collected by the study team via online surveys. Abbreviation: e-cigarette, electronic cigarette.

than the rise typically reported among this age group.[11] However, it appears that Tobacco 21 was not associated with a reduction in e-cigarette use. Rather, first-year students in 2018 were using e-cigarettes at more than double the prevalence of first-year students in 2016, and we found a 2-fold rise in e-cigarette use from first year to third year. The attitudes and beliefs reported by the young adults in our study likewise demonstrated a skepticism about Tobacco 21's effect, and they underscore its challenges in curbing all tobacco use. Despite modest support for and agreement with the policy, students reported observing few changes in tobacco use among their peers and friends.

Additional questions asked of study participants help shed light on the patterns of these findings. In particular, reported sources of obtaining tobacco products indicated that cigarettes, cigars, and cigarillos were most commonly obtained by purchasing them outside Columbus. Thus, Tobacco 21 was reducing access to such an extent that most users were needing to travel to non–Tobacco 21 jurisdictions to purchase these products. Similarly, few e-cigarette users (<8%) were purchasing their products in Columbus. Instead, most users (nearly 62%) reported their e-cigarettes were borrowed. This high prevalence of borrowing is consistent with other e-cigarette research among young people,[12,13] and some researchers have suggested that borrowing is part of the social experience of vaping.[12]

Overall, our findings about tobacco sources suggest that the campus e-cigarette surge was not related to a failure of Tobacco 21 enforcement—local retailers were not selling many products to underage students. Rather, our findings suggest that a local Tobacco 21 ordinance is necessary but not sufficient to curb the e-cigarette surge, as demonstrated by the finding that students had other means of access. A key question for future research is where the people lending their e-cigarettes obtained their devices (ie, the original source).

Limitations

An important limitation to this study is that we were unable to perform a difference-in-differences test and examine changes in e-cigarette use on a control campus (ie, a campus not under a Tobacco 21 ordinance). The e-cigarette surge may have been worse in such non–Tobacco 21 areas. Alternative explanations for our findings also cannot be ruled out. For example, use of combustible tobacco may have declined, in part, because people who would otherwise

Table 2. Prevalence of ever use and past-30-day use of tobacco among undergraduate cohorts during the fall semesters 2016 and 2018, Columbus, Ohio[a]

Item	Cohort 1		Cohort 2
	First-year students in 2016	Third-year students in 2018	First-year students in 2018
Ever use			
E-cigarettes	18.5	49.0[b]	42.6[c]
Cigarettes	12.3	22.9[b]	9.5
Cigars	25.8	30.7[b]	18.0[c]
Cigarillos	17.2	23.7[b]	11.3[c]
Smokeless tobacco	8.9	12.1[b]	4.7[c]
Hookah	17.6	26.0[b]	12.1[c]
Dual/poly use	25.7	43.6[b]	25.9
Past-30-day use			
E-cigarettes	7.4	32.6[b]	34.5[c]
Cigarettes	6.6	8.2[b]	4.1
Cigars	11.6	5.4[b]	6.5[c]
Cigarillos	9.3	5.2[b]	5.9[b]
Smokeless tobacco	3.4	4.6[b]	2.0
Hookah	5.5	4.9	4.4
Dual/poly use	10.8	16.8[b]	13.1

Abbreviation: e-cigarette, electronic cigarette.
[a]Tobacco 21 is a policy that raises the minimum legal age for selling tobacco to 21. Data were collected by the study team via online surveys. When enrolled in 2016, there were 529 students in Cohort 1; there were 388 students in Cohort 1 by the 2018 follow-up. When enrolled in 2018, there were 611 students in Cohort 2.
[b]Significant difference in use prevalence between 2016 and 2018. Determined by McNemar test; $P < .05$ considered significant.
[c]Significant difference in use prevalence between 2016 first-year students (Cohort 1) and 2018 first-year students (Cohort 2), determined by Pearson χ^2 test; $P < .05$ considered significant.

be using those products were instead using e-cigarettes. It would be valuable for researchers with access to data from early and late Tobacco 21 adoption areas to conduct these types of comparisons. Future studies should also use longer follow-up periods to assess the long-term effects of Tobacco 21. It is likewise important to distinguish the role of strong versus weak Tobacco 21 enforcement. Finally, our study was conducted when Columbus implemented Tobacco 21, but before Ohio and the United States implemented Tobacco 21. It is likely that a more widespread Tobacco 21 policy will remove the ability of youth to travel to non–Tobacco 21 jurisdictions for access.

It is worth pointing out that many tobacco users reported Columbus store clerks did not consistently check identification during tobacco purchases; some users also reported purchasing tobacco products online. Thus, a need exists to improve Tobacco 21 enforcement at the retail point of sale and online (ie, penalties for retailers not conducting age verification checks). Nevertheless, our data on tobacco sources also point to other pressing targets for intervention. Because most e-cigarette users reported access to e-cigarettes via borrowing, interventions to reduce borrowing and sharing are critical. For example, policies restricting youth access to flavored tobacco products are critical, and increased pricing and taxes on e-cigarettes should be applied not only to the device but also to the e-liquids/cartridge refills. Such strategies are especially important for preventing experimentation from escalating into dependence and regular use.

Conclusions

Ultimately, our findings indicate that although Tobacco 21 has some benefit to reducing youth use of combustible tobacco products, its effect may not be sufficient to curb or reverse the recent surge in e-cigarette use. Rather than a silver bullet, Tobacco 21 needs to be seen as part of a broader network of tobacco control efforts that tackle the issue of e-cigarette use among young people on many fronts. Additional policies addressing youth access may be needed, including those restricting flavors, reducing retailer density, and raising prices.

Declaration of Conflicting Interests

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