



Short communication

Cigarette and electronic vapor product use among high school students in Georgia, 2015–2018

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ABSTRACT

Adolescent use of electronic vapor products (EVP) is increasing; however, changes in EVP use in the context of cigarette smoking is less certain. We analyzed trends in EVP and cigarette use among high school students in the state of Georgia. We used self-reported EVP and cigarette use from the annual *Georgia Student Health Survey 2.0* for 2015 to 2018 (N = 1,405,108). Users were categorized as exclusive EVP users, exclusive cigarette users, or dual users. We assessed current (≥ 1 day in past 30 days) use of EVPs, cigarettes, and dual users of both products, as well as number of days the products were used among current users. We compared current users, as well as number of days used, across adjacent years using tests for proportion and Wilcoxon t-tests, respectively. The proportion of current exclusive EVP users and dual users increased during 2017–2018 (4.2% to 6.9% and 1.6% to 3.7%, $p < 0.001$, respectively) after declining during 2015–2017, while the proportion of exclusive cigarette users declined during 2015–2018 (2.0% to 1.0%, $p < 0.001$). Similarly, the mean number of days of EVP use increased among exclusive EVP and dual users, and mean number of days of cigarette use increased among dual users during 2017–2018 ($p < 0.001$). These findings reinforce the importance of continued efforts to reduce all forms of tobacco products use among Georgia high school students.

1. Introduction

Adolescent use of electronic vapor products (EVP), including e-cigarettes, has increased in the United States (U.S.) in recent years. For example, data from the National Youth Tobacco Survey (NYTS) show that current (past-30-day) use increased from 1.5% in 2011 to 16.0% in 2015 among U.S. high school students (grades 9–12) (US Department of Health and Human Services, 2016). After declines occurred during 2016–2017, current use increased 78% (from 11.7% to 20.8%) during 2017–2018 (Gentzke et al., 2018). In 2019, among high school students 27.5% currently used e-cigarettes (Wang et al., 2019). Similarly, results from the 2019 Monitoring the Future (MTF) survey, based on a sample of U.S. 8th, 10th and 12th grade students, revealed an increase in EVP use in the past year of 20.1%, 35.7%, and 40.6%, respectively (National Institute on Drug Abuse, 2019) (from 7.5%, 15.8%, and 18.8%, respectively, in 2017) (Johnston et al., 2018), the largest year-over-year increase in the use of any substance assessed by MTF (National Institute on Drug Abuse, 2019). Further, MTF findings show that EVP use is now more common among high-school students than any other individual illicit drug use or tobacco products (Miech et al., 2019).

The 2019 MTF also reported a decrease in tobacco product use from

methods other than vaping (e.g., large and small cigars, hookah, or smokeless tobacco), suggesting a shift in the tobacco product landscape, with similar findings from NYTS (Wang et al., 2019; Miech et al., 2019). However, a recent meta-analysis found that adolescent and young adult EVP users were more than three times as likely to become cigarette smokers at follow-up when compared to those who had never used EVP (Soneji et al., 2017). These results were supported by a recent longitudinal study of over 1500 adults 18–30 years old in the US, which found that e-cigarette use at baseline was associated with initiation of cigarette smoking at 18 months follow-up (odds ratio: 6.8) (Primack et al., 2018).

Nicotine exposure during adolescence can cause addiction and can harm the developing adolescent brain (U.S. Department of Health and Human Services, 2016). The health consequences of EVP use extend beyond the potential initiation of cigarette use, including exposure to harmful and potentially harmful ingredients (Gaur and Agnihotri, 2019). Among youth, symptoms of dependence are increased in multiple tobacco product users, including dual users of e-cigarettes and cigarettes, compared to single product users (Apelberg et al., 2014). Furthermore, use of e-cigarettes and cigarettes are the most common combinations of more than two tobacco products' use among high

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school students (Gentzke et al., 2019). In this report, using population-based data of high-school students in the state of Georgia, we provide an analysis of trends in exclusive EVP use, exclusive cigarette use, and dual use of cigarettes and EVPs. This information can further inform policy in addressing e-cigarette use among adolescents (Warner, 2014).

2. Methods

2.1. Data

We used a repeated, annual cross-sectional design of high school students' self-reported responses from the *Georgia Student Health Survey 2.0* (GSHS 2.0) data for 2015 through 2018 (Georgia Department of Education, 2020). GSHS 2.0 is an annual, anonymous, self-reported, web- and population-based survey developed by the Georgia Department of Education for public schools (and private schools that wish to participate) in Georgia for the School Climate Star Rating program (<https://www.gadoe.org/schoolsafetyclimate/Pages/School-Climate-Star-Rating.aspx>) and at least 75% of students (in grades 6–12) completed the survey. The survey is administered every school year from October through February. Therefore, data for each calendar year (e.g., 2017) spans the last quarter of the previous year (i.e., 2016) to the first quarter of the survey year. The data were obtained from the Department of Education as open records with redacted race and ethnicity. A total of 1,405,108 high school students participated in the survey across all four years.

2.2. Measures

The EVP use question is a recent addition to GSHS 2.0; therefore, this analysis is limited to student responses for the four separate survey administrations that occurred each school year between 2015 and 2018. In the GSHS 2.0, students were asked, "During the past 30 days, on how many days did you smoke cigarettes?" and "During the past 30 days, on how many days did you smoke an electronic vapor product (such as JUUL, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, or hookah pens)?" The responses were included in analyses as continuous measures for the mean and median number of days of use (1 day or more) and as binary measures for current use in the past 30 days. We classified current users into three mutually exclusive categories: exclusive cigarette users, exclusive EVP users, and dual users of both EVPs and cigarettes. We also created non-mutually exclusive any use categories as any cigarette use, any EVP use, and EVP or cigarette use.

2.3. Analysis

Wilcoxon tests and t-tests were used to assess statistical differences in the average measures of number of days of use between adjacent years within each category of use. We also included analysis of the median number of days because the distribution was U-shaped (large numbers reporting < 5 days and > 25 days). Prevalence of current use of each product category was computed along with 95% confidence intervals. Pearson's chi-square test was used to assess differences in proportion of using a product between adjacent years. Statistical significance was reported at p -value < 0.05. All data management and analyses were completed in R (<https://www.r-project.org/about.html>).

3. Results

The percentage of Georgia high school students defined as exclusive EVP users and dual users decreased from 2015 to 2017 (p < 0.001); by year, prevalence of EVP users was 7.9% (2015), 5.8% (2016), and that of dual users was 4.2% (2017), 3.2% (2015), 2.3% (2016), and 1.6% (2017) (Table 1). However, during 2017–2018, the percentage of students in these two categories increased to 6.9% and 3.7%, respectively, (p < 0.001) in 2018. Unlike EVP use, the percentage of students

Table 1
Percentage of Georgia High School Students^a (95% Confidence Interval) Reporting Electronic Vapor Product (EVP) and/or Cigarette Use, Georgia Student Health Survey 2.0 (GSHS 2.0), 2015–2018.

	2015	2016	2017	2018
Number of respondents ^b	326,345	354,732	361,500	362,531
Exclusive EVP users	7.9 (7.9, 8.0)	5.8 (5.7, 5.8)	4.2 (4.2, 4.3)	6.9 (6.9, 7.0)
p -value ^c		< 0.001	< 0.001	< 0.001
Exclusive cigarette users	2.0 (2.0, 2.1)	1.6 (1.6, 1.7)	1.5 (1.5, 1.6)	1.0 (1.0, 1.0)
p -value ^c		< 0.001	< 0.001	< 0.001
Dual (EVP and cigarette) users	3.2 (3.2, 3.3)	2.3 (2.2, 2.3)	1.6 (1.6, 1.7)	3.7 (3.7, 3.8)
p -value ^c		< 0.001	< 0.001	< 0.001
Any EVP use ^d	11.2 (11.0, 11.3)	8.0 (7.9, 8.1)	5.8 (5.8, 5.9)	10.6 (10.5, 10.7)
p -value ^c		< 0.001	< 0.001	< 0.001
Any cigarette use ^e	5.2 (5.1, 5.3)	3.9 (3.8, 4.0)	3.1 (3.1, 3.2)	4.7 (4.6, 4.8)
p -value ^c		< 0.001	< 0.001	< 0.001
Any EVP or cigarette use	13.2 (13.0, 13.3)	9.7 (9.6, 9.8)	7.4 (7.3, 7.5)	11.6 (11.5, 11.7)
p -value ^c		< 0.001	< 0.001	< 0.001

^a The percentage of students are based on those reporting at least 1 day of use in the past 30 days.

^b Response rate is at least 75% as required for reporting of the GSHS 2.0 survey.

^c p -values are from test of proportions between adjacent years.

^d Any EVP use is the sum of exclusive EVP and dual users.

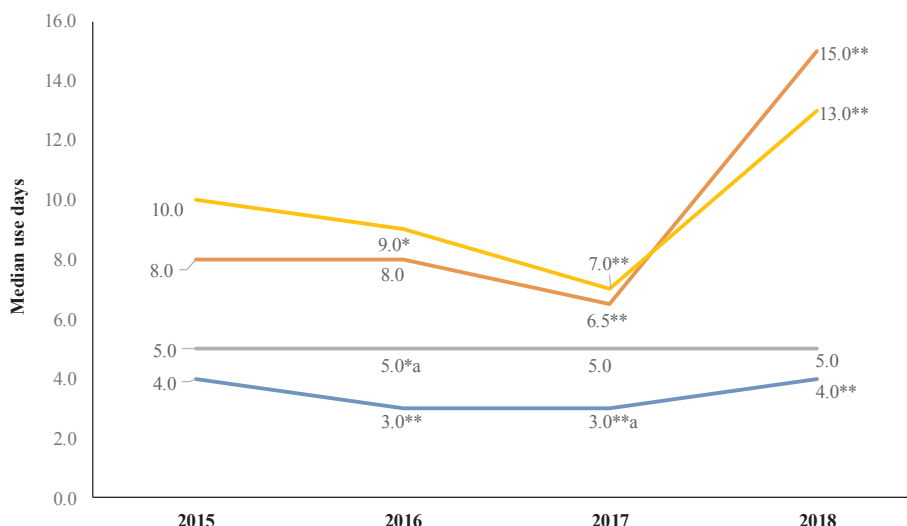
^e Any cigarette use is the sum of exclusive cigarette users and dual users.

classified as exclusive cigarette users steadily declined during the entire study period, from 2% in 2015 to 1% in 2018. However, the percentage of students reporting any cigarette use increased from 3.1% in 2017 to 4.7% in 2018 (p < 0.001) (Table 1).

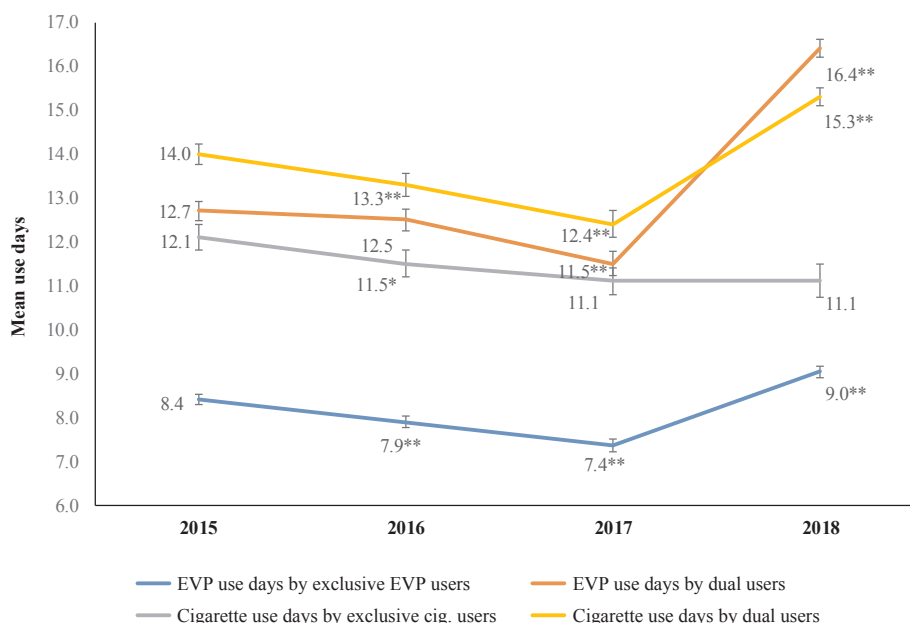
The mean and median numbers of days of EVP use days decreased by about one day from 2015 to 2017 for students classified as exclusive EVP users and dual users (Fig. 1). However, the mean and median number of days of EVP use increased (p < 0.001) for both groups in 2018, to 9.0 and 4.0 days for exclusive EVP users and 16.4 and 15.0 days for dual users. The mean and median increase of EVP use by dual users were 4.9 and 8.5 days, from 11.5 and 6.5 days to 16.4 and 15.0 days, respectively (p < 0.001). The increase in mean number of days of EVP use for exclusive EVP users was about 2.0 days, from 7.4 and to 9.0 days (p < 0.001), and the increase in median number of days of EVP use was about 1 day, from 3 to 4 days (p < 0.001). There also was an increase in mean and median cigarette use days by dual users from 12.4 and 7.0 days in 2017 to 15.3 and 13.0 days in 2018 (p < 0.001), after a decrease during 2015–2017 (Fig. 1).

4. Discussion

In this study, we found an increase in self-reported dual use of EVP and cigarettes among high school students in Georgia. The percentage of dual and exclusive EVP users increased during 2017–2018, following a decrease during 2015–2017. In 2018, both the prevalence and frequency of EVP use among exclusive EVP users and dual users increased during 2017–2018. The estimated prevalence of any EVP use in 2017 was lower in this study compared with reports based on the 2017 Georgia Youth Tobacco Survey (12.7%) (Chung and Bayakly, 2018). In addition to differences in data collection methods, this variation could be due to differences in the survey period. For this study, data was collected during the 2016–2017 school year, while data for Georgia YTS was collected in 2017. However, these findings are consistent with recently reported national trends in EVP use (Wang et al., 2019; National Institute on Drug Abuse, 2019).



(a) Median use days by user type, 2015-2018



(b) Mean use days by user type, 2015-2018

Fig. 1. Median (a) and mean (b) number of days of electronic vapor product (EVP) and cigarette use by exclusive and dual users, Georgia high school students, Georgia Student Health Survey 2.0, 2015–2018. The averages are based on those reporting at least 1 day of use in the past 30 days: n = 25,921, 6539, and 10,460 exclusive EVP, exclusive cigarette and dual users respectively in 2015; n = 20,447, 5817, and 8027 respectively in 2016; n = 15,259, 5546, and 5836 respectively in 2017; and n = 25,115, 3549, and 13,447 respectively in 2018. ***p*-value < 0.001, **p*-value < 0.05, *p*-values for mean and medians are based on *t*-test and Wilcoxon test.

This study also assessed the average number of days per month that Georgia high school students engaged in EVP and cigarette use for both exclusive and dual users. Based on these measures, average numbers of days of EVP use increased during 2017–2018 among exclusive and dual EVP users. In addition to an increase in EVP use, the number of days of cigarette use also significantly increased during 2017–2018 among dual users of EVP and cigarettes, effectively erasing the decline that occurred during 2015–2017.

This study has some limitations. First, because the survey was optional for private schools, the participation from private schools could be small, so the results may not be representative of all high school students in Georgia. Second, our measures did not allow for distinguishing experimenters from regular users. Third, this study only

includes two forms of tobacco products, cigarettes and EVP, and does not include other tobacco products like cigars, hookah, or smokeless tobacco. However, the use of these products is decreasing among high school students nationally (National Institute on Drug Abuse, 2019).

In response to recent increases nationally (Layden et al., 2019; U.S. Department of Health and Human Services, 2016; King et al., 2020), the U.S. Surgeon General has declared e-cigarette use among youth an epidemic (Office of the Surgeon General, 2020). Continued monitoring of trends and patterns of EVP use and the use of both EVP and cigarettes is important to inform national and sub-national efforts to prevent and reduce the use of these products among U.S. youth. Further, we found that exclusive cigarette use was decreasing. In contrast, dual use and any use of cigarettes and EVP were increasing. A longitudinal study

assessing the association between the use of cigarettes and EVP products is warranted. Research is also warranted on the patterns of cigarette and EVP use among exclusive and dual use among high school students, particularly by sociodemographic factors such as sex, race/ethnicity, geography, and socioeconomic status.

5. Public health implications

The percentage of Georgia high school students who are dual users of EVPs and cigarettes increased during 2017–2018. Furthermore, among dual users of EVP and cigarettes, a significant increase in the numbers of days of cigarette use was observed. Taken together, these findings reinforce the importance of evidence-based public health strategies to prevent and reduce the use of these products among youth. Such strategies include smoke-free indoor air policies that include e-cigarettes, restricting access of young people to e-cigarettes in retail settings, licensing retailers, implementing price policies, developing educational initiatives targeting young people, curbing e-cigarette advertising and marketing that are appealing to young people, and reducing access to flavored tobacco products by young people (U.S. Department of Health and Human Services, 2020).

CRedit authorship contribution statement

Justin B. Ingels: Writing - original draft. **Kiran Thapa:** Writing - original draft. **Sundar Shrestha:** Writing - original draft. **Janani Rajbhandari-Thapa:** Writing - original draft.

Disclaimer

The findings and conclusions in this study are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention. The authors have no conflict of interest.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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