

Trends in E-Cigarette, Cigarette, Cigar, and Smokeless Tobacco Use Among US Adolescent Cohorts, 2014–2018

Rebecca Evans-Polce, PhD, Phil Veliz, PhD, Carol J. Boyd, PhD, MSN, Vita V. McCabe, MD, MHSA, and Sean Esteban McCabe, PhD, MSW

Objectives. To examine changes in age of initiation of e-cigarette, cigarette, cigar, and smokeless tobacco use among adolescents in the United States.

Methods. We used data from 5 cohorts of the National Youth Tobacco Survey (2014–2018; n = 26 662).

Results. In 2014, 8.8% of lifetime e-cigarette users initiated use at 14 years or younger, as compared with 28.6% of lifetime e-cigarette users in 2018. There was no such change in initiation ages for cigarettes, cigars, and smokeless tobacco among lifetime users of each of these products.

Conclusions. US adolescents are initiating e-cigarette use at younger ages in recent years. This is concerning given the association of e-cigarette use with subsequent cigarette use. Continued surveillance of these trends and additional prospective research are needed. Tobacco prevention programs, policies, and regulations that make it more difficult for youths to obtain e-cigarettes are warranted. (*Am J Public Health.* 2020;110:163–165. doi:10.2105/AJPH.2019.305421)

E-cigarette use has increased among adolescents in the United States over the past decade, with more than 1 in every 10 US high school students reporting past-month use.^{1,2} Data from 2014 demonstrate e-cigarette initiation beginning as early as 7 years, with a mean age of 17.5 years.³ Despite this concerning increase in e-cigarette use since the introduction of e-cigarettes to the US market in the mid-2000s,⁴ there remains a gap in knowledge regarding whether age at initiation of e-cigarette use is changing.

The literature demonstrates the risks associated with early initiation of cigarettes, including later dependence, difficulty quitting, risk for other substance use,^{5–7} and physical health risks including lung damage.⁸ Less research to date has focused on age at initiation of e-cigarette use. One study showed that early use was associated with an increased risk of subsequent cigarette use.⁹

Although the increasing prevalence of e-cigarette use is well documented, no studies to our knowledge have examined whether age at initiation of e-cigarette use has changed across time and how changes in initiation of

e-cigarettes compares with changes in initiation of other tobacco products. The purpose of this study was to examine trends in age of initiation of e-cigarettes across 5 cohorts and how these trends compare with those observed for other tobacco products in a large, nationally representative sample of young people in the United States.

METHODS

The National Youth Tobacco Survey (NYTS) annually surveys a cross-sectional, nationally representative sample of middle school and high school students (6th–12th grade) in public and private schools in the United States. The NYTS involves a multi-stage sampling procedure at the county,

school, and student levels. The average response rate for the survey is 76.2%.¹⁰

Our study focused on youths 16 and 17 years of age to (1) provide for the possibility of e-cigarette initiation beginning at 12 years old and earlier (e-cigarettes emerged in the US market when the 2014 cohort of 16- and 17-year-old youths would have been 11 and 12 years old⁴) and (2) allow all in the sample to have had the opportunity to initiate e-cigarettes through the ages of 16 and 17 years. A total of 26 662 youths 16 and 17 years old participated in the NYTS between 2014 and 2018. Each trend analysis was restricted to those reporting lifetime use of the relevant tobacco product (8918 e-cigarette users, 7936 cigarette users, 6639 cigar users, 2946 smokeless tobacco users). The sample was 49.9% male and 67.1% White, and was evenly split between youths 16 (51.5%) and 17 (48.5%) years old. Given that age at first e-cigarette use was introduced to the NYTS in 2014, we used this year as the starting point for assessing trends.

As a means of assessing age at first e-cigarette, cigarette, cigar, and smokeless tobacco use, respondents were asked “How old were you when you first tried [an e-cigarette, cigarette smoking, cigars/cigarillos/little cigars, chewing tobacco/snuff/dip], even once or twice?” The response options ranged from 8 years or younger to 19 years or older. Age categories were recoded as 12 years or younger, 13 years, 14 years, 15 years, 16 or 17 years, and never used. The results reported here focus on those initiating use at 14 years or younger and 16 or 17 years.

ABOUT THE AUTHORS

Rebecca Evans-Polce, Phil Veliz, Carol J. Boyd, and Sean Esteban McCabe are with the Center for the Study of Drugs, Alcohol, Smoking and Health, School of Nursing, University of Michigan, Ann Arbor. Vita V. McCabe is with the Lung Care and Smoking Cessation Program, Section of Thoracic Surgery, St. Joseph Mercy, Ann Arbor.

Correspondence should be sent to Rebecca Evans-Polce, PhD, 400 N Ingalls, Ann Arbor, MI 48109 (e-mail: hjevans@umich.edu). Reprints can be ordered at <http://www.ajph.org> by clicking the “Reprints” link.

This article was accepted October 5, 2019.

doi: 10.2105/AJPH.2019.305421

We used design-based χ^2 tests to examine age at initiation among lifetime users of e-cigarettes, cigarettes, cigars, and smokeless tobacco across 5 age cohorts. The analyses included weights to account for the complex 3-stage sample design. When estimating standard errors, we used specialized variance estimation techniques to accommodate complex sample design features.¹⁰

RESULTS

Figure 1 shows ages at initiation of use among lifetime users of e-cigarettes, cigarettes, cigars, and smokeless tobacco for each of the 5 cohorts from 2014 to 2018. Among lifetime e-cigarette users, 63.0% initiated use at 16 or 17 years old in 2014, as compared with 42.7% in

2018. Conversely, 8.8% and 28.6% of lifetime e-cigarette users initiated use at 14 years or younger in 2014 and 2018, respectively. The difference in initiation of e-cigarette use between age cohorts was statistically significant ($\chi^2 = 17.46; P < .001$).

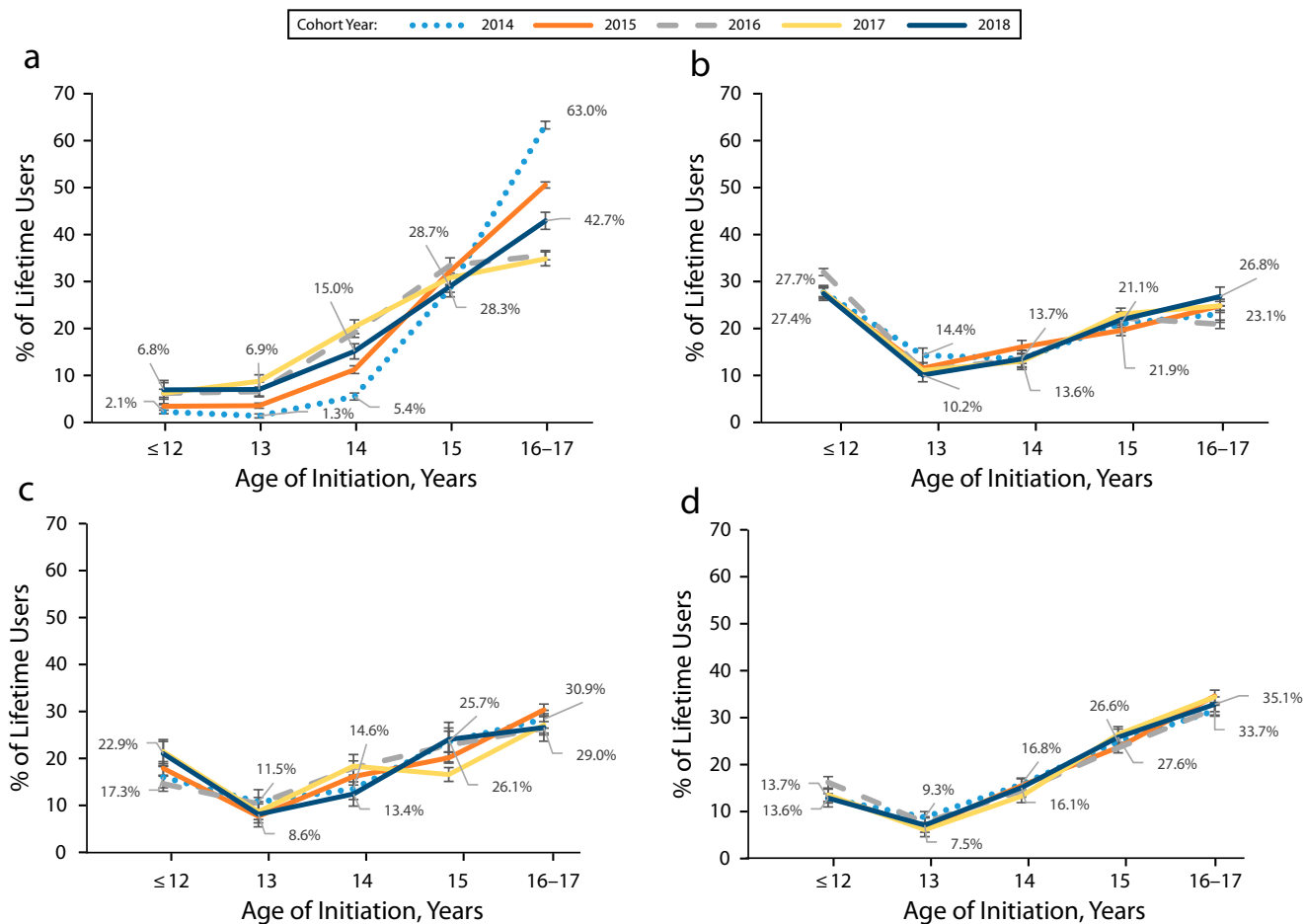
By comparison, there were no significant cohort differences in age of initiation of cigarette use ($\chi^2 = 1.62; P = .077$), cigar use ($\chi^2 = 0.985; P = .464$), or smokeless tobacco use ($\chi^2 = 1.30; P = .212$). Among lifetime cigarette users in particular, 55.8% initiated cigarette use at 14 years or younger in 2014, as compared with 51.3% in 2018.

DISCUSSION

This study examined age at initiation of e-cigarette use versus use of other tobacco

products in cohorts of 16- and 17-year-old lifetime tobacco users from 2014 to 2018. We found that age of initiation of e-cigarette use was younger among more recent cohorts. Thus, not only are more youths reporting e-cigarette use,^{1,2} but they are also beginning to use e-cigarettes at earlier ages.

Importantly, this decline in age of initiation was specific to e-cigarettes; we did not see differences for cigarettes, cigars, or smokeless tobacco products. These differing trends could reflect the longer existence of other tobacco products in the market and the consistent proportion of younger adolescents initiating use of these other products relative to e-cigarettes. Although we did not see significant cohort differences in age of initiation of other tobacco products, early initiation of cigarette use remains an endemic



Note. The overall sample size was 26 662. E-cigarette users, n = 8918; cigarette users, n = 7936; cigar users, n = 6639; smokeless tobacco users, n = 2946. Prevalence values for earliest and latest years are labeled. All analyses are weighted to adjust for the NYTS sampling design.

FIGURE 1—Age of Tobacco Use Initiation Among Current 16- to 17-Year-Old Lifetime Users by Cohort Year for (a) E-Cigarettes, (b) Cigarettes, (c) Smokeless Tobacco, and (d) Cigars: United States, National Youth Tobacco Survey (NYTS), 2014–2018

problem, with more than one quarter of cigarette users starting by 12 years of age. Data from the Monitoring the Future survey show that cigarettes are still the first product used by most tobacco (cigarette and e-cigarette) dual users, but the proportion of adolescents who begin with e-cigarettes is increasing.¹¹ Taken together, trends toward earlier initiation of e-cigarette use, e-cigarettes increasingly serving as a starter tobacco product, and increases in adolescent e-cigarette use prevalence signal a significant public health concern.

The earlier initiation of e-cigarette use in the most recent cohorts of adolescents is particularly alarming given research showing that early initiation of e-cigarettes is associated with a subsequent risk for cigarette use.⁹ Nicotine exposure earlier in development, when the brain is continuing to mature, may confer particular risk.¹² Recent reports linking e-cigarettes to respiratory illnesses add to the health concerns of early e-cigarette use (see <http://bit.ly/2mscQff> for the recent Food and Drug Administration [FDA] press release). Future research should examine how early e-cigarette use is associated with subsequent tobacco use and health risks in adulthood and whether recent federal actions enforcing regulation of flavored tobacco products will influence these trends of earlier use (see <http://bit.ly/2ksVuhI> for the FDA announcement).

This study has limitations, including a reliance on self-reported data and omission of some tobacco products (e.g., hookah products). Also, given the cross-sectional nature of the data, we relied on retrospective reports of age of initiation, introducing the potential for recall bias.

Ongoing surveillance of these initiation trends is warranted to monitor whether age at initiation continues to decrease. Given our findings, tobacco prevention programs addressing e-cigarette use may need to tailor risk communications and policy efforts to youths of younger ages to deter initiation.

PUBLIC HEALTH IMPLICATIONS

Public policies that restrict access to e-cigarettes and e-liquids and denormalize their use should be paramount priorities given

the increasing number of adolescents initiating use early. **AJPH**

CONTRIBUTORS

All of the authors made significant contributions to the article. R. Evans-Polce designed the study and wrote the first draft of the article. P. Veliz performed the statistical analysis. P. Veliz and S. E. McCabe assisted R. Evans-Polce with refining the analysis and interpreting results. P. Veliz, S. E. McCabe, C. J. Boyd, and V. V. McCabe all assisted with editing the article.

ACKNOWLEDGMENTS

This research was supported by awards from the National Cancer Institute (R01CA203809 to S. E. M.) and the National Institute on Drug Abuse (R01DA044157 to C. J. B.).

Note. The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the sponsors.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

HUMAN PARTICIPANT PROTECTION

No protocol approval was needed for this study because no human participants were involved.

REFERENCES

1. Gentzke AS, Creamer M, Cullen KA, et al. Tobacco product use among middle and high school students—United States, 2011–2018. *MMWR Morb Mortal Wkly Rep.* 2019;68(6):157–164.
2. Miech RA, Schulenberg JE, Johnston LD, Bachman JG, O'Malley PM, Patrick ME. National adolescent drug trends in 2018. Available at: <http://www.monitoringthefuture.org>. Accessed October 28, 2019.
3. Chen X, Yu B, Wang Y. Initiation of electronic cigarette use by age among youth in the US. *Am J Prev Med.* 2017;53(3):396–399.
4. *E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General.* Atlanta, GA: Centers for Disease Control and Prevention; 2018.
5. Agrawal A, Grant JD, Waldron M, et al. Risk for initiation of substance use as a function of age of onset of cigarette, alcohol and cannabis use: findings in a mid-western female twin cohort. *Prev Med.* 2006;43(2):125–128.
6. Breslau N, Fenn N, Peterson EL. Early smoking initiation and nicotine dependence in a cohort of young adults. *Drug Alcohol Depend.* 1993;33(2):129–137.
7. Breslau N, Peterson EL. Smoking cessation in young adults: age at initiation of cigarette smoking and other suspected influences. *Am J Public Health.* 1996;86(2):214–220.
8. Wiencke JK, Thurston SW, Kelsey KT, et al. Early age at smoking initiation and tobacco carcinogen DNA damage in the lung. *J Natl Cancer Inst.* 1999;91(7):614–619.
9. McCabe SE, West BT, McCabe VV. Associations between early onset of e-cigarette use and cigarette smoking and other substance use among US adolescents: a national study. *Nicotine Tob Res.* 2017;20(8):923–930.
10. *2018 National Youth Tobacco Survey: Methodology Report.* Atlanta, GA: Centers for Disease Control and Prevention; 2018.
11. Evans-Polce RJ, Veliz PT, Boyd CJ, McCabe SE. Initiation patterns and trends of e-cigarette and cigarette use among US adolescents. *J Adolesc Health.* 2019; Epub ahead of print.
12. England LJ, Bunnell RE, Pechacek TF, Tong VT, McAfee TA. Nicotine and the developing human: a neglected element in the electronic cigarette debate. *Am J Prev Med.* 2015;49(2):286–293.

Copyright of American Journal of Public Health is the property of American Public Health Association and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.