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Youth Observation of E-Cigarette Use In or Around School, 2019

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Abstract

Introduction: E-cigarette use increased dramatically among U.S. students during 2017–2019, and school plays an important role in preventing and reducing youth substance use. This study examines the prevalence and correlates of self-reported youth observation of e-cigarette use on school grounds.

Methods: Data from the 2019 National Youth Tobacco Survey (N=19,018) were analyzed to examine the prevalence and factors associated with youth observation of e-cigarette use in or around the school. Multivariable logistic regressions were performed to assess the associations between youth observation of e-cigarette use and susceptibility to initiate cigarettes or e-cigarettes. Analyses were conducted in 2020.

Results: In 2019, about 63.9% of students (16.8 million) reported noticing youth use of e-cigarettes in or around the school with bathroom or locker room as the most common location (33.2%). Female (versus male) students, high school (versus middle school) students, non-Hispanic Whites (versus other groups), former and past 30-day e-cigarette users (versus never users), students with exposure to tobacco marketing (versus none), and students living with a household member using e-cigarettes (versus not) had higher odds of reporting observation of vaping in schools. Among never tobacco users ($n=11,518$), observation of vaping in schools was associated with higher odds of being susceptible to smoking cigarettes (AOR=1.2, 95% CI=1.0, 1.3) and using e-cigarettes (AOR=1.7, 95% CI=1.6, 1.9), especially among middle school students.

Conclusions: E-cigarette use is common on school grounds, and youth observation of vaping in school may increase the risk of initiating tobacco use in the future. School vaping policy and education programs are needed to curb youth e-cigarette use.

INTRODUCTION

Although the cigarette smoking rate among youth has been declining over the last several decades,^{1,2} the prevalence of current e-cigarette use among teens increased dramatically

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during 2017–2019.^{2,3} In 2019, more than 1 in 4 students in the 12th grade and more than 1 in 5 in the 10th grade reported using e-cigarettes in the past 30 days.³ In September 2018, the U.S. Food and Drug Administration warned that youth e-cigarette use is reaching an epidemic proportion.⁴ It is critical to identify risk factors that may influence youth vaping and inform strategies to prevent and reduce youth e-cigarette use.

Recently, pod-mod style e-cigarette products, such as JUUL, are gaining popularity among teens. These products closely resemble a USB flash drive with nicotine salts and high levels of nicotine concentration.⁵ School is an essential venue for youth growth, and adolescents spend a significant amount of time studying and playing with their friends in the school environment.⁶ Anecdotal evidence suggests that many students use JUUL in school hallways, bathrooms, and even in the classrooms.⁷ A previous study also reported a large number of YouTube videos regarding “JUUL at school,” “JUUL in class,” and “JUUL in the school bathroom” as of June 2018, and the search of stealth products to conceal vaping in school continues to grow.⁸ However, the prevalence at the population level and factors associated with youth observation of vaping behaviors on school grounds remain unknown. Such knowledge will be important to develop school policies and evidence-based programs in preventing and reducing youth vaping.

Youth observation of e-cigarette use in or around the school may normalize the vaping behaviors and reduce the perceived harmfulness of e-cigarette use, thus increasing the susceptibility to initiating e-cigarette use. Furthermore, youth use of e-cigarettes may serve as a gateway to cigarette smoking, marijuana, and other substance use.^{9,10} However, no studies have examined the relationship between youth observation of e-cigarette use in the school and future tobacco use behaviors. Meanwhile, adolescents undergo multiple stages of development, with younger adolescents more likely to be influenced by peers, which could increase the risk of initiating substance use.¹¹ The author hypothesizes that there might be an interaction between youth observation of vaping in schools and the developmental stage (i.e., middle school versus high school) in association with adolescents’ susceptibility to tobacco use.

To address the gaps in knowledge, this study uses data from the 2019 National Youth Tobacco Survey (NYTS) to analyze the prevalence and correlates of youth observation of e-cigarette use in or around the school. Further, this paper reports population estimates of youth noticing vaping at specific locations on school grounds and assesses whether this observation is associated with susceptibility to smoking cigarettes or using e-cigarettes among never tobacco users.

METHODS

Study Sample

The NYTS is a cross-sectional, school-based survey conducted annually to produce a nationally representative sample of U.S. middle school (Grades 6–8) and high school (Grades 9–12) students. The 2019 NYTS was conducted using a stratified, 3-stage cluster sampling procedure and a detailed description of the 2019 NYTS survey can be found on the NYTS website.¹² In 2019, a total of 19,018 students (aged 11–18 years) from 251

schools completed the NYTS questionnaire. The school participation rate was 77.2%, and the student response rate was 85.8%, yielding an overall response rate of 66.3%.¹³ The 2019 NYTS was electronically administrated in the school classroom setting for the first time, and a previous study has demonstrated that an electronic administration of NYTS can lead to more timely and valid surveillance of youth tobacco use.¹⁴ Given the use of public data with de-identified information, this study is exempt from the University of Nebraska Medical Center IRB.

Measures

The survey participants were asked the question: *Have you ever seen anyone using an e-cigarette, such as JUUL, Vuse, MarkTen, or blu in any locations in or around your school? (Select one or more)*. Response options were in the sequence of *no; yes, inside a school bathroom or locker room; yes, inside a classroom; yes, inside some other area of the school (hallway, cafeteria); yes, outside of the school, such as in the parking lot, sidewalk, or other school grounds; and yes, somewhere else not listed here*. Those who responded affirmatively were defined with observations of e-cigarette use in or around the school.

Student e-cigarettes status was defined as never (students who reported having never tried an e-cigarette), former (students who reported having ever tried an e-cigarette but having not used it in the last 30 days), and past 30–day users (students who reported having used an e-cigarette 1 day in the past 30 days).¹⁵ Similarly, this study defined the status of cigarette smoking and other tobacco use as never, former, and past 30–day users. Other tobacco products included cigars (cigars, little cigars, and cigarillos), smokeless tobacco (chewing tobacco, snuff, dip, snus, and dissolvable tobacco), hookahs, pipe tobacco, bidis, and heated tobacco products.¹⁶

Among never tobacco users, the susceptibility to smoke cigarettes was measured on the basis of 3 NYTS questionnaire items:

1. Do you think you will try a cigarette soon?
2. Do you think you will smoke a cigarette in the next year?
3. If one of your best friends were to offer you a cigarette, would you smoke it?

Responses for these questions included: *definitely yes, probably yes, probably not, and definitely not*. The respondents who answered *definitely not* to all 3 questions were classified into the group no susceptibility to smoking cigarettes.¹⁷ A similar method was used to create a dichotomous variable for susceptibility to use e-cigarettes.

Demographic variables included sex (male or female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, or non-Hispanic others), and school level (middle or high school). As exposure to tobacco marketing and tobacco use by household members could increase the risk of tobacco use,¹⁵ these confounding variables are also included in the analysis as covariates.

Statistical Analysis

Weighted estimates along with 95% CIs of the prevalence of youth observation of vaping in or around the school were calculated, both overall and stratified by demographic characteristics and tobacco-related variables. Multivariable logistical regression was performed to examine factors (explanatory variables) associated with youth observation of vaping (dependent variable). This study further reported the prevalence and population estimates of youth vaping at separate locations, overall and by grade and e-cigarette use status. Sampling weights, survey stratum, and primary sampling units were included in the analysis to account for the complex survey design. Among never tobacco users, logistic regression models were conducted to examine the associations between youth observation of e-cigarette use in or around the school (explanatory variable) and susceptibility to smoke cigarettes and use e-cigarettes (separate dependent variables). Stratified analyses were performed by middle and high school students. AORs were calculated in the multivariable analysis to adjust for confounding effects from covariates. Statistical analyses were performed using SAS, version 9.4 and $p < 0.05$ was considered statistically significant. Analyses were conducted in 2020.

RESULTS

Table 1 depicts the sample characteristics of 2019 NYTS data, which included 48.0% female students, 55.9% high school students, 56.2% non-Hispanic Whites, 13.3% non-Hispanic Blacks, 25.0% Hispanics, 20.0% past 30-day e-cigarette users, 4.3% past 30-day cigarette smokers, and 9.4% other tobacco users. Exposure to tobacco marketing was common among adolescents with 81.7% of respondents reporting exposure to cigarette/other tobacco marketing and 69.0% reporting exposure to e-cigarette marketing. About 14.2% of students reported living with a household member who uses e-cigarettes.

The prevalence and population estimates of youth observation of e-cigarette use in specific locations are presented in Table 2. Overall, 63.9% (weighted $n=16,850,000$) of U.S. students reported observation of e-cigarette use in or around the school. Inside a school bathroom or locker room was the most common location, with 33.2% of students (8,964,000) reporting observation of someone vaping, followed by outside of the school (32.8%, 8,851,000), somewhere else not listed here (28.4%, 7,661,000), inside a classroom (21.4%, 5,792,000), and inside some other area of the school (hallway, cafeteria; 19.8%, 5,338,000). Moreover, 33.5% of students ($n=8,818,000$) reported observation of youth e-cigarette use in only 1 location in or around the school, 8.4% ($n=2,222,000$) reported on 2 locations, 6.7% ($n=1,777,000$) on 3 locations, 8.2% ($n=2,148,000$) on 4 locations, and 7.2% ($n=1,884,000$) on all 5 locations.

High school students (versus middle school students) and former or past 30-day e-cigarette users (versus never e-cigarette users) were more likely to report observation of e-cigarette use in all locations except somewhere else. They were also more likely to report observation of e-cigarette use on multiple locations in or around the school than their counterparts.

As shown in Table 3, female students were more likely than male students to report noticing vaping in or around the school (65.7% vs 62.4%, AOR=1.1, 95% CI=1.0, 1.2)

and high school students had higher odds of reporting observation of e-cigarette use in schools than middle school students (73.4% vs 52.0%, AOR=2.3, 95% CI=2.0, 2.8). Non-Hispanic Whites (versus other groups), former and past 30-day e-cigarette users (versus never users), students with exposure to tobacco marketing (versus no), and students living with a household member using e-cigarettes (versus no) were associated with higher odds of reporting observation of vaping in or around the school. For instance, 78.3% of past 30-day e-cigarette users reported seeing e-cigarette use on school grounds versus 56.7% of never e-cigarette users (AOR=1.8, 95% CI=1.5, 2.1).

Self-reported observation of youth vaping in or around the school was associated with higher odds of susceptibility to smoking cigarettes (AOR=1.2, 95% CI=1.0, 1.3, $p=0.008$) and using e-cigarettes (AOR=1.7, 95% CI=1.6, 1.9, $p<0.0001$) (Table 4). Moreover, the associations were more pronounced among middle school students than high school students. For instance, youth observation of vaping in or around the school was significantly associated with being susceptible to smoking cigarettes among middle school students (AOR=1.2, 95% CI=1.1, 1.3, $p=0.001$), but not among high school students ($p=0.53$).

DISCUSSION

This study used nationally representative data to estimate that nearly two thirds of U.S. middle and high school students reported observing e-cigarette use in or around the school in 2019. Given that students in the U.S. spend an average of 180 days in the school year and 6.64 hours in school during school days⁶ and there is a strong interplay between school environments and teen health behaviors,^{18,19} these statistics are concerning. The findings from youth observation of e-cigarette use echo with the high prevalence of e-cigarette use.^{2,3} As the newer generations of e-cigarette products often contain high concentrations of nicotine,⁵ adolescent e-cigarette users could quickly develop nicotine addiction and may have to vape in school. Furthermore, the prevalence of exposure to secondhand aerosol among U.S. youth significantly increased from 25.6% in 2017 to 33.2% in 2018.²⁰ Owing to the clustering of students in the school environment, youth vaping on school grounds could lead to exposure to secondhand aerosol among other students, including never tobacco users.²¹

The findings of this study indicate an urgent need to enforce vape-free campus policies and implement evidence-based programs to prevent and reduce youth vaping on school grounds. Some school districts have taken actions to counteract the surge in e-cigarette use in the school. For instance, some districts have installed vaping detectors or camera surveillance near restrooms, some others have tried limiting the number of students allowed in the restroom at once or assigning teachers to restroom duty for surveillance, and a few schools have even tried to remove stall doors.²² These actions are consistent with the finding that inside a school bathroom or locker room is the most common location where youth noticed vaping (33.2%). However, a large number of students also reported observation of youth vaping inside the classroom (21.4%) and inside some other areas of the school (hallway or cafeteria, 19.8%). This brings additional challenges for school educators to track youth vaping behaviors as these pod-mod style vaping products have a sleek design to look like school supplies, such as pens, highlighters, and USB drives, and provide emissions that

are hard to detect.⁵ Thus, students can take quick whiffs undetected while sitting inside the classroom or walking down the hallway. A previous study also reported that less than half of middle and high school teachers and administrators could accurately identify a photo of JUUL as a vaping device.²³ As e-cigarette products evolve quickly,²⁴ ongoing training for school personnel and parents about new generations of vaping products and their harmfulness is warranted to curb e-cigarette use in schools.

Youth have a more positive norm toward vaping than smoking.²⁵ Social norms, including friends' e-cigarette use, are strongly associated with initiation and frequent use of e-cigarettes among adolescents.²⁶ Previous studies have also shown that the school-level prevalence of vaping was significantly associated with student-level e-cigarette use.^{27,28} This study found that youth observation of vaping on school grounds was associated with significantly higher odds of being susceptible to smoking cigarettes (AOR=1.2) and using e-cigarettes (AOR=1.7). The Ecological Systems Theory²⁹ posits that youth development is influenced by factors near to adolescents such as family and friends and more distal factors such as school environments. Students who have seen vaping in or around the school may develop curiosity about vaping, perceive vaping as a school norm, and model peers to initiate e-cigarette use. Past studies have demonstrated that some influencing factors could lead to higher risks of substance initiation among younger (versus older) adolescents.^{10,30} Consistently, this study found heterogeneity in the association of youth observation of vaping and susceptibility to tobacco use by school level with more pronounced effects among middle school students than high school students. As younger adolescents (versus older) are more likely to be influenced by their peers,³¹ findings from this study highlight the importance of starting prevention efforts on vaping at an earlier age.

To the best of the author's knowledge, this is the first study to report that vaping is prevalent in or around the school, with 16.8 million U.S. middle and high school students reporting observation of vaping behaviors on school grounds in 2019. Furthermore, female (versus male) students, high school (versus middle school) students, non-Hispanic Whites (versus other groups), and past 30-day tobacco users were more likely to report the notice of youth vaping. The disparities may reflect vaping norms and clustering of e-cigarette use among these vulnerable students, and thus tailored education and messages are needed to reduce youth e-cigarette use in or around the school.

This study also identified heterogeneity in the prevalence of self-reported observation of vaping among never (57%), former (77%), and current e-cigarette users (78%). A previous study has found similar disparities in reporting exposure to e-cigarette advertising promotions with a higher prevalence among current and former e-cigarette users than never users.¹⁵ There may be several plausible explanations. First, former or current e-cigarette users are more prone to observe this potentially surreptitious behavior on school grounds because they are more familiar with e-cigarette products than never users. They may over-report the occurrence of e-cigarette use as a confirmation of vaping as indicative of their own identity. Second, never users may under-report the observation of vaping behaviors in or around the school owing to their unfamiliarity of e-cigarette devices, especially given the ease of concealment for the new generation of vaping products.⁸ Thus, caution needs to be placed in the interpretation of these self-reported data.

Recently, some institutes have started to develop evidence-based programs to address the vaping behaviors in or around the school. For instance, a pilot study of “CATCH My Breath,” an e-cigarette prevention program, has shown positive effects in improving youth knowledge on e-cigarette use and preventing e-cigarette ever use among Texas middle school students.³² The U.S. Food and Drug Administration has included e-cigarette products in the “The Real Cost” campaign to educate youth that e-cigarettes, just like cigarettes, put them at risk for addiction.³³ The Stanford Tobacco Prevention Toolkit also provides lecture-based materials on e-cigarette use.³⁴ However, the adoption and dissemination of evidence-based vaping prevention in school settings is limited. Schools also lack clear and consistent guidelines for restricting vaping behaviors. For instance, >80% of schools reported that they had an e-cigarette policy. Still, less than half indicated that their policies specifically included JUUL in a survey of 1,420 middle and high school teachers and administrators.²³ Moreover, studies have found little or no evidence on the long-term effectiveness of school-based anti-tobacco programs.³⁵ More research is needed to evaluate each of these programs and increase the reach, effectiveness, adaptation, implementation, and maintenance³⁶ of these programs to simultaneously target prevention, cessation, and denormalization of youth vaping behaviors.

Limitations

This study is subject to limitations. First, the 2019 NYTS data are cross-sectional; thus, causal inference cannot be established. Second, tobacco use behaviors were self-reported, subject to recall and social desirability biases, especially for younger respondents.³⁷ However, the test–retest reliability of self-reported behaviors related to tobacco use among adolescents is high.³⁷ Third, youth observation of e-cigarette use on school grounds was measured by the question with check-all-that-apply options, which may be biased downward in estimating the true prevalence.³⁸ Future surveys should consider using an alternative design with forced-choice questions. Finally, given that a majority of study participants were never tobacco users, they may not be able to accurately recognize an e-cigarette as a wide range of devices fall under the umbrella term “e-cigarettes.”³⁹ Furthermore, e-cigarette use in youth may be underestimated when it was assessed with the term “e-cigarette” rather than with brand names.³⁹ However, the 2019 NYTS provided brand names including JUUL, Vuse, Mark Ten, and blu in the instructions to reduce bias in estimating e-cigarette use prevalence.

CONCLUSIONS

Despite these limitations, this study demonstrated that e-cigarette use is common in or around schools, and youth observation of vaping in school may increase the risk of initiating cigarettes or e-cigarettes in the future. Evidence-based vaping programs are needed to prevent and reduce youth e-cigarette use.

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REFERENCES

1. HHS. Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General. Atlanta, GA: HHS, CDC, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2012.
2. Gentzke AS, Creamer M, Cullen KA, et al. Vital signs: tobacco product use among middle and high school students – United States, 2011–2018. *MMWR Morb Mortal Wkly Rep.* 2019;68(6):157–164. 10.15585/mmwr.mm6806e1. [PubMed: 30763302]
3. Miech R, Johnston L, O’Malley PM, Bachman JG, Patrick ME. Trends in adolescent vaping, 2017–2019. *N Engl J Med.* 2019;381:1490–1491. 10.1056/nejmc1910739. [PubMed: 31532955]
4. Food and Drug Administration. FDA Statement: Statement from FDA Commissioner Scott Gottlieb, MD, on new steps to address epidemic of youth e-cigarette use. <https://www.fda.gov/news-events/press-announcements/statement-fda-commissioner-scott-gottlieb-md-new-steps-address-epidemic-youth-e-cigarette-use>. Published September 11, 2018. Accessed August 5, 2020.
5. Barrington-Trimis JL, Leventhal AM. Adolescents’ use of “pod mod” e-cigarettes – urgent concerns. *N Engl J Med.* 2018;379(12):1099–1102. 10.1056/nejmp1805758. [PubMed: 30134127]
6. National Center for Educational Statistics. Schools and Staffing Survey (SASS): average number of hours in the school day and average number of days in the school year for public schools, by state: 2007–08. https://nces.ed.gov/surveys/sass/tables/sass0708_035_s1s.asp. Published 2010. Accessed December 31, 2019.
7. Jargon J Vaping moves from the bathroom to the classroom. *Wall Street Journal.* https://www.wsj.com/articles/vaping-moves-from-the-bathroom-to-the-classroom-11566293404?mod=ig_vaping1007. Published August 20, 2019. Accessed August 5, 2020.
8. Ramamurthi D, Chau C, Jackler RK. JUUL and other stealth vaporisers: hiding the habit from parents and teachers. *Tob Control.* 2019;28(6):610–616. 10.1136/tobaccocontrol-2018-054455.
9. National Academies of Sciences Engineering and Medicine. Public Health Consequences of E-Cigarettes. Washington, DC: The National Academies Press; 2018. 10.17226/24952.
10. Dai H, Catley D, Richter KP, Goggin K, Ellerbeck EF. Electronic cigarettes and future marijuana use: a longitudinal study. *Pediatrics.* 2018;141(5):e20173787. 10.1542/peds.2017-3787. [PubMed: 29686146]
11. Nock NL, Minnes S, Alberts JL. Neurobiology of substance use in adolescents and potential therapeutic effects of exercise for prevention and treatment of substance use disorders. *Birth Defects Res.* 2017;109(20):1711–1729. 10.1002/bdr2.1182. [PubMed: 29251846]
12. CDC. 2015 National Youth Tobacco Survey. http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/. Updated December 23, 2019. Accessed on December 28, 2016.
13. CDC Office on Smoking and Health. 2019 National Youth Tobacco Survey: Methodology Report. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. https://www.cdc.gov/tobacco/data_statistics/surveys/nyts/data/index.html. Updated December 23, 2019. Accessed August 17, 2020.
14. Hu SS, Gentzke A, Jamal A, Homa D, Neff L. Feasibility of administering an electronic version of the National Youth Tobacco Survey in a classroom setting. *Prev Chronic Dis.* 2020;17:190294. 10.5888/pcd17.190294.
15. Dai H, Hao J. Exposure to advertisements and susceptibility to electronic cigarette use among youth. *J Adolesc Health.* 2016;59(6):620–626. 10.1016/j.jadohealth.2016.06.013. [PubMed: 27528472]
16. Wang TW, Gentzke AS, Creamer MR, et al. Tobacco product use and associated factors among middle and high school students – United States, 2019. *MMWR Surveill Summ.* 2019;68(12):1–22. 10.15585/mmwr.ss6812a1.

17. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Merritt RK. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychol.* 1996;15(5):355–361. 10.1037/0278-6133.15.5.355. [PubMed: 8891714]
18. Alexander C, Piazza M, Mekos D, Valente T. Peers, schools, and adolescent cigarette smoking. *J Adolesc Health.* 2001;29(1):22–30. 10.1016/s1054-139x(01)00210-5. [PubMed: 11429302]
19. Bonell C, Parry W, Wells H, et al. The effects of the school environment on student health: a systematic review of multi-level studies. *Health Place.* 2013;21:180–191. 10.1016/j.healthplace.2012.12.001. [PubMed: 23501377]
20. Dai H Exposure to secondhand aerosol from electronic cigarettes among U.S. youth from 2015 to 2018. *JAMA Pediatr.* 2020;174(3):298–300. 10.1001/jamapediatrics.2019.5665. [PubMed: 31985771]
21. Wang TW, Marynak KL, Agaku IT, King BA. Secondhand exposure to electronic cigarette aerosol among U.S. youths. *JAMA Pediatr.* 2017;171(5):490–492. 10.1001/jamapediatrics.2016.4973. [PubMed: 28319226]
22. Initiative Truth. How are schools responding to JUUL and the youth e-cigarette epidemic? <https://truthinitiative.org/research-resources/emerging-tobacco-products/how-are-schools-responding-juul-and-youth-e-cigarette>. Published January 18, 2019. Accessed February 28, 2020.
23. Schillo BA, Cuccia AF, Patel M, et al. JUUL in school: teacher and administrator awareness and policies of e-cigarettes and JUUL in U.S. middle and high schools. *Health Promot Pract.* 2020;21(1):20–24. 10.1177/1524839919868222. [PubMed: 31530185]
24. Williams R The rise of disposable JUUL-type e-cigarette devices. *Tob Control.* In press. Online December 5, 2019. 10.1136/tobaccocontrol-2019-055379.
25. East KA, Hitchman SC, McNeill A, Thrasher JF, Hammond D. Social norms towards smoking and vaping and associations with product use among youth in England, Canada, and the U.S. *Drug Alcohol Depend.* 2019;205:107635. 10.1016/j.drugalcdep.2019.107635. [PubMed: 31765990]
26. Vogel EA, Ramo DE, Rubinstein ML. Prevalence and correlates of adolescents' e-cigarette use frequency and dependence. *Drug Alcohol Depend.* 2018;188:109–112. 10.1016/j.drugalcdep.2018.03.051. [PubMed: 29763848]
27. Lippert AM, Corsi DJ, Venchuk GE. Schools influence adolescent e-cigarette use, but when? Examining the interdependent association between school context and teen vaping over time. *J Youth Adolesc.* 2019;48(10):1899–1911. 10.1007/s10964-019-01106-y. [PubMed: 31446585]
28. Lippert AM. Association between school-level prevalence of electronic cigarette use and student-level use behaviors, pre-use intentions, and risk perceptions: evidence from the 2014 U.S. National Youth Tobacco Survey. *Nicotine Tob Res.* 2018;20(2):231–238. 10.1093/ntr/ntw395. [PubMed: 28028128]
29. Bronfenbrenner U. Ecological systems theory. In Vasta R, ed. *Six Theories of Child Development: Revised Formulations and Current Issues*. London, UK: Jessica Kingsley Publishers; 1992:187–249.
30. Taioli E, Wynder EL. Effect of the age at which smoking begins on frequency of smoking in adulthood. *N Engl J Med.* 1991;325(13):968–969. 10.1056/nejm199109263251318. [PubMed: 1881424]
31. Musher-Eizenman DR, Holub SC, Arnett M. Attitude and peer influences on adolescent substance use: the moderating effect of age, sex, and substance. *J Drug Educ.* 2003;33(1):1–23. 10.2190/yed0-bqa8-5rvx-95jb. [PubMed: 12773022]
32. Kelder SH, Mantey DS, Van Dusen D, Case K, Haas A, Springer AE. A middle school program to prevent e-cigarette use: a pilot study of “CATCH My Breath”. *Public Health Rep.* 2020;135(2):220–229. 10.1177/0033354919900887. [PubMed: 31968177]
33. Food and Drug Administration. FDA launches new campaign: “The Real Cost” youth e-cigarette prevention campaign. <https://www.fda.gov/tobacco-products/real-cost-campaign/fda-launches-new-campaign-real-cost-youth-e-cigarette-prevention-campaign>. Updated May 1, 2020. Accessed August 5, 2020.
34. Stanford Medicine. Stanford tobacco prevention toolkit. <https://med.stanford.edu/tobaccopreventiontoolkit/E-Cigs.html>. Accessed August 5, 2020.

35. Wiehe SE, Garrison MM, Christakis DA, Ebel BE, Rivara FP. A systematic review of school-based smoking prevention trials with long-term follow-up. *J Adolesc Health*. 2005;36(3):162–169. 10.1016/j.jadohealth.2004.12.003. [PubMed: 15737770]
36. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health*. 1999;89(9):1322–1327. 10.2105/ajph.89.9.1322. [PubMed: 10474547]
37. Brener ND, Billy JO, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Health*. 2003;33(6):436–457. 10.1016/s1054-139x(03)00052-1. [PubMed: 14642706]
38. Delnevo CD, Gundersen DA, Manderski MTB, Giovenco DP, Giovino GA. Importance of survey design for studying the epidemiology of emerging tobacco product use among youth. *Am J Epidemiol*. 2017;186(4):405–410. 10.1093/aje/kwx031. [PubMed: 28369184]
39. Morean ME, Camenga DR, Bold KW, et al. Querying about the use of specific e-cigarette devices may enhance accurate measurement of e-cigarette prevalence rates among high school students. *Nicotine Tob Res*. 2020;22(5):833–837. 10.1093/ntr/nty240. [PubMed: 30395344]

Table 1.

Sample Characteristics of 2019 NYTS (n=19,018)

Characteristic	n	Weighted % (95% CI) ^a
Overall	19,018	100
Sex		
Male	9,803	52.0 (50.4, 53.7)
Female	9,099	48.0 (46.3, 49.6)
School level		
Middle school	8,837	44.1 (39.8, 48.3)
High School	10,097	55.9 (51.7, 60.2)
Race/ethnicity		
NH White	9,351	56.2 (51.7, 60.7)
NH Black	2,430	13.3 (10.5, 16.2)
Hispanic	5,564	25.0 (21.8, 28.1)
Others	1,227	5.5 (4.4, 6.6)
Cigarette smoking		
Never	16,061	83.7 (81.5, 86.0)
Former	2,161	12.0 (10.4, 13.5)
Past 30 days	748	4.3 (3.4, 5.2)
E-cigarette use ^b		
Never	12,563	65.2 (63.0, 67.3)
Former	2,720	14.8 (13.5, 16.1)
Past 30 days	3,627	20.0 (18.5, 21.5)
Other tobacco use ^c		
Never	15,058	78.3 (75.9, 80.6)
Former	2,258	12.3 (10.8, 13.8)
Past 30 days	1,702	9.4 (8.3, 10.6)
Exposure to cigarette and other tobacco marketing ^d		
No	3,391	18.3 (17.2, 19.3)
1	6,392	34.8 (33.6, 36.0)
2	8,417	46.9 (45.2, 48.5)
Exposure to e-cigarette marketing ^d		
No	5,830	31.0 (29.5, 32.5)
1	4,778	25.8 (24.9, 26.8)
2	7,721	43.1 (41.8, 44.4)
Tobacco use by household members ^e		
None	11,265	59.7 (57.2, 62.2)
Cigarettes and other tobacco products ^b	4,718	26.1 (24.2, 28.0)
E-cigarettes	2,449	14.2 (13.0, 15.3)

^aWeighted percentage (95% CI) within the column.

^b Students were provided instruction that *The next several questions are about electronic cigarettes or e-cigarettes. Some brand examples include JUUL, Vuse, MarkTen, and blu. E-cigarettes are battery powered devices that usually contain a nicotine-based liquid that is vaporized and inhaled. You may also know them as e-cigs, vape-pens, e-hookahs, vapes, or mods.*

^c Other tobacco products include cigars (cigars, little cigars, and cigarillos), smokeless tobacco (chewing tobacco, snuff, dip, snus, and dissolvable tobacco), hookahs, pipe tobacco, bidis, and heated tobacco product.

^d Four dichotomous variables were created to measure the channels of exposure to advertising: the Internet, newspapers/magazines, stores, and TV/streaming services/movies, with 0 including response options of *I don't use*, *Never*, and *Rarely*, were coded as 0 (no exposure), while response options of *Sometimes*, *Most of the time*, and *Always* were coded as 1 (exposure). The number of exposures from multiple channels were further summed as exposure from 0, 1, 2 types of channels.

^e Tobacco use by other household members was defined as “none,” “e-cigarette”, and “other tobacco product use” by the question *Does anyone who lives with you now...? (CHOOSE ALL THAT APPLY)* with the following response options: *Smoke cigarettes, Smoke cigars, cigarillos, or little cigars, Use chewing tobacco, snuff, or dip, Use electronic cigarettes or e-cigarettes, Smoke tobacco from a hookah or waterpipe, Smoke pipes filled with tobacco (not waterpipes), Use snus, Use dissolvable tobacco products, Smoke bidis (small brown cigarettes wrapped in a leaf), Use heated tobacco products, and No one who lives with me now uses any form of tobacco.*

NYTS, National Youth Tobacco Survey; NH, non-Hispanic.

Table 2.

Distribution of Youth Observation of E-cigarette Use in or Around School, NYTS, 2019 (n=19,018)

Observations	n	Overall		School level ^b		P-value ^c	E-cigarette use status, weighted % (95% CI) ^b			P-value ^c
		Weighted % (95% CI)	Weighted n (thousands) ^a	Middle school, weighted % (95% CI)	High school, weighted % (95% CI)		Never use, weighted % (95% CI)	Former use, weighted % (95% CI)	Past 30-day use, weighted % (95% CI)	
Venue										
Inside a school bathroom or locker room	6,071	33.2 (30.9, 35.5)	8,964	17.9 (15.8, 20.0)	45.3 (42.0, 48.7)	<0.0001	25.8 (23.6, 27.9)	48.1 (44.6, 51.7)	46.7 (43.6, 49.8)	<0.0001
Inside a classroom	3,834	21.4 (19.4, 23.5)	5,792	8.8 (7.2, 10.5)	31.4 (28.4, 34.5)	<0.0001	15.1 (13.4, 16.8)	33.1 (29.5, 36.6)	34.0 (31.0, 36.9)	<0.0001
Inside some other area of the school (e.g., hallway, cafeteria)	3,523	19.8 (18.0, 21.6)	5,338	8.5 (7.2, 9.8)	28.7 (26.0, 31.5)	<0.0001	14.4 (12.7, 16.0)	29.8 (26.3, 33.3)	30.2 (27.6, 32.9)	<0.0001
Outside of the school ^d	6,017	32.8 (30.6, 34.9)	8,851	20.5 (18.7, 22.4)	42.5 (39.6, 45.4)	<0.0001	26.4 (24.3, 28.5)	45.8 (42.7, 49.0)	44.4 (41.6, 47.2)	<0.0001
Somewhere else not listed here	5,266	28.4 (27.2, 29.5)	7,661	29.5 (27.7, 31.2)	27.5 (26.0, 29.0)	0.0877	27.5 (26.2, 28.7)	33.7 (31.5, 36.0)	27.7 (25.7, 29.7)	<0.0001
Number of locations										
0	6,942	36.1 (34.1, 38.1)	9,502	48.0 (45.3, 50.7)	26.6 (24.1, 29.0)	<0.0001	43.3 (41.2, 45.5)	22.8 (20.4, 25.2)	21.7 (19.2, 24.2)	<0.0001
1	6,214	33.5 (32.4, 34.6)	8,818	34.5 (32.8, 36.2)	32.7 (31.2, 34.1)		33.0 (31.8, 34.2)	32.8 (30.1, 35.5)	35.5 (33.5, 37.5)	
2	1,554	8.4 (7.9, 8.9)	2,222	7.7 (7.0, 8.4)	9.0 (8.2, 9.8)		7.9 (7.2, 8.5)	9.8 (8.3, 11.3)	9.2 (8.2, 10.3)	
3	1,189	6.7 (6.1, 7.4)	1,777	4.2 (3.6, 4.9)	8.8 (7.8, 9.7)		5.8 (5.2, 6.4)	9.7 (8.0, 11.4)	7.7 (6.5, 8.9)	
4	1,448	8.2 (7.2, 9.1)	2,148	3.0 (2.3, 3.7)	12.3 (10.9, 13.6)		5.2 (4.4, 5.9)	11.8 (10.1, 13.5)	15.4 (13.8, 17.1)	
5	1,206	7.2 (6.2, 8.1)	1,884	2.5 (2.0, 3.1)	10.8 (9.2, 12.3)		4.8 (4.1, 5.6)	13.1 (10.3, 16.0)	10.4 (8.9, 11.8)	

Notes: Boldface indicates statistical significance ($p < 0.05$).

^aWeighted n based on the weighted total population estimate of 27,011,216 U.S. middle and high school students.

^bWeighted percentage (95% CI) within the column.

^cRao-Scott χ^2 tests were performed to compare the prevalence by school level and e-cigarette use status.

^dOutside of the school, such as in the parking lot, on sidewalk, or on other school grounds.

NYTS, National Youth Tobacco Survey.

Table 3.

Factors Associated with Youth Observation of E-cigarette Use in or Around School, NYTS, 2019 (n=19,018)

Factor	Youth observation of e-cigarette use in or around school		
	% (95% CI) ^a	AOR (95% CI) ^b	p-value ^b
Overall	63.9 (61.9, 65.9)	—	—
Sex			
Male	62.4 (60.2, 64.6)	ref	—
Female	65.7 (63.5, 68.0)	1.1 (1.0, 1.2)	0.005
Grade			
Middle school	52.0 (49.3, 54.7)	ref	—
High school	73.4 (71.0, 75.9)	2.3 (2.0, 2.8)	<0.0001
Race/ethnicity			
NH White	67.9 (65.8, 69.9)	ref	—
NH Black	54.7 (50.3, 59.1)	0.6 (0.5, 0.8)	0.0001
Hispanic	62.5 (59.8, 65.2)	0.9 (0.8, 1.0)	0.0499
Others	58.1 (52.9, 63.4)	0.8 (0.7, 1.0)	0.0124
E-cigarette use			
Never	56.7 (54.5, 58.8)	ref	—
Former	77.2 (74.8, 79.6)	1.9 (1.6, 2.2)	<0.0001
Past 30 days	78.3 (75.8, 80.8)	1.8 (1.5, 2.1)	<0.0001
Exposure to cigarette and other tobacco marketing			
No	49.4 (46.3, 52.4)	ref	—
1	64.2 (61.8, 66.6)	1.4 (1.3, 1.7)	<0.0001
2	69.8 (67.9, 71.7)	1.5 (1.3, 1.7)	<0.0001
Exposure to e-cigarette marketing			
No	49.1 (46.4, 51.8)	ref	—
1	65.2 (62.8, 67.7)	1.5 (1.4, 1.8)	<0.0001
2	73.9 (71.9, 75.9)	2.1 (1.8, 2.4)	<0.0001
Tobacco use by household members			
None	60.4 (58.1, 62.7)	ref	—
Other tobacco products	65.1 (62.4, 67.7)	1.1 (0.9, 1.2)	0.3845
E-cigarettes	78.2 (75.6, 80.9)	1.6 (1.4, 1.9)	<0.0001

Notes: Boldface indicates statistical significance ($p < 0.05$).

^aWeighted percentage (95% CI) within the column.

^bIn multivariable logistic regression, youth observation of e-cigarette use in or around the school (yes versus no) was the dependent variable, and all factors listed in the first column were explanatory variables.

NYTS, National Youth Tobacco Survey; NH, non-Hispanic.

Table 4.

Association Between Youth Observation of E-cigarette Use in or Around School and Susceptibility to Use Cigarettes and E-cigarettes Among Never Tobacco Users, NYTS, 2019 (n=11,518)

Observation of e-cigarette use in or around School by grade	Susceptible to e-cigarette use			Susceptible to cigarette smoking		
	Weighted % (95% CI)	AOR (95% CI) ^a	P-value	Weighted % (95% CI)	AOR (95% CI) ^a	P-value
Overall						
No	26.5 (24.9, 28.1)			24.1 (22.4, 25.8)		
Yes	39.5 (38.0, 41.0)	1.7(1.6, 1.9)	<0.0001	26.7 (25.3, 28.1)	1.2 (1.0, 1.3)	0.008
Middle school ^b						
No	26.9 (25.0, 28.8)			24.7 (22.6, 26.8)		
Yes	43.8 (41.2, 46.4)	1.8 (1.6, 2.1)	<0.0001	31.8 (29.5, 34.1)	1.2 (1.1, 1.4)	0.001
High school ^b						
No	25.7 (22.8, 28.7)			22.7 (19.8, 25.7)		
Yes	35.8 (33.7, 37.9)	1.6 (1.3, 1.9)	<0.0001	22.3 (20.8, 23.9)	0.9 (0.8, 1.1)	0.53
Interaction ^c		1.2 (1.0, 1.5)	0.11		1.3 (1.1, 1.7)	0.02

Notes: Boldface indicates statistical significance ($p < 0.05$).

^aMultivariable regression models were performed to assess the association between youth observation of e-cigarette use (predictive variable) and susceptibility to tobacco use (dependent variable) among non-tobacco users. Covariates include sex, race/ethnicity, school level, exposure to cigarette and other tobacco marketing, exposure to e-cigarette marketing, and tobacco use by household members.

^bSeparate analyses were performed on two susceptibility variables (e-cigarette use and cigarette smoking) for all students and were further stratified by middle and high school students.

^cThe results of interaction analysis indicate that, as compared to high schools, middle schools have higher odds of initiating cigarette smoking for students who had observation (versus none) of e-cigarette use.

NYTS, National Youth Tobacco Survey.