Published in final edited form as:

Addict Behav. 2020 November ; 110: 106516. doi:10.1016/j.addbeh.2020.106516.

E-cigarette Devices Used on School Grounds

Asti Jackson, PhD¹, Grace Kong, PhD¹, Ran Wu, MS¹, Meghan E. Morean, PhD^{1,2}, Danielle R. Davis, PhD¹, Deepa R. Camenga, MD³, Dana A. Cavallo, PhD¹, Krysten W. Bold, PhD¹, Patricia Simon, PhD¹, Suchitra Krishnan-Sarin, PhD¹

¹Department of Psychiatry, Yale School of Medicine, CMHC, 34 Park Street, New Haven, CT 06519, USA

²Department of Psychology, Oberlin College, 120 W. Lorain St., Oberlin, OH 44074, USA

³Department of Emergency Medicine, Yale School of Medicine, 464 Congress Ave, Ste 260 New Haven, CT, 06514, USA

Abstract

Introduction—Preliminary evidence suggests adolescents use e-cigarettes in school. However, little is known about the types of devices that are used in schools, where they are used, and who uses them. Knowledge about these issues is critical to inform school regulations.

Methods—Cross-sectional surveys were conducted in 6 Connecticut high schools in 2019. Adolescents reported on current use (past 30-day use) of the following e-cigarette devices in school: JUUL, any pod system other than JUUL, vape pens, disposables, mods, and on device use in different locations: class, bathroom, hallways, outside on school grounds, and other school locations. Separate binary logistic regressions investigated predictors of use (demographics and past month use frequency of each device) in school for each device.

Results—Overall, 45.0% of current users (N=1447) used e-cigarettes at school. Among users of each device, prevalence of current use at school varied by device with 45.7% reporting JUUL use, 41.3% other pod use, 34.6% vape pen use, 38.3% disposables use and 27.3% mod use. Current users used devices in bathrooms (75.1%), followed by outside on school grounds (52.2%), classrooms (45.7%), hallways (38.8%) and other school locations (11.7%). Greater e-cigarette past month use frequency for each device was associated with device use in school.

Address correspondence to: Asti Jackson, Department of Psychiatry, Yale School of Medicine, Connecticut Mental Health Center, Office S- 212, 34 Park Street, New Haven, CT 06519. asti.jackson@yale.edu.

Contributors' Statements:

Dr. Jackson conceptualized the current study, survey development, contributed to data analysis and interpretation of data, wrote the first draft and reviewed and revised the manuscript. Ms. Wu conducted data analysis, contributed to interpretation of data and helped with the initial first draft of manuscript. Drs. Kong, Camenga, Cavallo, Davis, Morean, Simon, Bold and Krishnan-Sarin contributed to the conceptualization of the current study, survey item development, interpretation of data, and critical editing of the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for aspects of the work.

Conflicts of Interest: The authors have no conflicts of interest relevant to this article to disclose.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusions—This study is the first to examine use of specific e-cigarette devices in schools and demonstrates that e-cigarette use frequency predicts school use. Despite rules against vaping, e-cigarette use remains prevalent in many school locations, suggesting alternative strategies such as prevention and e-cigarette education are needed.

Keywords

JUUL; vaping; e-cigarettes; adolescents; school use

1. Introduction

E-cigarettes are used at an alarming rate among youth (Cullen et al., 2019; Gentzke et al., 2019), and youth use various kinds of e-cigarette devices (Hammond et al., 2018; Krishnan-Sarin et al., 2019). Of concern, studies examining Twitter posts (Allem et al., 2018) and YouTube videos (Ramamurthi et al., 2018) suggest that adolescents use JUUL, a popular e-cigarette brand, in school. Recent evidence suggests that the ability to conceal JUUL from teachers is one of the top reasons why high school youth like these devices (Kong et al., 2019). However, it is currently unknown if other e-cigarette devices (e.g. vape pens, mods, disposables) are also used in schools. Additionally, it is unclear in which school locations specific types of e-cigarette devices are used. Examining use prevalence and locations by device type is important given that e-cigarette devices have varied product characteristics (e.g., shape, size, amount of vapor produced) (Eaton et al., 2018), which may facilitate or deter their use in more public school locations such as classrooms versus more discreet locations like bathrooms. Further, this information could also help with the development and enforcement of school rules around use of e-cigarettes. The aims of the current study were to examine use prevalence and predictors of use of different e-cigarette devices in school including (1) JUUL, (2) any pod system other than JUUL, (3) vape pens, (4) disposables and (5) mods. We also examined specific locations within the school where e-cigarette devices were used.

2. Methods

2.1. Participants and procedures

In Spring 2019, students from 6 Connecticut high schools (N=4875) completed twenty-minute, anonymous, tablet-based surveys assessing tobacco product use. Six schools were selected from different District Reference Groups, which classifies Connecticut school districts based on family income levels, parental education and occupation levels, and use of non-English language in the home (Connecticut School Finance Project, 2016). The surveys were administered during health or English classes. Two weeks prior to administering the survey, information sheets describing the study's purpose and procedures were mailed to parents/guardians, who were instructed to contact the school if they did not want their child to participate (n =3). Prior to survey administration, research staff informed students that participation was voluntary and anonymous, and survey completion was considered assent/consent. Students received a stylus for participating in the survey. The Yale School of Medicine Institutional Review Board and the participating high schools approved the study.

2.2. Measures

2.2.1. Demographics—Age (13–19), sex (male or female), race/ethnicity (coded as non-Hispanic White, non-Hispanic Black, Hispanic and non-Hispanic Other), and socioeconomic status (SES) [(measured using the 4-item Family Affluence Scale (Boyce et al., 2006) with sum scores segmented into tertiles: low, medium, high (Boyce et al., 2006; Currie et al., 2008))] were assessed.

2.2.2. Current Users of Each E-cigarette Device—Participants were asked: “Approximately how many days out of the past 30 days did you vape?” (response options: 0–30?days). Participants who vaped on 1 day were considered current e-cigarette users. A picture was provided for each e-cigarette device along with a descriptor: 1) “JUUL (Rechargeable with USB charger, has pods that insert in device)”, 2) “Any pod system other than a JUUL, such as a Phix or Suorin (Rechargeable; has pods that insert in device)”, 3) “Vape-Pen or EGO (Has a battery and a tank for e-liquids)”, 4) “Disposable, Cig-a-like or E-hookah (shaped like a cigarette, disposables can be used one time, cig-a-likes have a rechargeable battery and can be used many times)”, and 5) “Mods or Advanced Personal Vaporizers (Highly customizable, has customized battery and tank)”. Participants were asked: “Which of the following products have you EVER TRIED? [For each product, please select either no (I have never tried the product) or yes (I have tried the product)]. For each device that a participant tried they were asked: “Approximately how many days out of the PAST 30 DAYS did you use the device?” (response options: 0–30 days). Students who indicated they had used a device on 1 day were classified as current users of that device.

2.2.3. Current E-cigarette Device Use in School—Current users of each e-cigarette device type were asked: “In the PAST 30 DAYS, did you use a [insert e-cigarette device] at school?” (response options: no, yes).

2.2.4. School Locations of E-cigarette Device Use—Students who indicated current e-cigarette device(s) use in school were asked: “In the PAST 30 DAYS, where did you use a [insert e-cigarette device] while at school?” [select all that apply: in class, in the bathroom, in the hallway or stairwell, outside but on school grounds (behind a building, on a sports field, in the parking lot), and other (open-ended)].

2.3. Statistical Analysis

Descriptive statistics of current e-cigarette users (N=1447; 29.7% of the total sample) were used to examine frequencies of use of each e-cigarette device. Among current users of each e-cigarette device, prevalence of using each device in school were examined. Among those who indicated device use at school, prevalence of use in specific school locations for each device were examined. Of the 650 (45.0% of current e-cigarette users) who used e-cigarette devices in school, we computed the percentages of use in school locations. Five separate binary logistic regressions (one per e-cigarette device type) were used to investigate which factors [i.e., demographics (age, race, sex, SES) and past month use frequency of each e-cigarette device] were associated with current use of that device in school. The analytic sample for each binary logistic regression comprised current users of each e-cigarette device. School was also added in the models as a covariate. Bonferroni post-hoc testing was utilized

to account for multiple comparisons. $p < 0.01$ signified significance. All analyses were conducted using SPSS version 26.

3. Results

3.1. Current E-cigarette Device Use in School

Current e-cigarette users (N=1447) were 55.1% male, 50.1% non-Hispanic White, 6.4% non-Hispanic Black, 29.1% Hispanic and 14.1% non-Hispanic Other with a mean age of 16.2 (SD=1.29). The prevalence of current use of the various devices was - JUUL: 82.7% (N=1196), Other pods: 36.6% (N=530); Vape pens: 45.0% (N=651), Disposables: 21.4% (N=308), Mods: 20.5% (N=296). Across all devices, 45% (N=650) of current e-cigarette users used an e-cigarette device at school. Among users of each device, 45.7% (N=547) of current JUUL users, 41.3% (N=219) of current other pod users, 34.6% (N=225) of current vape pens users, 38.3% (N=118) of current disposable users and 27.3% (N=81) of current mod users used their e-cigarette devices in school.

3.2. School Locations of E-cigarette Device Use

Across all device types the prevalence of endorsement for locations for vaping in schools were: school bathrooms (75.1%, N=488), outside but on school grounds (52.2%, N=339), classroom (45.7%, N=297), hallway (38.8%, N=252), and other school locations (11.7%, N=76). Youth who reported use in school endorsed various locations with the highest endorsement for all devices being in the bathroom [75.7% (N=414) JUUL, 72.2% (N=158) other pods, 78.2% (N=176) vape pens, 80.5% (N=95) disposables, 71.6% (N=58) mods] and the lowest endorsement for “other” school related locations [8.6% (N=47) JUUL, 10.5% (N=23) other pods, 9.3% (N=11) disposables, 8% (N=18) vape pens and 10.5% (N=11) mods] (Figure 1).

3.3. Predictors of Past Month E-cigarette Device Use in School

Of the independent variables assessed, past month use frequency for each e-cigarette device was significantly associated with the use of each respective e-cigarette device at school (see Table 1).

4. Discussion

This study is the first to examine use of specific e-cigarette devices in schools. Overall, 45% of current youth e-cigarette users reported using a device in school. For specific device types, current JUUL users were most likely to report e-cigarette use in school, while mod e-cigarette use was less frequently reported. Prior evidence suggests that assessing e-cigarette use by specific device type is important to accurately capture use rates among youth (Morean et al., 2018), and the current study adds to this by providing evidence of use prevalence of specific devices in school. The lower endorsement of mod e-cigarette use in school may be due to their bulkiness, large size, and ability to produce large vapor clouds, which make them harder to conceal (Eaton et al., 2018). However, it is important to note that youth still report using mods in school locations, even in locations such as classrooms.

The concealability of specific types of e-cigarettes may contribute to the use of these products in school (Allem et al., 2018; Kong et al., 2019). One of the most discreet places in school, the bathroom, was the most frequently reported place for use of all devices. However, our results also demonstrate that adolescents are using e-cigarettes at school in other less discreet places like classrooms (Figure 1). This evidence suggests that stricter enforcement of rules regarding use of e-cigarette devices in school locations may be needed. Of note, all the schools included in the survey had implemented e-cigarette policies at the time of the survey; in general, if students were found to have an e-cigarette in their possession during school hours, the device was confiscated, and the student could receive a suspension or a ticket by the local police. Use of these devices in places like classrooms where there may be greater chances of getting caught, or penalties for use may be higher, also suggests that perhaps youth who use in these locations are more dependent and cannot abstain from using these devices while in class. Furthermore, we also observed that greater past month use frequency of each e-cigarette device predicts e-cigarette use in school (Table 1). E-cigarette use frequency has been associated with nicotine dependence in adolescents (Morean et al., 2018). Therefore, future studies need to explore the role of nicotine dependence on the use of e-cigarette devices in prohibited places like schools.

This study is not without limitations. This evidence was collected from a local sample of high school students in southeastern Connecticut, which may limit generalizability of the findings. Also, because novel e-cigarette devices continue to be added to the market, the e-cigarette device categories assessed during this study may not be inclusive of all products.

In sum, this study observed that in high schools, youth use many e-cigarette devices in a variety of locations. The use of e-cigarette devices in school locations where use is easily observed raises concerns about normalization of e-cigarette use in school amongst students especially those who are susceptible to future tobacco product use. Further, the use of e-cigarettes in schools despite the disciplinary school policies suggests the need for more effective non-disciplinary strategies such as education and prevention programs. Future research is needed to determine how to best implement school-based tobacco control strategies to mitigate e-cigarette use on school grounds.

Acknowledgments

Funding Source: Research reported in this publication was supported by grant number U54DA036151 from the NIDA and FDA Center for Tobacco Products (CTP). Author K. Bold is supported by K12DA000167 from NIDA. Authors A. Jackson and D. Davis are supported by T32DA007238 from NIDA, and author A. Jackson is supported by R25DA0352163 from NIDA. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the Food and Drug Administration

Financial Disclosure: MM has a restricted stock agreement with Gofire, Inc. All other authors have no financial relationships relevant to this article to disclose.

References

- Allem J, Dharmapuri L, Unger JB, Cruz TB, 2018 Characterizing JUUL-related posts on Twitter. *Drug Alcohol Depend.* 190, 1–5. 10.1016/j.drugalcdep.2018.05.018.Characterizing [PubMed: 29958115]
- Boyce W, Torsheim T, Currie C, Zambon A, 2006 THE FAMILY AFFLUENCE SCALE AS A MEASURE OF NATIONAL WEALTH: VALIDATION OF AN ADOLESCENT SELF-REPORT MEASURE. *Soc. Indic. Res.* 78, 473–487. 10.1007/s11205-0051607-6

- Cullen KA, Gentzke AS, Sawdey MD, Chang JT, Anic GM, Wang TW, Creamer MR, Jamal A, Ambrose BK, King BA, 2019 e-Cigarette Use Among Youth in the United States, 2019. *JAMA* 322, 2095–2103. 10.1001/jama.2019.18387
- Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M, 2008 Researching health inequalities in adolescents: The development of the Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale. *Soc. Sci. Med.* 66, 1429–1436. 10.1016/j.socscimed.2007.11.024 [PubMed: 18179852]
- Eaton D, Kwan L, Stratton K, 2018 E-Cigarette Devices, Uses, and Exposures, in: *Public Health Consequences of E-Cigarettes*. p. <https://www.ncbi.nlm.nih.gov/books/NBK507187/>.
- Gentzke AS, Creamer M, Cullen KA, Ambrose BK, Willis G, Jamal A, King BA, 2019 Vital Signs: Tobacco Product Use Among Middle and High School Students — United States, 2011 – 2018. *MMWR Morb Mortal Wkly Rep* 68, 157–164. [PubMed: 30763302]
- Hammond D, Wackowski OA, Reid JL, Connor RJO, Tobacco I, 2018 Use of JUUL E-cigarettes Among Youth in the United States. *Nicotine Tob. Res.* 1–6. 10.1093/ntr/nty237
- Kong G, Bold KW, Morean ME, Bhatti H, Camenga DR, Jackson A, Krishnan-sarin S, 2019 Appeal of JUUL among adolescents. *Drug Alcohol Depend.* 205, 1–6. 10.1016/j.drugalcdep.2019.107691
- Krishnan-Sarin S, Jackson A, Morean M, Kong G, Bold KW, Camenga DR, Cavallo DA, Simon P, Wu R, 2019 E-cigarette devices used by high-school youth. *Drug Alcohol Depend.* 194, 395–400. 10.1016/j.drugalcdep.2018.10.022 [PubMed: 30497057]
- Morean Meghan E, Camenga DR, Bold K, Kong G, Jackson A, Simon P, Cavallo DA, Krishnan-sarin S, 2018 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.* 1–5. 10.1093/ntr/nty240
- Morean Meghan E., Krishnan-sarin S, O'Malley SS, 2018 Assessing nicotine dependence in adolescent E-cigarette users: The 4-item Patient-Reported Outcomes Measurement Information System (PROMIS) Nicotine Dependence Item Bank for electronic cigarettes. *Drug Alcohol Depend.* 188, 60–63. 10.1016/j.drugalcdep.2018.03.029 [PubMed: 29753155]
- Project CSF, 2016 <http://ctschoolfinance.org/assets/uploads/files/DRG-One-Pager-FINAL.pdf> (Accessed [WWW Document]).
- Ramamurthi D, Chau C, Jackler RK, 2018 JUUL and other stealth vaporisers: Hiding the habit from parents and teachers. *Tob. Control.* 10.1136/tobaccocontrol-2018054455

- E-cigarette use frequency for each device category predicts use of respective devices in school
- Current JUUL users frequently reported e-cigarette use in school
- Mod e-cigarette use was less frequently reported in school
- The bathroom was the most frequently reported place for use of all devices
- Adolescents also reported using e e-cigarettes in less discreet places like classrooms

Figure 1: E-cigarette Device Use by Locations in School Among Past Month Device Users in School

Note: The Ns displayed represent the number of participants who endorsed current use of each e-cigarette device in school. Each bar within the same e-cigarette device represents the percentage of those who used that specific e-cigarette device in each school location among those who reported current use of that specific e-cigarette device in school. Prevalence between e-cigarette devices were not statistically compared because each e-cigarette device was assessed separately and represents a different subset of participants. Outside represents outside but on school grounds.

Table 1:

Predictors of Past Month E-cigarette Device Use in School

	JUUL (N=1196)	Other Pods (N=530)	Vape Pen (N=651)	Disposable (N=308)	Mod (N=296)
Demographics					
Age	0.97(0.88–1.08)	0.97(0.83–1.12)	0.91(0.79–1.04)	0.85(0.70–1.03)	0.82(0.67–0.99)
Male ^A	1.10(0.84–1.43)	1.32(0.89–1.96)	1.38(0.97–1.97)	1.11(0.65–1.87)	1.58(0.90–2.79)
Non-Hispanic Black ^B	1.55(0.86–2.80)	1.51(0.49–4.70)	2.24(1.05–4.78)	0.65(0.16–2.64)	1.04(0.20–5.40)
Hispanic ^B	1.19(0.84–1.68)	1.50(0.90–2.51)	1.34(0.83–2.16)	2.30(1.13–4.70)	1.86(0.90–3.88)
Non-Hispanic Other ^B	1.37(0.91–2.07)	1.16(0.64–2.12)	2.26(1.27–4.01)	1.20(0.56–2.59)	2.19(0.90–5.31)
Medium SES ^C	1.36(0.98–1.87)	1.74(1.05–2.87)	0.68(0.45–1.03)	0.84(0.46–1.56)	1.44(0.74–2.80)
High SES ^C	1.23(0.85–1.77)	1.56(0.90–2.69)	0.61(0.37–1.00)	1.14(0.55–2.39)	1.76(0.77–4.00)
Past Month Use Frequency of Device	1.10(1.08–1.110)	1.08(1.06–1.10)	1.07(1.05–1.08)	1.07(1.05–1.09)	1.06(1.04–1.09)

Note: bolded numbers have p < 0.01. School was added to the models as a covariate.

^A vs female

^B vs Non-Hispanic White

^C vs low SES. Past month users for each e-cigarette device type served as the sample for each respective model