Prevalence and Correlates of Lifetime E-Cigarette Use among Adolescents Attending Public Schools in a Low Income Community in the US

Kenneth P. Tercyak, PhD[a], Lilianna Phan, PhD, MPH, MS[a], Katia Gallegos-Carrillo, PhD[b], Darren Mays, PhD, MPH[a], Janet Audrain-McGovern, PhD[c], Kathryn Rehberg, MA[a], Yameng Li, MS[a], Francisco Cartujano-Barrera, MD[b], A. Paula Cupertino, PhD[a,b]

[a]Lombardi Comprehensive Cancer Center, Georgetown University, 3300 Whitehaven St., NW, Suite 4100, Washington, DC 20007, USA

[b]John Theurer Cancer Center, Hackensack Meridian Health, 40 Prospect Ave., Hackensack, NJ 07601, USA

[c]Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania, 3400 Civic Center Blvd., Philadelphia, PA 19104, USA

Abstract

Introduction: The prevalence of e-cigarette use among US adolescents is increasing. However, there is limited research on the prevalence and correlates of e-cigarette use among adolescents in low income and under resourced communities. We report on their e-cigarette susceptibility and use behaviors, and perceived risks of harm and addiction.

Methods: Students in grades 7, 9, and 11 from a Title I school district in the northeastern US completed an online survey during a class period. Lifetime e-cigarette use and its correlates were tested in bivariate and logistic regression models.

Results: Most students were of Latino ethnicity (66%), and 36% identified as Black/African American. Overall, 55% of the full sample were considered 'susceptible' to e-cigarette use: 19% were lifetime e-cigarette users while 6% were lifetime smokers. Students in 11th grade were more likely (OR = 2.5) to have ever used e-cigarettes compared to students in 7th grade. Those that were more curious (OR = 11.8), intended to use e-cigarettes in the next 12 months (OR = 2.8), and would use the product if it was offered by a friend (OR = 2.4) had greater odds of lifetime e-

cigarette use. By contrast, students who perceived at least moderate risks of health harm (OR = 0.44) were less likely to have used e-cigarettes.

Conclusions: Adolescents from marginalized communities are susceptible to and are using e-cigarettes. Prevention efforts targeting underserved areas may benefit from e-cigarette health education messages that reduce curiosity, interrupt social aspects of initiation, and emphasize health harms.

Keywords

adolescents; middle school students; high school students; tobacco use

1. Introduction

Although adult smokers may reduce tobacco-associated harm from completely switching to electronic nicotine delivery systems (ENDS; e-cigarettes, vaping),[1] harm reduction is uncertain[2] and trends indicate smokers are likely to become dual users.[3] Of significant concern is e-cigarette use among adolescents[2] at a developmental period highly vulnerable to nicotine addiction.[4] Public health recommendations unequivocally state that adolescents should avoid e-cigarettes because they are unsafe--posing risks of both harm and addiction.[4] Meanwhile, e-cigarettes have risen rapidly in popularity[4] to become the most prevalent tobacco product used by adolescents.[5] E-cigarette use during adolescence is associated with neurological effects that sensitize the brain to other drugs and substance abuse,[6] and to subsequent tobacco use including among adolescents who would otherwise be less susceptible.[7]

Adolescent curiosity about e-cigarette use is largely driven by the swift ascent of JUUL,[8,9] a brand that has dominated mass market sales[10] and is known for its discrete, easily concealable features.[11] Until recently, JUUL refillable pods were available in child-friendly flavors including cucumber, mango, and crème[12] with varying nicotine concentrations (3%, 5%).[13] As called for by supporting research,[14] such flavorings in refillable pod-based e-cigarettes were banned by the Food and Drug Administration (FDA) in January 2020.[15] Several US states, including New York and Massachusetts, have also clamped down on the sale of vaping products including flavorings.[12] However, menthol, a flavoring associated with interest[16] and use[17] of e-cigarettes and an established gateway flavor to smoking among adolescents,[18] has not been prohibited.[15] At present, it is unknown how these regulatory actions by the FDA and certain states will ultimately affect e-cigarette sales, and their corresponding use among middle and high schoolers.

In addition to their flavorings, adolescents appear to be drawn to e-cigarettes given their ready availability and perceptions that they are less harmful than cigarettes.[5] Most surveys conducted on adolescent e-cigarette use behavior assess adolescents from majority groups (e.g., non-Hispanic white students, those with higher socioeconomic status)[19,20] despite some evidence of an association between lower socioeconomic status and e-cigarette use prevalence.[21,22] This leaves substantial gaps in the public health community's understanding of e-cigarette use prevalence, attitudes, and behaviors among low income, underserved, and minority adolescents (e.g., African American/Blacks, Hispanic/Latinos) living in

impoverished areas. Regrettably, the history of Big Tobacco is replete with examples of these very groups being aggressively targeted by promotional marketing campaigns, including efforts to lure young people into nicotine addiction.[23] Little is known if and how adolescents from low income communities use e-cigarettes to initiate and/or maintain a vaping habit, do so in isolation or in combination with cigarettes, and if use is associated with misperceptions of risks. Without this critical information, disparities in tobacco-related diseases will undoubtedly persist and hamper prevention and control efforts.

Given this gap in information about e-cigarette use among vulnerable adolescents, this study sought to examine the prevalence of e-cigarettes, cigarettes, and dual use among middle and high school students in a low income community setting. We also sought to characterize use patterns by sociodemographic factors, and attitudes and beliefs commonly associated with adolescent tobacco use behavior. These results will inform future development of prevention interventions tailored to racially diverse adolescents in under-represented, low income regions.

2.   Materials and Methods

2.1.   Project design and population

The project was presented to a school superintendent in a low income, urban district in northern New Jersey and approved by a local school board. A cross-sectional survey was developed in English and Spanish by the study team (see below). Students in grades 7, 9, and 11 were approached and completed the online survey in the spring semester of 2019. US Census Bureau data for this region indicate lower proportions of White (45.8% vs. 72.1%) and more African American/Black (25.3% vs. 15.0%) and Hispanic/Latino (38.2% vs. 20.4%) residents than statewide, more residents speaking languages other than English at home (48.4% vs. 31.0%), and those living in poverty (14.3% vs. 10.0%). The school district is designated through a Title I schoolwide program, qualifying it for additional funds to meet the educational goals of low income and at-risk students.

2.2.   Data collection procedures

Planning meetings were held with the school district superintendent. The superintendent, school principals, and study team collaborated with the administration to conduct the research. School district leadership and the study team prepared an information letter in English and Spanish to the bilingual parent/guardian community about the study's purpose. The letter was distributed to parents/guardians of potentially eligible students via regular mail, e-mail, "backpack" mail, and other means used for parent/guardian communication. The letter included an opt-out response alternative: parents/guardians who did not wish for their students to participate in the confidential and anonymous survey were asked to notify the student's homeroom teacher within 7 days. Homeroom teachers electronically administered the survey online to students in their classrooms by providing each student a secure survey link. The research university hosted the survey, and the protocol was approved by its Institutional Review Board, and the school district's office of the superintendent and board of education.

2.3. Measures

Survey preparation and items were modeled from the Youth Risk Behavior Survey[24] administered biannually to conduct nationwide surveillance about adolescent health behavior.

Sociodemographic Characteristics.—We measured students' sociodemographic characteristics including age, sex, race, Latino ethnicity, country of birth (US/Other country), language spoken at home (1 = Only Spanish, 2 = More Spanish than English, 3 = Spanish and English equally, 4 = More English than Spanish, 5 = Only English), and school grade. We combined responses for language spoken at home to create a dichotomous variable (English only/English and Spanish).

Cigarette Smoking.—Both lifetime and past-30 day smoking were assessed. Lifetime smoking was captured with "Have you ever tried cigarette smoking, even one or two puffs?" (Yes/No). Students who reported lifetime smoking were asked, "During the past 30 days, on how many days did you smoke cigarettes?" Students who reported smoking on 1 or more days were categorized as current smokers. Those who reported smoking 0 days were defined as non-current smokers.

E-Cigarette Use.—Students were instructed in the survey that e-cigarette use included vaping, JUUL use, and use of other ENDS products. Lifetime use was measured by "Have you ever used an e-cigarette/electronic vapor product?" (Yes/No). Among students who reported lifetime use, we measured past-30 day use as, "During the past 30 days, on how many days did you use an e-cigarette/electronic vapor product?" Students who used e-cigarettes on 1 or more days were considered current e-cigarette users. Students who did not use e-cigarettes (0 days) were characterized as non-current e-cigarette users.

Susceptibility to E-Cigarette Use.—Susceptibility was assessed with three items tapping curiosity, intent, and social influence. Students were asked: "Have you ever been curious about using e-cigarettes/vaping?"; "Do you think that you will use e-cigarettes/vape in the next 12 months?", and; "If one of your best friends were to offer you an e-cigarette/ electronic vapor product, would you use it?" (1 = Definitely not to 4 = Definitely yes). These response categories were combined to create dichotomous variables (0 = Definitely not, 1 = Probably not, Probably yes, Definitely yes). We then merged these items to create an overall susceptibility variable. Those who responded with a response other than "Definitely not" to one or more items were deemed susceptible (Yes/No), as informed by prior foundational research on youth tobacco use.[25]

E-Cigarette Use Behaviors.—E-cigarette purchasing and use behavior, including how students acquired e-cigarettes and brands they had used, were assessed. Social use of e-cigarettes was measured by asking students if they ever shared an e-cigarette/vapor product (Yes/No), and their relationship to the person(s) they had shared the product with, collected as an open-ended response. We coded open-ended responses as 1 = Friend/peer, 2 = Family members including parents, siblings, and cousins, and 3 = Friend/peer and family member, 4 = Other. All relationship categories were derived from those reported directly by students.

Perceived Harm and Addictiveness of E-Cigarettes.—Perceived harm and addictiveness were each measured with an adapted item.[26] Students were asked, "How much do you think people harm themselves when they use an e-cigarettes/vape?" (1 = No harm to 4 = A lot of harm) and "How addictive do you think using e-cigarettes/vaping is?" (1 = Not at all addictive to 4 = Very addictive). Similar to susceptibility items, dichotomous variables were created (0 = No/A little harm, 1 = Moderate/A lot of harm; 0 = Not at all/A little addictive, 1 = Moderately/Very addictive).

2.4. Analyses

Descriptive statistics summarized the full sample's sociodemographic characteristics. Additionally, among lifetime e-cigarette users in this sample, we used univariate statistics to assess how students had acquired e-cigarettes, brands of use, whether they shared the product(s), and with whom they shared the product(s). Lifetime e-cigarette use was then stratified by sociodemographic, lifetime smoking, susceptibility, and perceived harm and addiction risks variables (Table 1): bivariate t-tests and chi-square tests examined associations between these variables and lifetime e-cigarette use. We applied Yates' continuity correction for 2×2 chi-square tests. Significant associations with lifetime e-cigarette use (at the $p < 0.10$ level) were tested in an unadjusted logistic regression model, followed by a logistic regression model that adjusted for lifetime smoking (Table 2). We did not include age in logistic regression models as it was confounded with school grade ($p < 0.001$). All analyses were performed using R as the statistical software package.

3. Results

3.1. Sample

Of the >1,350 potentially eligible students, the study received opt-out responses from <5% of students/families who were not administered an online survey. We excluded 10% of survey attempts from further analysis due to student misreporting or correctly reporting class grade levels other than 7, 9, or 11 (e.g., in classrooms with mixed homeroom grade levels). The study participation rate was 77% (N=963) after adjusting for these cases and the schools' daily attendance/census counts.

The sampled population included approximately equal numbers of 7th, 9th, and 11th grade students (see Table 1). About half of participating students were female, most identified with Latino ethnicity and Black/African American or other non-White race, and spoke both English and Spanish in their homes. We compared the demographics of survey respondents to those published by the school district and determined there were no differences based on sociodemographic trends between survey respondents and those who opted out.

In this racially and ethnically diverse school-based sample, nearly 19% had ever used an e-cigarette (i.e., lifetime e-cigarette users) and 6% had ever tried smoking (i.e., lifetime smokers). Among lifetime smokers, 79% had experimented with e-cigarettes at some point in the past (i.e., lifetime dual users). Of those who reported lifetime e-cigarette use, 53% were current users: there were no differences in current use by grade, gender, race (White vs.

all other), or Latino ethnicity (all p's were nonsignificant). Approximately 35% of lifetime smokers reported being current smokers.

3.2. Susceptibility to E-Cigarette Use

In the full sample, 45% reported being curious about e-cigarettes, 34% thought they would try e-cigarettes, and 40% were open to using e-cigarettes if a friend offered it. Combined, 55% of adolescents were deemed 'susceptible' to trying e-cigarettes or continuing their use. With respect to students' beliefs, the clear majority perceived e-cigarettes to carry at least moderate risks of harm (84%) and addiction (80%).

3.3. E-Cigarette Use Behaviors

Among 176 (19%) lifetime e-cigarette users in this sample, 139 (79%) responded to a follow-up item on how they acquired e-cigarettes. The common methods were: borrowing e-cigarettes from someone else (62%), giving money to someone else to buy e-cigarettes (21%), buying them in a store (e.g., convenience store, gas station) (17%), and obtaining e-cigarettes some other way (17%). Regarding the socialization of e-cigarette use, 130 (75%) lifetime users reported sharing an e-cigarette with others. Among those who reported sharing e-cigarettes, approximately 81% responded to an open-ended item that probed whom the products were shared with: friends (72%), family members (11%), or friends and family members (15%) were most cited. Regarding brands, 135 (77%) lifetime users reported the brand they used most often: JUUL (66%) dominated and other brands included Apollo, Blue, Greensmoke, and VaporFi—each accounting for <1% of the brands reported. Adolescents also reported not having a preferred/usual brand (36%), or using another unspecified brand (36%).

3.4. Associations with Lifetime E-Cigarette Use

E-cigarette users were older, more likely to be female, in 11th grade, be lifetime smokers, and perceived no to low harm and addiction risks of product use (Table 1; all p's <0.10). Among those who perceived no or low e-cigarette harm, approximately 35% reported lifetime e-cigarette use in comparison to about 15% who perceived at least moderate harm risks. Similarly, about 30% of the sample who perceived no or low addiction risks were also lifetime e-cigarette users compared to approximately 15% who reported at least moderate addiction risks.

In the unadjusted logistic regression model (Table 2), 11th grade students were 2.5 times more likely to have ever used e-cigarettes compared to 7th grade students. Those that were curious (OR = 11.8), intended to use e-cigarettes in the next year (OR = 2.8), and would use e-cigarettes if offered by a friend (OR = 2.4) had greater odds of lifetime use. By contrast, students who perceived at least moderate harm risks (OR = 0.44) were less likely to have used e-cigarettes previously.

A somewhat attenuated, but nearly identical and still statistically significant, pattern of findings was observed when adjusting for lifetime smoking. In the adjusted logistic regression model, 11th grade students were 2.3 times more likely to have ever used e-cigarettes compared to 7th grade students. Adolescents had higher odds of lifetime e-

cigarette use if they were curious (AOR = 10.6), likely to use e-cigarettes in the next year (AOR = 2.4), and would use e-cigarettes if they were offered by a friend (AOR = 2.6). However, those with at least moderate harm risk perceptions (AOR = 0.39) were less likely to have been lifetime e-cigarette users.

4. Discussion

We identified a 19% lifetime e-cigarette use prevalence among adolescents attending public middle and high schools in a low income community. Stratified by grade, their prevalence of lifetime use was approximately 18%, 13%, and 25% among 7th, 9th, and 11th graders, respectively. In unadjusted and adjusted logistic regression models, lifetime e-cigarette users were more likely to be in an advanced year of school. Other factors associated with use were increased cognitive susceptibility and decreased appreciation for the health-harming consequences of e-cigarettes.

Importantly, our study population included an ethnically (66% Latino) and racially diverse sample (36% Black, 28% other non-White races) of middle and high school students attending schools in an underserved community. Our results indicating that approximately 19% of the sample had experimented with e-cigarettes, and about 6% with cigarettes, are consistent with those of a diverse student sample from the 2014 Adolescent California Health Interview Survey,[27] and increasing trends of e-cigarette initiation over time.[28,29] A nationally-representative study reported even higher e-cigarette prevalence estimates among minority adolescents (35% for Hispanics/Latinos; 27% for African Americans/Blacks, and 24% among other races),[30] further underscoring the need for monitoring of e-cigarette use among ethnic/racial minority populations.

Our findings support the need for all adolescents, regardless of their school setting, to have equitable access to e-cigarette prevention interventions to reduce their risks to e-cigarette harm and addiction[2] and dual or poly tobacco use,[31] and avert tobacco use escalation.[32] Adolescents are vulnerable to progression in their nicotine and tobacco use behavior, especially in light of exposure to tobacco retailers[33] in their daily routines[34] and aggressive tobacco marketing.[35] A recent study of vape shops found them more densely distributed in school districts with more Black/African American and Asian students.[36] In addition to a high proportion of those who were susceptible to e-cigarettes in this study (55%), half of all e-cigarette experimenters reported past-30 day use and 79% of lifetime smokers were lifetime e-cigarette users. Thus, diverse adolescents attending Title I schools in underserved communities may not only be experimenting with ENDS products, but using e-cigarettes regularly and similar to patterns observed nationally and among young adults.[37]

Data from the 2018 New Jersey Youth Tobacco Survey (NJYTS) found current e-cigarette use, including JUUL, among minority students (23% among Hispanics/Latinos; 19% among African American/Blacks; and 12% among other race) to be higher in an overall, less diverse (non-Hispanic White 50%), older sample of high school students.[9] Although community-wide socioeconomic index status among students in the NJYTS study was not analyzed, it reported elevated rates of current e-cigarette use among older high school students and non-Hispanic White students, but with lower trends of use among minority students.[9] Proportions

of current use in their study also increased when combining prevalence estimates for general e-cigarette use, and specifically JUUL use, with nearly twice as many Black/African American high school students categorized as current e-cigarette users when reported in this manner. Though we instructed students in the current survey that e-cigarette use included JUUL, only one construct assessed ENDS products. This limitation may explain differences for current use prevalence estimates, in addition to variation in sociodemographic characteristics across samples including grade, racial, and ethnic diversity. Additionally, unlike others,[9] our sample includes 7th graders, a population with reportedly lower e-cigarette use prevalence than high school students.[19, 21] Nonetheless, consistent with Hrywna and colleagues[9] and prior research,[41,42] JUUL use predominated (66%). This is concerning because pod-type ENDS contain nicotine salts that mimic the nicotine delivery of cigarettes, and pose greater addictive risks than non-pod, older generations of e-cigarettes.[43] Ongoing monitoring of the interest and use of brands including JUUL and newer disposable pod mods[44] will be critical in light of recent FDA policies against flavored, cartridge-based e-cigarettes[15] and evolving patterns of adolescent e-cigarette use.

Our findings highlight the interplay among e-cigarette susceptibility, use behavior, and risk beliefs in an understudied and vulnerable population. Susceptibility among non-users and those who had ever used e-cigarettes were rather pronounced, including curiosity (45%) and accepting an offer to use e-cigarettes from a friend (40%), and keeping in mind that the interpretation of these results may differ from other studies examining susceptibility among non-users only. Nonetheless, the majority of lifetime users reported borrowing and sharing e-cigarettes amongst friends and similar to prior work.[5] Curiosity and peer-influence are also among the chief causes for initiating use in other studies.[45,46] Reducing curiosity[45] and targeting social aspects of use may be promising strategies to curb uptake.

Though research on effective e-cigarette risk communication for adolescents is limited, there is some evidence to suggest modifying perceptions about harm and addiction may be effective at preventing and reducing use.[47] Adolescents with higher perceived harm risks were less likely to use e-cigarettes than were those with lower risk perceptions. Though low perceived addiction risk has been associated with lifetime e-cigarette use,[48] addiction messaging may produce limited impact on risk beliefs, and ultimately e-cigarette use behavior.[26,49] A recent pilot study found harm messaging (e.g., chemicals, brain development) more effective than addiction messaging among adolescents.[50]

Recent recommendations[51] and adolescent health education programs targeting substance use and smoking including doing so among minority groups[52] point to brief, e-cigarette risk messages delivered in school settings[53] or primary care clinics.[54–56] Future research examining primary prevention strategies may include updating school-based tobacco prevention curricula to address emergent ENDS and tobacco products. One approach is a virtual field trip connecting students with scientists via webcasts and other activities to learn about e-cigarette risks.[57] Additionally, screening procedures for e-cigarette use are lacking,[51] and training primary care providers to play a more central role in educating youth about the harms of e-cigarettes and nicotine addiction may be beneficial in this vulnerable population.[58]

Our study is among a small but growing number of inquiries into the susceptibility to, experimentation with, and use of e-cigarettes among adolescents in low income, underserved communities that are predominantly minority and additional research is needed. In designing those future studies, it is important to keep in mind several limitations that may impact the external validity of our findings, including the similarity of our study's Title I school setting, passive consent/opt-out methodology, and confidential and anonymous e-survey data collection procedures. Although this facilitated representative study sampling, it generally precluded inquiry about family income and a statistical examination of the similarities and differences among students in the same classrooms (i.e., intra-class correlations or clustering effects). Some of these limitations may have been mitigated by the high participation rate and approximately even engagement/response distribution within and across grade levels. Of course, as a cross-sectional investigation, it was not possible to determine the causal nature of any of the associations we observed and reported herein: the study was also not designed to evaluate the role of area-based, environmental, and broader social determinants of ENDS use among youth living in these communities and that would be informative as well. Additionally, our prevalence rates of e-cigarette behavior use were somewhat lower than those reported in a nationally-representative study,[30] and a recent study of high schoolers:[9] the reason for this variance is unknown. Valuable future directions are to examine correlates of past-30 day e-cigarette use among a similarly-situated population, and to examine associations of their e-cigarette use with other popular tobacco products (e.g., cigars, cigarillos).[21]

5. Conclusions

This research is among the few available studies examining e-cigarette use and associated attitudes and beliefs among a diverse sample of middle and high school students attending schools in a low income and underserved community. Findings suggest that e-cigarette experimentation (19% overall) and continued use (53% among lifetime users) occur, and can be associated with adolescent curiosity, future intentions, and social opportunity, and lower perceptions of harms. These attitudes and risk perceptions are malleable targets for intervention, and important considerations for designing e-cigarette use prevention efforts. By partnering with schools, primary care settings, and other community organizations that serve large numbers of teens, the preventing ENDS use initiation and escalation may be possible. Given the continued market evolution of e-cigarettes and FDA and state regulatory policies, both primary and secondary prevention efforts are needed to offer brief, impactful messages targeting these aspects of use in those settings.

Acknowledgements

References

1. Green LW, Fielding JE, Brownson RC. The debate about electronic cigarettes: harm minimization or the precautionary principle. Annu Rev Public Health. 2018;39:189–191. doi:10.1146/annurev-publhealth-102417-124810 [PubMed: 29323610]

2. Callahan-Lyon P Electronic cigarettes: human health effects. Tobacco Control. 2014;23(2):ii36–ii40. doi:10.1136/tobaccocontrol-2013-051470 [PubMed: 24732161]

3. Owusu D, Huang J, Waver SR, et al. Patterns and trends of dual use of e-cigarettes and cigarettes among U.S. adults, 2015–2018. Preventive Medicine Reports. 2019;16. doi:10.1016/j.pmedr.2019.101009 [PubMed: 30456054]

4. U.S. Department of Health and Human Services. E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General. 2016; 298.

5. Tsai J, Walton K, Coleman BN, et al. Reasons for electronic cigarette use among middle and high school students - National Youth Tobacco Survey, United States, 2016. MMWR Morb Mortal Wkly Rep. 2018;67(6):196–200. doi:10.15585/mmwr.mm6706a5 [PubMed: 29447148]

6. Yuan M, Cross SJ, Loughlin SE, et al. Nicotine and the adolescent brain. J Physiol. 2015;593(6):3397–3412. doi:10.1113/JP270492 [PubMed: 26018031]

7. Wills TA, Knight R, Williams RJ, et al. Risk factors for exclusive e-cigarette use and dual e-cigarette use and tobacco use in adolescents. Pediatrics. 2015;135 (1) e43–e51. doi:10.1542/peds.2014-0760 [PubMed: 25511118]

8. The Lancet Child & Adolescent Health. Juuling adolescents: a new health concern. The Lancet Child & Adolescent Health. 2018; 2(7):465 10.1016/S2352-4642(18)30182-2 [PubMed: 30169308]

9. Hrywna M, Bover Manderski MT, Delnevo CD. Prevalence of electronic cigarette use among adolescents in New Jersey and association with social factors. JAMA Netw Open. 2020;3(2):e1920961. doi:10.1001/jamanetworkopen.2019.20961 [PubMed: 32049291]

10. Business News. Juul continues to expand market share gap with Vuse.https://www.journalnow.com/business/juul-continues-to-expand-market-share-gap-with-vuse/article_381b4da5-a13e-58a8-9807-88d1bb6bd1c8.amp.html. Accessed February 11, 2019.

11. Ramamurthi D, Chau C, Jackler RK. JUUL and other stealth vaporisers: hiding the habit from parents and teachers. Tobacco Control. 2018:tobaccocontrol-2018–054455. doi:10.1136/tobaccocontrol-2018-054455

12. Leavens ELS, Stevens EM, Brett EI, et al. JUUL electronic cigarette use patterns, other tobacco product use, and reasons for use among ever users: Results from a convenience sample. Addictive Behaviors. 2019;95:178–183. doi:10.1016/j.addbeh.2019.02.011 [PubMed: 30933713]

13. JUUL Labs. The Smoking Alternative, unlike any E-Cigarette or Vape | JUUL. https://www.juul.com/. Accessed February 10, 2019.

14. Kong G, Bold KW, Morean ME, et al. Appeal of JUUL among adolescents. Drug Alcohol Depend. 2019;205:107691. doi:10.1016/j.drugalcdep.2019.107691 [PubMed: 31706249]

15. US Food and Drug Administration.FDA finalizes enforcement policy on unauthorized flavored cartridge-based e-cigarettes that appeal to children, including fruit and mint. FDA http://www.fda.gov/news-events/press-announcements/fda-finalizes-enforcement-policy-unauthorized-flavored-cartridge-based-e-cigarettes-appeal-children. Published January 3, 2020. Accessed February 14, 2020.

16. Pepper JK, Ribisl KM, Brewer NT. Adolescents' interest in trying flavoured e-cigarettes. Tobacco Control. 2016;25(2):ii62–ii66. doi:10.1136/tobaccocontrol-2016-053174 [PubMed: 27633762]

17. Cullen KA, Gentzke AS, Sawdey MD, et al. E-cigarette use among youth in the United States, 2019. JAMA. 2019;322(21):2095–2103. doi:10.1001/jama.2019.18387

18. Villanti AC, Collins LK, Niaura RS, Gagosian SY, Abrams DB. Menthol cigarettes and the public health standard: a systematic review. BMC Public Health. 2017;17(1):983. doi:10.1186/s12889-017-4987-z [PubMed: 29284458]

19. Bold KW, Kong G, Camenga DR, et al. Trajectories of e-cigarette and conventional cigarette use among youth. Pediatrics. 2018;141(1). doi:10.1542/peds.2017-1832

20. Vogel EA, Ramo DE, Rubinstein ML. Prevalence and correlates of adolescents' e-cigarette use frequency and dependence. Drug Alcohol Depend. 2018;188:109–112. doi:10.1016/j.drugalcdep.2018.03.051 [PubMed: 29763848]

21. Simon P, Camenga DR, Kong G, et al. Youth e-cigarette, blunt, and other tobacco use profiles: does SES matter? Tob Regul Sci. 2017;3(1):115–127. doi:10.18001/TRS.3.1.12 [PubMed: 29082301]

22. Pérez A, Morello P, Braun S, Thrasher J, Mejía R. Family and school socioeconomic status as predictors of tobacco and e-cigarette use in adolescents: a study from a perspective of material, human, and social capital. Tob Induc Dis. 2018;16(1). doi:10.18332/tid/84237

23. Johnson DM, Wine LA, Zack S, et al. Designing a tobacco counter-marketing campaign for African American youth. Tob Induc Dis. 2008;4:7. doi:10.1186/1617-9625-4-7. [PubMed: 18822164]

24. Kann L, McManus T, Harris WA, et al. Youth Risk Behavior Surveillance - United States, 2017. MMWR Surveill Summ. 2018;67(8):1–114. doi:10.15585/mmwr.ss6708a1

25. Pierce JP, Farkas AJ, Evans N, et al. An improved surveillance measure for adolescent smoking? Tob Control. 1995;4(1):S47–S56. doi:10.1136/tc.4.suppl1.S47

26. Mays D, Smith C, Johnson AC, et al. An experimental study of the effects of electronic cigarette warnings on young adult nonsmokers' perceptions and behavioral intentions. Tob Induc Dis. 2016;14:17. doi:10.1186/s12971-016-0083-x [PubMed: 27231479]

27. Alcalá HE, Albert SL, Ortega AN. E-cigarette use and disparities by race, citizenship status and language among adolescents. Addict Behav. 2016;57:30–34. doi:10.1016/j.addbeh.2016.01.014 [PubMed: 26835605]

28. Chadi N, Hadland SE, Harris SK. Understanding the implications of the "vaping epidemic" among adolescents and young adults: A call for action. Substance Abuse. 2019;40(1):7–10. doi:10.1080/08897077.2019.1580241 [PubMed: 30883295]

29. Primack BA, Shensa A, Sidani JE et al. Initiation of traditional cigarette smoking after electronic cigarette use among tobacco-naïve US young adults. The American Journal of Medicine. 2018 131(2); 443.e1–443.e9. doi:10.1016/j.amjmed.2017.11.005

30. Wang TW. Tobacco product use and associated factors among middle and high school students — United States, 2019. MMWR Surveill Summ 2019;68. doi:10.15585/mmwr.ss6812a1

31. King JL, Reboussin D, Cornacchione Ross J, et al. Polytobacco use among a nationally representative sample of adolescent and young adult e-cigarette users. J Adolesc Health. 2018;63(4):407–412. doi:10.1016/j.jadohealth.2018.04.010 [PubMed: 30115508]

32. Berry KM, Fetterman JL, Benjamin EJ, et al. Association of electronic cigarette use with subsequent initiation of tobacco cigarettes in US youths. JAMA Netw Open. 2019;2(2):e187794–e187794. doi:10.1001/jamanetworkopen.2018.7794 [PubMed: 30707232]

33. D'Angelo H, Ammerman A, Gordon-Larsen P, et al. Sociodemographic disparities in proximity of schools to tobacco outlets and fast-food restaurants. Am J Public Health. 2016;106(9):1556–1562. doi:10.2105/AJPH.2016.3032 [PubMed: 27459453]

34. Burgoon ML, Albani T, Keller-Hamilton B, et al. Exposures to the tobacco retail environment among adolescent boys in urban and rural environments. The American Journal of Drug and Alcohol Abuse. 2019;45(2):217–226. doi:10.1080/00952990.2018.1549562 [PubMed: 30601033]

35. Lee JGL, Henriksen L, Rose SW, et al. A systematic review of neighborhood disparities in point-of-sale tobacco marketing. Am J Public Health. 2015;105(9):e8–e18. doi:10.2105/AJPH.2015.302777

36. Venugopal PD, Morse AL, Tworek C, Chang HW. Socioeconomic disparities in vape shop density and proximity to public schools in the conterminous United States, 2018. Health Promot Pract. 2020;21(1):9S–17S. doi:10.1177/1524839919887738 [PubMed: 31908194]

37. Vallone DM, Bennett M, Xiao H, et al. Prevalence and correlates of JUUL use among a national sample of youth and young adults. Tobacco Control. 10 2018:tobaccocontrol-2018–054693. doi:10.1136/tobaccocontrol-2018-054693

38. Hammond D, Reid JL, Rynard VL, et al. Prevalence of vaping and smoking among adolescents in Canada, England, and the United States: repeat national cross sectional surveys. BMJ. 2019;365. doi:10.1136/bmj.l2219

39. Huang J, Kim Y, Vera L, et al. Electronic cigarettes among priority populations: role of smoking cessation and tobacco control policies. Am J Prev Med. 2016;50(2):199–209. doi:10.1016/j.amepre.2015.06.032 [PubMed: 26410185]

40. Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students — United States, 2011–2014. MMWR Morb Mortal Wkly Rep. 2015;64(14):381–385. [PubMed: 25879896]

41. McKeganey N, Russell C. Prevalence of awareness and use of JUUL e-cigarettes in a national probability sample of adolescents in the United States. doi:info:doi/10.5993/AJHB.43.3.13

42. Hammond D, Reid JL, Rynard VL, et al. Prevalence of vaping and smoking among adolescents in Canada, England, and the United States: repeat national cross sectional surveys. BMJ. 2019;365. doi:10.1136/bmj.l2219

43. Goniewicz ML, Boykan R, Messina CR, et al. High exposure to nicotine among adolescents who use Juul and other vape pod systems ('pods'). Tobacco Control. 2018:tobaccocontrol-2018–054565. doi:10.1136/tobaccocontrol-2018-054565

44. Delnevo C, Giovenco DP, Hrywna M. Rapid proliferation of illegal pod-mod disposable e-cigarettes. Tob Control. 2020. doi:10.1136/tobaccocontrol-2019-055485

45. Kong G, Morean ME, Cavallo DA, et al. Reasons for electronic cigarette experimentation and discontinuation among adolescents and young adults. Nicotine Tob Res. 2015;17(7):847–854. doi:10.1093/ntr/ntu257 [PubMed: 25481917]

46. Perikleous EP, Steiropoulos P, Paraskakis E, et al. E-cigarette use among adolescents: an overview of the literature and future perspectives. Front Public Health. 2018;6. doi:10.3389/fpubh.2018.00086 [PubMed: 29435442]

47. Wagoner KG, Cornacchione J, Wiseman KD, et al. E-cigarettes, hookah pens and vapes: adolescent and young adult perceptions of electronic nicotine delivery systems. Nicotine Tob Res. 2016;18(10):2006–2012. doi:10.1093/ntr/ntw095 [PubMed: 27029821]

48. Rohde JA, Noar SM, Horvitz C, et al. The role of knowledge and risk beliefs in adolescent e-cigarette use: a pilot study. Int J Environ Res Public Health. 2018;15(4). doi:10.3390/ijerph15040830

49. Wackowski OA, Sontag JM, Hammond D, et al. The impact of e-cigarette warnings, warning themes and inclusion of relative harm statements on young adults' e-cigarette perceptions and use intentions. Int J Environ Res Public Health. 2019;16(2). doi:10.3390/ijerph16020184

50. Noar SM, Rohde JA, Horvitz C, et al. Adolescents' receptivity to E-cigarette harms messages delivered using text messaging. Addict Behav. 2019;91:201–207. doi:10.1016/j.addbeh.2018.05.025 [PubMed: 29960716]

51. Singh S, Windle SB, Filion KB, et al. E-cigarettes and youth: patterns of use, potential harms, and recommendations. Preventive Medicine. 2020:106009. doi:10.1016/j.ypmed.2020.106009 [PubMed: 32027913]

52. Kong G, Singh N, Krishnan-Sarin S. A review of culturally targeted/tailored tobacco prevention and cessation interventions for minority adolescents. Nicotine Tob Res. 2012;14(12):1394–1406. doi:10.1093/ntr/nts118 [PubMed: 22614548]

53. Stewart DG, Moise-Campbell C, Chapman MK, et al. The effectiveness of a school-based intervention for adolescents in reducing disparities in the negative consequences of substance use among ethnic groups. J Racial and Ethnic Health Disparities. 2017;4(3):337–345. doi:10.1007/s40615-016-0233-0

54. Hollis JF, Polen MR, Whitlock EP, et al. Teen Reach: outcomes from a randomized, controlled trial of a tobacco reduction program for teens seen in primary medical care. Pediatrics. 2005;115(4):981–989. doi:10.1542/peds.2004-0981 [PubMed: 15805374]

55. Maciosek MV, LaFrance AB, Dehmer SP, et al. Health benefits and cost-effectiveness of brief clinician tobacco counseling for youth and adults. Ann Fam Med. 2017;15(1):37–47. doi:10.1370/afm.2022 [PubMed: 28376459]

56. Duncan LR, Pearson ES, Maddison R. Smoking prevention in children and adolescents: A systematic review of individualized interventions. Patient Education and Counseling. 2018;101(3):375–388. doi:10.1016/j.pec.2017.09.011 [PubMed: 28987451]

57. Mitchko J, Lewis S, Marynak KL, et al. E-Cigarettes and young people: communicating an emerging public health risk. Am J Health Promot. 2019;33(6):955–957. doi:10.1177/0890117119835519 [PubMed: 30871329]

58. Society for Adolescent Health and Medicine. Protecting youth from the risks of electronic cigarettes. J Adolesc Health. 2020;66(1):127–131. doi:10.1016/j.jadohealth.2019.10.007 [PubMed: 31780385]

Highlights

- Adolescents from low income, low resource, and underserved communities are vulnerable to e-cigarette experimentation and use.

- Use is associated with cognitive susceptibility and low perceived harm risks.

- These correlates of use are malleable targets for future prevention interventions.

- E-cigarette prevention efforts should include a focus on populations of adolescents from marginalized and underserved communities.

Table 1:

Sample characteristics and e-cigarette use by adolescent group (N=963)

Variable	Level	Full sample		Lifetime e-cigarette use[a]		
		N	% or M (SD)	N	% or M (SD)	*p*
Lifetime e-cigarette use	No	758	81.2%	-	-	-
	Yes	176	18.8%	-	-	-
Age		959	14.8 (1.7)	174	15.0 (1.6)	0.05
Sex	Male	469	49.0%	71	15.1%	0.02
	Female	489	51.0%	103	21.1%	
Latino ethnicity	No	321	34.0%	54	16.8%	0.40
	Yes	622	66.0%	119	19.9%	
Race	White	255	36.5%	45	17.6%	0.17
	Black/African American	250	35.8%	33	13.2%	
	Other	193	27.7%	39	20.2%	
Country of birth	US	791	84.0%	146	18.5%	1
	Other country	151	16.0%	27	17.9%	
Language spoken at home	English only	341	37.8%	58	17.0%	0.35
	English and Spanish	560	62.2%	109	19.5%	
School grade	7th	301	31.3%	54	17.9%	<0.001
	9th	351	36.4%	45	12.8%	
	11th	311	32.3%	77	24.8%	
Lifetime cigarette use	No	890	93.6%	128	14.4%	<0.001
	Yes	61	6.4%	48	78.7%	
Susceptibility to e-cigarette use[b]	Have you ever been curious about using e-cigarettes/vaping?	418	44.8%	160	38.3.0%	<0.001
	Do you think that you will use e-cigarettes/vape in the next 12 months?	317	34.2%	135	42.6%	<0.001
	If one of your best friends were to offer you an e-cigarette/electronic vapor product would you use it?	375	40.3%	147	39.2%	<0.001
Perceived harm risk	No/A little harm	147	15.8%	51	34.7%	<0.001
	Moderate/A lot of harm	785	84.2%	121	15.4%	
Perceived addiction risk	No/A little addictive	187	20.2%	56	29.9%	<0.001
	Moderately/Very Addictive	739	79.8%	114	15.4%	

[a] Percentages and means represent the portion of each group reporting a positive lifetime history of e-cigarette use.

[b] Percentages represent the proportion of each group reporting anything other than "definitely not."

[c] p values indicate associations in t-tests and chi-square tests for independent variables with lifetime e-cigarette use; p <0.10 was used as the selection for model entry in Table 2.

Table 2:

Logistic regression models of adolescent lifetime e-cigarette use (N=903)

Independent variable	Level	Model 1 unadjusted			Model 2 adjusted		
		OR	95% CI	p	AOR	95% CI	p
School grade	7	-			-		
	9	0.82	(0.49, 1.4)	0.47	1.1	(0.64, 2.0)	0.68
	11	2.5	(1.5, 4.2)	<0.001	2.3	(1.3, 4.0)	<0.01
Sex	Female	-			-		
	Male	0.94	(0.61, 1.5)	0.79	0.86	(0.55, 1.4)	0.53
Susceptibility/curious	Definitely not	-					
	Other	11.8	(5.6, 24.7)	<0.001	10.6	(4.9, 22.9)	<0.001
Susceptibility/next 12 months	Definitely not	-					
	Other	2.8	(1.7, 4.7)	<0.001	2.4	(1.4, 4.1)	<0.01
Susceptibility/best friends	Definitely not	-					
	Other	2.4	(1.3, 4.4)	<0.01	2.6	(1.34, 5.0)	<0.01
Perceived addiction risk	Not/a little	-					
	Moderate/very	0.69	(0.42, 1.1)	0.14	0.88	(0.52, 1.5)	0.64
Perceived harm risk	Not/a little	-					
	Moderate/very	0.44	(0.26, 0.75)	<0.01	0.39	(0.23, 0.67)	<0.001

Note: OR = Odds ratio; 95% CI = 95% Confidence interval; AOR = Adjusted odds ratio. Model 2 controls for lifetime cigarette use.