



# HHS Public Access

Author manuscript

*J Adolesc Health*. Author manuscript; available in PMC 2019 April 01.

Published in final edited form as:

*J Adolesc Health*. 2018 April ; 62(4): 457–462. doi:10.1016/j.jadohealth.2017.10.009.

## Reasons for Vaping among US 12<sup>th</sup> Graders

Rebecca J. Evans-Polce, Ph.D.<sup>a,\*</sup>, Megan E. Patrick, Ph.D.<sup>a</sup>, Stephanie T. Lanza, Ph.D.<sup>b</sup>,  
Richard A. Miech, Ph.D.<sup>a</sup>, Patrick M. O'Malley, Ph.D.<sup>a</sup>, and Lloyd D. Johnston, Ph.D.<sup>a</sup>

<sup>a</sup>Institute for Social Research, University of Michigan, 426 Thompson, Ann Arbor, Michigan 48104

<sup>b</sup>The Methodology Center and Department of Biobehavioral Health, 433 Health and Human Development Building, Pennsylvania State University, University Park, PA

### Abstract

**Introduction**—Vaping has recently increased in popularity among adolescents. Little is known about heterogeneity of vapers, particularly in terms of why they vape. Identifying major subgroups of adolescent vapers by reasons for vaping is important to understand adolescent vaping behavior and to identify those most at risk for other substance use.

**Methods**—Monitoring Future data from 2015 and 2016 were used in a latent class analysis to identify subgroups of 12<sup>th</sup> graders based on their endorsement of 10 potential reasons for vaping. Multinomial regression with a latent class outcome was used to predict class membership.

**Results**—Three distinct classes of vapers were identified: adolescents who were (1) Vaping to Experiment (29.4%), (2) Vaping to Replace Cigarettes (7.3%), and (3) Vaping for Taste + Entertainment (63.4%). Vaping only flavors was associated with lower odds of membership and cigarette use was associated with higher odds of membership in the Vaping to Replace Cigarettes subgroup, and marijuana was associated with lower odds of membership in the Vaping to Experiment subgroup, compared to the Vaping for Taste + Entertainment subgroup.

**Conclusions**—This study identified multiple subgroups of vapers based on reasons for vaping. While a small subgroup vaped for reasons related to cigarette use, most adolescent vapers reported vaping for reasons unrelated to cigarette use. There were considerable differences in primary reasons for vaping and risk for traditional cigarette and other substance use, suggesting different intervention strategies may be needed for different subgroups of vapers.

### Keywords

Vaping; adolescence; electronic cigarettes; tobacco; latent class analysis; reasons for substance use

---

\*Corresponding author: 426 Thompson St., Ann Arbor, MI 48106, Phone: (734) 647-9296, bjevans@umich.edu.

**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 citable 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.

## INTRODUCTION

The prevalence of vaping among adolescents has skyrocketed over the past five years, increasing from 1.5% in 2011 to 16.0% in 2015 among US high school students,<sup>1</sup> and has recently surpassed rates of cigarette use.<sup>2,3</sup> Vaping is the inhalation of an aerosol or vapor, which may or may not contain nicotine, produced by a device such as an electronic cigarette. Spending on vaping advertising has greatly increased (from \$6.4 million in 2011 to \$115 million in 2014) and targets youth specifically.<sup>4</sup> More than 18 million US middle and high school students were exposed to ads in 2014. A recent review of e-cigarette research suggests that awareness of vaping is rapidly increasing among teens,<sup>5</sup> potentially leading to even greater increases in vaping in the future.

Understanding why adolescents are vaping becomes an important research endeavor given the fast rise to popularity and the potentially harmful consequences of vaping for youth, such as escalation to cigarette smoking.<sup>6</sup> Experimentation,<sup>7</sup> curiosity,<sup>8,9</sup> flavoring or taste,<sup>7,10</sup> and enjoyment<sup>11</sup> top the list of reasons for vaping among adolescents. Less than 10% of middle and high school students report vaping to help facilitate smoking cessation<sup>7</sup> and a slightly higher percentage in a sample of college students (14–19%) endorsed vaping to replace or stop cigarette smoking.<sup>11</sup> Somewhat larger percentages of youth and young adults (up to 80% of vapers) report vaping because they believe it is safer and more convenient than smoking cigarettes.<sup>8,10</sup>

To date studies have examined individual reasons for vaping among adolescents, with each reason explored separately. This approach provides the reasons teens give for vaping; however, it does not tell us how these reasons cluster together among vapers. We do not know the extent to which subgroups of adolescent vapers are motivated by a single reason for use or, alternatively, by a set of inter-related reasons. Given that distinct subgroups of users have been found for other substances (including alcohol,<sup>12</sup> marijuana,<sup>13</sup> and non-medical prescription drug use<sup>14</sup>) based on their reasons for use, we expect to find that reasons for use may also distinguish vapers into meaningful subgroups. Documenting heterogeneity in patterns of reasons for adolescent vaping may be particularly informative for adolescent vaping given the current debate over whether adolescent vapers do so to aid in smoking cessation, as a supplement to smoking, or for reasons unrelated to cigarette smoking.<sup>1,8,9,15</sup> It is likely that more than one of these groups exist among adolescent vapers.

Understanding what individual characteristics, such as socio-demographics and other substance use, are associated with subgroups of vapers will further shed light on the heterogeneity of vapers and why they vape. It may also help to identify which vapers are at risk for heavier vaping and other substance use, including current and future use of traditional cigarettes. Overall, vaping is associated with and prospectively predictive of other risk behaviors such as traditional cigarette use and other substance use.<sup>6,16–20</sup> Most high school vapers report relatively infrequent vaping<sup>19</sup> and a majority (65% of 12<sup>th</sup> graders) report vaping only flavors without nicotine, marijuana, or other substances.<sup>21</sup> These potentially lower risk behaviors may be associated with a specific pattern of reasons for vaping while those vaping nicotine or other substances (e.g., marijuana) may vape for a

different pattern of reasons. Understanding how these characteristics relate to different patterns of reasons for use would inform our understanding of what sets of reasons for vaping may be riskier than others. This would also inform intervention strategies as different types of interventions may be effective for different types of adolescents who vape. Interventions addressing higher-risk reasons for vaping as well as their other risk behaviors may be best suited to a higher-risk subgroup of vapers, while this type of intervention would be ill-suited for those who vape primarily for experimentation and may not be using other substances. The current study, using national samples of 12<sup>th</sup> graders who have vaped, has two aims:

1. To identify subgroups (or “classes”) of adolescents based on their self-reported reasons for vaping. Given that recent studies have found considerable heterogeneity among vapers,<sup>22,23</sup> we hypothesize there will be heterogeneity in adolescents’ patterns of reasons for vaping with the majority of adolescents vaping for experimental reasons only<sup>7</sup> rather than social, enhancement, or cigarette use-related reasons.
2. To identify characteristics associated with the classes identified in Aim 1. We hypothesize that adolescents who do not report use of other substances will be more likely to vape for experimental reasons only; further, we hypothesize that those who report other substance use and report vaping substances (other than just flavoring) will be more likely to vape for social reasons and cigarette-related reasons.

## METHODS

### Participants/Sample

Data are from the Monitoring the Future (MTF) study which since 1975 has conducted annual cross-sectional surveys of nationally representative samples of 12<sup>th</sup> grade students in public and private schools across the contiguous United States.<sup>24</sup> The survey was administered using optically scanned paper-and-pencil questionnaires administered in classrooms during normal school hours. The MTF study was approved by the University of Michigan Institutional Review Board.

This study focuses on 12<sup>th</sup> graders who completed the 2015 and 2016 surveys when questions regarding reasons for vaping were included in the survey. In the MTF study, students are randomly assigned to one of six different questionnaire forms in order to increase the number of topics covered and reduce respondent burden. Questions regarding reasons for vaping were included on two forms, thereby including one-third of students; among these students, only those who reported any lifetime vaping (34.7% of the original sample) were asked about their reasons for vaping (N=2,664; 43% female and 63% White).

### Measures

**Reasons for vaping**—Students who reported ever vaping were asked about potential reasons for vaping with the question: “What have been the most important reasons for your using an electronic vaporizer such as an e-cigarette? (Mark all that apply).”<sup>7</sup> Ten potential

reasons were given: “to experiment—to see what it’s like,” “because it tastes good,” “because of boredom, nothing else to do,” “to have a good time with my friends,” “to relax or relieve tension,” “because it looks cool,” “to help me quit regular cigarettes,” “because regular cigarette use is not permitted,” “to get high,” and “because I am ‘hooked’—I have to have it.” These ten reasons were included as dichotomous (marked vs. not marked) indicators in the latent class analysis.

**Covariates**—We assessed whether vaping characteristics and other substance use were related to latent class membership. Vaping characteristics included *recency of vaping* (any past 30-day vaping vs. not) and whether the participant reported vaping *only flavorings* vs. vaping a substance (nicotine, marijuana, other substance) the last time they vaped. Other substance use included *past 30-day cigarette use* (any vs. none), *past 30-day alcohol use* (any vs. none), and *past 30-day marijuana use* (any vs. none). We also controlled for sociodemographic characteristics in multivariable regression models which included *sex*, *race/ethnicity* (white non-Hispanic, Black non-Hispanic, Hispanic, Other), and *parent education* (parent(s) with a college degree vs. no parent with a college degree).

### Statistical Analyses

Analyses were conducted in two stages. First, latent class analysis (LCA) was used to characterize subgroups of students based on their profiles of ten reasons for vaping. LCA is a person-centered modeling technique that divides a population into mutually exclusive and exhaustive subgroups. These subgroups are unobserved (or latent) and are identified using multiple observed indicators. We estimated latent class models specifying two to eight classes and assessed identification of each model using multiple starting values. Information criteria (AIC, BIC, aBIC) along with interpretability and empirical and theoretical knowledge were used to determine the best-fitting model.<sup>25</sup> Lower values on these fit statistics indicate models with a better fit. After selecting the final model, we included covariates in the latent class model to examine predictors of class membership<sup>26</sup>. For each predictor, this provides odds ratios corresponding to the increase in odds of membership in each latent class relative to a reference class. First, bivariate multinomial regression models were estimated for each predictor to estimate the overall associations with class membership. Second, a multivariable model was estimated including all predictors and controlling for sex, race/ethnicity, and parent(s) education. All analyses accounted for the complex multistage sampling design with the use of sample weights and adjusted for standard errors due to clustering. PROC LCA was used in SAS 9.4 for both steps of LCA modeling.<sup>27,28</sup>

## RESULTS

Table 1 provides weighted prevalences of reasons for vaping and all covariates in the analyses including sociodemographic characteristics, vaping characteristics, and other substance use behaviors among 12<sup>th</sup> graders who reported ever vaping. As in previous reports,<sup>7</sup> experimenting was the most prevalent reason for vaping and the only reason endorsed by more than half of the sample. Vaping because it tastes good was also fairly common, endorsed by over one-third of the sample. Cigarette-related reasons (i.e., to help

me quit regular cigarettes, because regular cigarette use is not permitted, hooked) had low endorsement, each endorsed by less than 10% of the sample. To get high was also endorsed by less than 10% of the sample. The majority of vapers were male, White and had at least one parent with a college degree. Almost two-thirds reported vaping only flavors the last time they vaped and about 40% vaped in the past 30 days, as reported previously.<sup>21</sup> Other substance use was reported, including past 30-day prevalence of cigarette use (28%), alcohol use (58%), and marijuana use (39%).

### Latent classes of self-reported reasons for vaping

Latent class models were estimated using ten dichotomous indicators of reasons for vaping. Models with two to eight latent classes were examined. We selected a three-class model based on several factors. The model fit information (shown in Table 2) indicated up to an eight-class solution; however, consideration of the class structures, class interpretation, and previous empirical and theoretical research indicated that including more than three classes did not offer substantially more information about reason-based subgroups (see Supplemental Table A for latent class solutions with 2 to 8 classes). Across the 2- through 8-class models, we consistently found a class dominated by vaping to experiment and one identified by vaping to replace cigarettes, suggesting robustness of these two subgroups. In the 3-class model, a third large and somewhat heterogeneous class emerged; subsequent models further divided this third class into multiple smaller classes but they did not provide meaningful interpretations. Furthermore, with larger numbers of classes, model identification became problematic. Across 2- to 4-class models, the percentage of starting values associated with the best-fitted model were 50% or higher, suggesting good model identification.<sup>25</sup> In the 5-class model this percentage dropped to 13% and remained low through an 8-class model. Therefore, favoring parsimony and model stability, we selected a model with three classes. The prevalence of the three classes and the probabilities of reporting each reason given class membership are presented in Table 3.

Nearly one-third (29.36%) of the sample was characterized by vaping only for experimental reasons (*Vaping to Experiment class*). Among adolescents in this class, nearly 100% endorsed experimenting as a reason and only 5% or fewer endorsed each other reason. A second, much smaller class (7.29%) was characterized by vaping primarily to help quit regular cigarettes and because regular cigarette use was not permitted; adolescents in this class also had an elevated probability of vaping to get high and a somewhat elevated probability of reporting vaping to relax (*Vaping to Replace Cigarettes class*). The third and largest class was characterized primarily by vaping because it tastes good (*Vaping for Taste + Entertainment class*; 63.35% of the sample); vaping because it tastes good had the highest probability, with more than 50% of adolescents in this class endorsing this reason. Vaping to experiment, because of boredom, and to have a good time were also relatively high in this class, with more than 30% of adolescents in this class endorsing each of these reasons. The heterogeneity among adolescents in this class indicates the wide variety of reasons reported for vaping once adolescents who are vaping specifically to experiment or to replace cigarettes are accounted for.

## Predictors of latent class membership

**Bivariate associations with vaping classes**—Table 4 provides the bivariate and multivariable multinomial regression analysis results for models that examined predictors of latent class membership; the largest class, Vaping for Taste + Entertainment, was specified as the reference class for all analyses. Thus the following findings from bivariate analyses all hold in comparison to the Vaping for Taste + Entertainment class. Adolescents who vaped only flavors were significantly more likely to be in the Vaping to Experiment class (OR=1.80; 95% CI [1.35, 2.39]). Those who vaped in the past 30 days, used cigarettes, alcohol, or marijuana in the past 30 days were less likely to be in the Vaping to Experiment class (OR ranged from 0.16 for past 30-day vaping to 0.61 for past 30-day alcohol use). Adolescents who vaped only flavors were significantly less likely to be in the Vaping to Replace Cigarettes class (OR=0.21 [0.13, 0.33]). Those who reported cigarette use and marijuana use in the past 30-days were more likely to be in the Vaping to Replace Cigarettes class (OR=20.39 [12.18, 34.13] and OR=2.00 [1.32, 3.01], respectively). Finally, with regard to sociodemographic characteristics, girls were more likely than boys to be in the Vaping to Experiment class (OR=1.61 [1.27, 2.06]) and less likely to be in the Vaping to Replace Cigarettes class (OR=0.62 [0.40, 0.95]). Adolescents whose parent(s) had a college degree were less likely than those whose parents did not have a degree to be in the Vaping to Experiment class (OR=0.76 [0.60, 0.96]).

**Multivariable associations with vaping classes**—In the multivariable model, in which all covariates were entered simultaneously, four significant associations remained. Adolescents who reported past 30-day vaping and marijuana use were significantly less likely to be in the Vaping to Experiment class compared to the Vaping for Taste + Entertainment class (OR = 0.19 and OR = 0.66, respectively). Adolescents vaping only flavors were less likely to be in the Vaping to Replace Cigarettes class (OR = 0.38) and those using cigarettes in the past 30 days were more likely to be in the Vaping to Replace Cigarettes class (OR = 17.60) compared to the Vaping for Taste + Entertainment class.

## DISCUSSION

Based on simultaneous consideration of multiple self-reported reasons for vaping, this study found three distinct subgroups of adolescent vapers. The three classes provide important information on who is using for what primary reasons, constellation of reasons, and exclusion of other reasons. This information sheds new light on the phenomenon of vaping and its popularity among adolescents in the US. While a small subgroup of adolescents vaped primarily for cigarette-related reasons, most adolescents vaped for reasons unrelated to cigarettes. In addition, a third of the sample vaped exclusively to experiment and did not endorse social, enjoyment, or cigarette-related reasons for vaping.

A small, unique group reported vaping to replace their cigarette use, either as a means to quit smoking or because of the inconvenience of cigarette smoking. This class may suggest an important minority of adolescents who can benefit from vaping if it acts as a cigarette smoking cessation aid. However, while individuals of the cigarette replacement subgroup reported vaping at least in part to help them quit cigarettes, this group also had the highest



probability by far of reporting vaping because cigarettes were not permitted, suggesting this group may also vape to supplement their cigarette smoking. Moreover, recent (past-30 day) cigarette smoking was a very strong predictor of belonging to the vaping to replace cigarettes subgroup, further suggesting that vaping may not actually be reducing or eliminating smoking. This is consistent with the recent Surgeon General's report warning that vaping may only be beneficial if it leads to complete cigarette smoking cessation. Further, any amount of nicotine may still pose significant negative health consequences for adolescents.<sup>1</sup> Another concern for those in the cigarette replacement subgroup is their high probability of vaping to get high, which may indicate a longer-term risk. Other studies have found that using marijuana to get high is associated with continued, though not problematic, use.<sup>13</sup> Interestingly, the cigarette replacement subgroup did not have a high probability of vaping because of taste. This suggests that flavors may not be an important cessation tool for this subgroup interested in smoking cessation, unlike links between flavors and cessation suggested in previous work.<sup>28</sup> This group may be a particularly good target for adolescent smoking cessation programs because of interest in quitting smoking. Members of this group are young, likely early in their smoking career, and interested in smoking cessation, but have so far been unsuccessful in quitting. Future research regarding the relative health risks and benefits of vaping among adolescent cigarette users is needed.

We expected that other risk behaviors such as use of cigarettes, alcohol, and marijuana would be associated with lower odds of being in the Vaping to Experiment subgroup, based on research on other substance use showing that using to experiment is associated with lower risk behaviors.<sup>29,31</sup> However, in the multivariable model, only marijuana use remained significantly negatively associated with Vaping to Experiment. Vaping to Replace Cigarettes was strongly positively associated with cigarette use. These findings suggest there is some variation in risk for other substance use among vapers. Those vaping exclusively to experiment have a potentially lower risk for other substance use but perhaps not as uniformly across substances as we had expected.

Experimentation was an important motivator for vaping among many adolescents, similar to findings in research on reasons for other substance use.<sup>13</sup> More than half of all 12<sup>th</sup> grade vapers reported vaping to experiment, including a large subgroup (29%) vaping exclusively for experimental reasons, and very low probabilities (2% or less) of vaping for social reasons or enjoyment from the product itself such as its taste.

Vaping because it tastes good stood out as a primary reason in a large subgroup of vapers (Vaping for Taste and Entertainment subgroup) — a subgroup that seems to be unique among vapers compared to other substance users. This may suggest that marketing campaigns promoting flavorings are effective for a large portion of adolescent vapers and that concerns about the lack of regulation around vaping flavorings are warranted.<sup>1</sup>

We failed to find a subgroup of individuals who used primarily to relax or a subgroup that was primarily characterized by using for social and pleasurable reasons other than taste, a result different from what has been found in other studies examining patterns of reasons for alcohol, marijuana, and non-medical prescription drug use.<sup>12,13,31</sup> Vaping out of boredom, to have a good time, and to relax all had at least a 25% probability in the subgroup of

adolescents who reported vaping for taste and entertainment; vaping for taste and relaxation had a greater than 30% probability of endorsement among those vaping for cigarette-related reasons. Thus, while there are some similarities between patterns of adolescents' reasons for vaping and for other substance use, the nature of vaping among adolescents also appears to include reasons quite different from reasons for other substance use. Vaping may currently be seen by many adolescents more as a novelty than as something to do for a social or psychological effect, although even experimental use may still pose longer-term risks.<sup>32</sup>

This study had many strengths including a nationally representative sample of US 12<sup>th</sup> graders and use of a methodology that allowed us to examine the heterogeneity among adolescent vapers. However, it is important to point out some limitations. First, this study is limited to US 12<sup>th</sup> graders and does not include those who drop out of school before 12<sup>th</sup> grade or absentees, a small but potentially important segment of the adolescent population. Individuals who drop out prior to 12<sup>th</sup> grade typically use substances at higher rates than those who do not<sup>33</sup>; to our knowledge, there is no similar information with regard to vaping. Second, this study relies on self-reports which may be subject to misclassification or underreporting of substance use behaviors including vaping. Third, the measure of reasons had a "Mark all that apply" answer with a set that may not have included all of the most important reasons. Qualitative research on reasons for vaping may be helpful in gaining an even more nuanced understanding of reasons for adolescent vaping.

This study adds to the growing literature examining adolescent vaping by documenting the heterogeneity in why adolescents are vaping, and the relationship of patterns of reasons for vaping with cigarette smoking and other substance use. While only a minority of adolescents vape for cigarette-related reasons, this subgroup consumes nicotine through multiple mechanisms and deserves particular attention from the public health community. Adolescents who vape to experiment have lower risk of engaging in other substance use and thus are less in need of intervention, but they may also be at risk for escalation of vaping and other substance use in the future. It is not known if these vaping subgroups represent different stages along a vaping trajectory or if these subgroups remain stable over time. A prospective study examining how reasons for vaping change over time is needed to examine the evolution of vaping reasons and prospective associations with substance use behavior.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

This study was supported by National Institute on Drug Abuse grants R01DA037902 (to M. E. Patrick), R01DA001411 (to L. D. Johnston/R. A. Miech), and P50DA039838 (to L.M. Collins). The content is solely the responsibility of the authors and does not necessarily represent the official views of the sponsors. All authors made significant contributions to this study. The authors declare no conflicts of interest.

## References

1. U.S. Department of Health and Human Services. E-cigarette use among youth and young adults: a report of the Surgeon General. 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; 2016. <https://www.surgeongeneral.gov/library/2016ecigarettes/index.html> [Accessed January 15, 2017]
2. Miech, RA., Johnston, L., O'Malley, PM., et al. Monitoring the Future national survey results on drug use, 1975–2014: Volume I, secondary school students. Ann Arbor, MI: Institute for Social Research, The University of Michigan; 2015. [http://monitoringthefuture.org/pubs/monographs/mtf-vol1\\_2014.pdf](http://monitoringthefuture.org/pubs/monographs/mtf-vol1_2014.pdf) [Accessed January 15, 2017]
  3. Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students-United States, 2011–2014. *MMWR*. 2015; 64(14):381–385. [PubMed: 25879896]
  4. Centers for Disease Control and Prevention. [Accessed January 12, 2017] New CDC Vital signs: e-cigarette ads and youth. 2016. <http://www.cdc.gov/media/dpk/2016/dpk-vs-e-cigarettes.html>
  5. Greenhill R, Dawkins L, Notley C, et al. Adolescent awareness and use of electronic cigarettes: a review of emerging trends and findings. *J Adolesc Health*. 2016; 59(6):612–619. DOI: 10.1016/j.jadohealth.2016.08.005 [PubMed: 27693128]
  6. Miech R, Patrick ME, O'Malley PM, Johnston LD. E-cigarette use as a predictor of cigarette smoking: results from a 1-year follow-up of a national sample of 12th grade students. *Tobacco Control*. 2017; doi: 10.1136/tobaccocontrol-2016-053291
  7. Patrick ME, Miech RA, Carlier C, et al. Self-reported reasons for vaping among 8th, 10th, and 12th graders in the US: nationally-representative results. *Drug Alcohol Depend*. 2016; 165:275–278. DOI: 10.1016/j.drugalcdep.2016.05.017 [PubMed: 27286951]
  8. 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]
  9. Suris JC, Berchtold A, Akre C. Reasons to use e-cigarettes and associations with other substances among adolescents in Switzerland. *Drug Alcohol Depend*. 2015; 153:140–144. DOI: 10.1016/j.drugalcdep.2015.05.034 [PubMed: 26077606]
  10. Ambrose BK, Day HR, Rostron B, et al. Flavored tobacco product use among us youth aged 12–17 years, 2013–2014. *JAMA*. 2015; 314(17):1871–1873. DOI: 10.1001/jama.2015.13802 [PubMed: 26502219]
  11. Saddleson ML, Kozlowski LT, Giovino GA, et al. Enjoyment and other reasons for electronic cigarette use: results from college students in New York. *Addict Behav*. 2016; 54:33–39. DOI: 10.1016/j.addbeh.2015.11.012 [PubMed: 26704429]
  12. Coffman DL, Patrick ME, Palen LA, et al. Why do high school seniors drink? Implications for a targeted approach to intervention. *Prev Sci*. 2007; 8(4):241–248. DOI: 10.1007/s11121-007-0078-1 [PubMed: 17963040]
  13. Patrick ME, Bray BC, Berglund P. Reasons for marijuana use among young adults and long-term associations with marijuana use and problems. *J Stud Alcohol Drugs*. 2016; 77(6):881–888. DOI: 10.15288/jsad.2016.77.881 [PubMed: 27797689]
  14. McCabe SE, Cranford JA. Motivational subtypes of nonmedical use of prescription medications: results from a national study. *J Adolesc Health*. 2012; 51(5):445–452. DOI: 10.1016/j.jadohealth.2012.02.004 [PubMed: 23084165]
  15. Kozlowski LT, Warner KE. Adolescents and e-cigarettes: objects of concern may appear larger than they are. *Drug Alcohol Depend*.
  16. Barrington-Trimis JL, Urman R, Berhane K, et al. E-cigarettes and future cigarette use. *Pediatrics*. 2016; 138(1)doi: 10.1542/peds.2016-0379
  17. Glasser AM, Collins L, Pearson JL, et al. Overview of electronic nicotine delivery systems: a systematic review. *Am J Prev Med*. 2017; 52(2):e33–e66. DOI: 10.1016/j.amepre.2016.10.036 [PubMed: 27914771]
  18. Lanza ST, Russell MA, Braymiller JL. Emergence of electronic cigarette use in US adolescents and the link to traditional cigarette use. *Addict Behav*. 2017; 67:38–43. DOI: 10.1016/j.addbeh.2016.12.003 [PubMed: 27988415]
  19. Leventhal AM, Stone MD, Andrabi N, et al. Association of e-cigarette vaping and progression to heavier patterns of cigarette smoking. *JAMA*. 2016; 316(18):1918–1920. DOI: 10.1001/jama.2016.14649 [PubMed: 27825000]

20. Primack BA, Soneji S, Stoolmiller M, et al. Progression to traditional cigarette smoking after electronic cigarette use among U.S. adolescents and young adults. *JAMA Pediatr.* 2015; 169(11): 1018–1023. DOI: 10.1001/jamapediatrics.2015.1742 [PubMed: 26348249]
21. Miech RA, Patrick ME, O'Malley PM, Johnston LD. What are kids vaping? Results from a national survey of U.S. adolescents. *Tobacco Control.* 2016; doi: 10.1136/tobaccocontrol-2016-053014
22. Miech RA, O'Malley PM, Johnston LD, Patrick ME. E-cigarettes and the drug use patterns of adolescents. *Nicotine Tob Res.* 2016; 18(5):654–659. DOI: 10.1093/ntr/ntv217 [PubMed: 26416823]
23. Morean ME, Kong G, Camenga DR, et al. Latent class analysis of current e-cigarette and other substance use in high school students. *Drug Alcohol Depend.* 2016; 161:292–297. DOI: 10.1016/j.drugalcdep.2016.02.018 [PubMed: 26922282]
24. Miech, RA., Johnston, LD., O'Malley, PM., et al. Monitoring the Future national survey results on drug use, 1975–2015: Volume I, Secondary school students. Ann Arbor: Institute for Social Research, The University of Michigan; 2016. [http://monitoringthefuture.org/pubs/monographs/mtf-vol1\\_2015.pdf](http://monitoringthefuture.org/pubs/monographs/mtf-vol1_2015.pdf) [Accessed January 15, 2017]
25. Collins, LM., Lanza, ST. Latent class and latent transition analysis: with applications in the social, behavioral, and health sciences. New York, NY: Wiley; 2010.
26. Lanza, S., Dziak, J., Huang, L., et al. [Accessed December 1, 2016] PROC LCA & PROC LTA users' guide (Version 1.3. 2). 2015. <http://methodology.psu.edu>
27. PROC LCA & PROC LTA (Version 1.3.2) [computer program]. University Park, PA: The Methodology Center, Penn State; 2015. <http://methodology.psu.edu> [Accessed November 15, 2016]
28. Farsalinos KE, Romagna G, Tsiapras D, Kyrzopoulos S, Spyrou A, Voudris V. Impact of flavour variability on electronic cigarette use experience: an internet survey. *Int J Environ Res Pub Health.* 2013; 10(12):7272–7282. [PubMed: 24351746]
28. Johnston LD, O'Malley PM. Why do the nation's students use drugs and alcohol? Self reported reasons from nine national surveys. *J Drug Issues.* 1986; 16(1):29–66.
29. Lee CM, Neighbors C, Woods BA. Marijuana motives: Young adults' reasons for using marijuana. *Addict Behav.* 2007; 32(7):1384–1394. DOI: 10.1016/j.addbeh.2006.09.010 [PubMed: 17097817]
30. Patrick ME, Schulenberg JE, O'Malley PM, et al. Age-related changes in reasons for using alcohol and marijuana from ages 18 to 30 in a national sample. *Psychol Addict Behav.* 2011; 25(2):330–339. DOI: 10.1037/A0022445 [PubMed: 21417516]
31. Terry-McElrath YM, O'Malley PM, Johnston LD. Reasons for drug use among American youth by consumption level, gender, and race/ethnicity: 1976–2005. *J Drug Issues.* 2009; 39(3):677–714. [PubMed: 20628558]
32. Soneji S, Barrington-Trimis JL, Wills TA, et al. Association between initial use of e-cigarettes and subsequent cigarette smoking among adolescents and young adults: a systematic review and meta-analysis. *JAMA Pediatr.* 2017; 171(8):788–797. DOI: 10.1001/jamapediatrics.2017.1488 [PubMed: 28654986]
33. Substance Abuse and Mental Health Services Administration. Results from the 2013 National Survey on Drug Use and Health: summary of national findings, NSDUH Series H-48, HHS Publication No. (SMA) 14-4863. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2014. <http://www.samhsa.gov/data/sites/default/files/NSDUHresultsPDFWHTML2013/Web/NSDUHresults2013.pdf> [Accessed November 20, 2017]

### **IMPLICATIONS AND CONTRIBUTIONS**

This study identifies patterns of why adolescents vape and how these reasons relate to cigarette smoking and other substance use. A minority of adolescents vape for cigarette-related reasons, consuming nicotine through multiple mechanisms. Adolescents who vape to experiment have lower risks, but may be at risk for escalation of vaping or other substance use.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

**Table 1**

Characteristics of 12th graders with a history of vaping

	% (weighted)
<u>Reasons for vaping</u>	
Experiment	54.59
Tastes good	36.66
Boredom	21.83
Good time	20.27
Relax	18.88
Looks cool	13.34
Get high	6.81
Help quit cig	8.55
Cig not permitted	5.16
Hooked	0.92
<u>Covariates</u>	
Female	46.68
White	63.46
Parent(s) with college degree	53.69
Vaping only flavors	64.14
Past 30-day vaping	39.86
30-day cigarette use	28.24
Past 30-day alcohol use	58.21
Past 30-day marijuana use	39.02

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

**Table 2**

Model fit information for competing latent class models

Number of classes	df	AIC	BIC	aBIC	Entropy
2	238	1531.98	1632.07	1578.05	0.76
3*	229	1125.91	1278.99	1196.38	0.82
4	220	876.71	1082.77	971.57	0.77
5	211	754.54	1013.59	873.79	0.81
6	202	650.58	962.62	794.23	0.79
7	193	568.29	933.32	736.33	0.80
8	184	472.86	890.88	665.29	0.84

\* Selected as final model.

Note. Df=degrees of freedom; AIC = Akaike Information Criterion; BIC=Bayesian Information Criterion; aBIC=adjusted Bayesian Information Criterion

**Table 3**

Probabilities of reasons for vaping by latent class

	<b>Experiment</b>	<b>Replace Cigarettes</b>	<b>Taste+Entertainment</b>
Latent class membership probabilities	0.294	0.073	0.634
<b>Reasons</b>			
Experiment	0.999	0.151	0.372
Tastes good	0.051	0.358	0.521
Boredom	0.010	0.166	0.326
Good time	0.010	0.075	0.312
Relax	0.022	0.337	0.253
Looks cool	0.024	0.054	0.196
Get high	0.000	0.700	0.101
Help quit cigarettes	0.010	0.945	0.025
Cigarettes not permitted	0.010	0.516	0.021
Hooked	0.000	0.039	0.010

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript



Latent class bivariate and multivariable regression models: Predictors of latent class membership

**Table 4**

	Bivariate (N=2664)		Multivariable (N=2029)	
	Vaping to Experiment OR (95% CI)	Vaping to Replace Cigarettes OR (95% CI)	Vaping to Experiment OR (95% CI)	Vaping to Replace Cigarettes OR (95% CI)
Vaping only flavors	<b>1.80 (1.35, 2.39)*</b>	<b>0.21 (0.13, 0.33)*</b>	1.20 (0.93, 1.55)	<b>0.38 (0.24, 0.59)*</b>
Past 30-day vaping	<b>0.16 (0.11, 0.22)*</b>	1.46 (0.88, 2.43)	<b>0.19 (0.14, 0.25)*</b>	0.80 (0.52, 1.24)
30-day cigarette use	<b>0.54 (0.37, 0.78)*</b>	<b>20.39 (12.18, 34.13)*</b>	0.89(0.65, 1.20)	<b>17.60 (10.99, 28.21)*</b>
Past 30-day alcohol use	<b>0.61 (0.48, 0.77)*</b>	1.29 (0.82, 2.03)	0.95 (0.74, 1.21)	0.72 (0.47, 1.10)
Past 30-day marijuana use	<b>0.51 (0.39, 0.66)*</b>	<b>2.00 (1.32, 3.01)*</b>	<b>0.66 (0.51, 0.86)*</b>	0.76 (0.48, 1.19)
Female	<b>1.61 (1.27, 2.06)*</b>	<b>0.62 (0.40, 0.95)*</b>	1.20 (0.94, 1.52)	1.10 (0.72, 1.68)
White	1.00 (0.79, 1.26)	1.26 (0.80, 1.97)	1.28 (1.00, 1.64)	0.80 (0.50, 1.25)
Parent(s) with college degree	<b>0.76 (0.60, 0.96)*</b>	0.81 (0.51, 1.29)	0.78 (0.61, 1.00)	0.78 (0.51, 1.17)

\* p-value<0.05

Note: Reference category for the regression models is the Vaping for Taste + Entertainment class.