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Latent class analysis of current e-cigarette and other substance use in high school students

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ABSTRACT

Objective: There is limited research on adolescents' use of e-cigarettes and other substances.
Materials and methods: 2241 Connecticut high school students completed anonymous, cross-sectional surveys assessing e-cigarette and other substance use. We used latent class analysis (LCA) to: (1) classify students based on their past-month use of e-cigarettes, cigarettes, cigars, smokeless tobacco, hookah, blunts, marijuana, and alcohol, and (2) determine if age, sex, or race predicted class membership.
Results: Past-month e-cigarette use was 11.6%, and use rates for the remaining substances ranged from 2.8% (smokeless tobacco) to 20.7% (alcohol). The optimal latent class solution comprised four classes: (1) primarily abstainers (81.6%; abstainers), (2) primarily e-cigarette and alcohol users (4.6%; E-cigarette–Alcohol), (3) primarily marijuana and alcohol users (6.9%; Marijuana–Alcohol), and (4) primarily users of all products (6.9%; All Products). Compared to abstainers, (1) all substance-using classes comprised older students, (2) the All Products and E-cigarette–Alcohol classes were more likely to comprise males and less likely to comprise Blacks, and (3) the Marijuana–Alcohol class was more likely to comprise Blacks and Latinos. Relative to the All Products and E-cigarette–Alcohol classes, the Marijuana–Alcohol class was more likely to comprise females, Blacks, and Latinos.
Conclusions: LCA identified four substance use classes, two of which included elevated e-cigarette use. Class membership differed by age, sex, and race. Additional research should evaluate characteristics that may explain the different product use profiles identified in the current study including cultural differences, peer group norms, and differing perceptions of the harmfulness of each substance.

1. Introduction

E-cigarettes are gaining popularity among all age groups in the U.S. despite limited research on their safety. Of particular concern, rates of e-cigarette use are growing exponentially among youth. With regard to past-month use, the 2014 National Youth Tobacco Survey indicated that e-cigarette use tripled among high school (HS) students from 4.5% in 2013 to 13.4% in 2014, surpassing all other tobacco use, including traditional cigarettes (9.2%; Arrazola et al., 2015). Similarly, results from a recent, large survey study conducted in Connecticut found that 12.0% of HS students reported past-month e-cigarette use (Krishnan-Sarin et al., 2015).

Research suggests that e-cigarette use among adolescents is associated with cigarette smoking, and there is evidence that e-cigarette use may maintain nicotine addiction among current tobacco users or promote dual use of e-cigarettes and other tobacco products (Krishnan-Sarin et al., 2015; Camenga et al., 2014; Dutra and Glantz, 2014). There also is concern that e-cigarette use among never-smokers may lead to nicotine addiction and/or serve as gateway to the use of other tobacco products including cigarettes. For instance, in a large, recent survey study, 24.8% of e-cigarette users who had never smoked a cigarette reported initiating e-cigarette use with e-cigarettes that did not contain nicotine and subsequently switching to using e-cigarettes containing nicotine (Krishnan-Sarin et al., 2015). Furthermore, a recent study indicated that e-cigarette use among youth prospectively predicts the initiation of cigarette smoking one year later (Primack et al., 2015). Finally, there is emerging evidence that adolescent

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e-cigarette users are more likely than non-users to engage in polysubstance use (e.g., Camenga et al., 2014; Miech et al., 2015; Morean et al., 2015), perhaps reflecting a broader, underlying profile of substance-related risk. Results of a recent study that analyzed data from Monitoring the Future indicated that e-cigarette users are more likely than non-users to smoke cigarettes, binge drink, smoke marijuana, and take prescription medications that were not prescribed to them by a doctor (i.e., amphetamines, sedatives including barbiturates, tranquilizers, and/or narcotics; Miech et al., 2015). Adolescent e-cigarette users also have been shown to be more likely than adolescents who smoke cigarettes exclusively to smoke hookah and blunts (Camenga et al., 2014). Finally, a recent study indicated that adolescent e-cigarette users are using e-cigarettes to vaporize marijuana at concerning rates (Morean et al., 2015). As e-cigarettes continue to gain popularity, developing a better understanding of the link between adolescent e-cigarette use and the use of a wide range of other commonly used substances is critical to identifying the role e-cigarettes may play in substance use among youth.

Prior research indicates that latent class analysis (LCA), which empirically identifies subgroups of participants based on similar patterns of responses, is a valuable statistical tool for identifying youth substance use profiles (e.g., Bohnert et al., 2014; Lanza and Rhoades, 2013; Miech et al., 2015; Tomczyk et al., 2015). However, only one study of which we are aware has used LCA to identify adolescent substance use profiles that include e-cigarettes; Miech et al. (2015) used LCA to identify substance use profiles based on past-month e-cigarette use, cigarette use, marijuana use, binge drinking, and prescription medication misuse. Among 10th grade students and 12th grade students, classes were identified that largely comprised abstainers (probability of substance use ranged from 0.01 for cigarettes to 0.07 for e-cigarettes in 10th grade and from 0.02 for cigarettes to 0.08 for marijuana in 12th grade) and that comprised polysubstance users (probability of substance use ranged from 0.26 for prescription medications to 0.70 for marijuana in 10th grade and from 0.30 for prescription medications to 0.83 for marijuana in 12th grade). Among 12th grade students, a second class of polysubstance users was identified that comprised predominantly e-cigarette users (probability of substance use ranged from 0.01 for prescription medications to 0.93 for e-cigarettes). The study conducted by Miech et al. (2015) makes an important contribution to the literature. However, the study did not examine the use of other tobacco products that previously have been linked to cigarette and/or e-cigarette use like cigars, hookah, and blunts (e.g., Camenga et al., 2014). Thus, it remains important to evaluate how the use of a wide range of tobacco products contributes to adolescent substance use profiles across the full range of high school students.

In the current study, we examined HS students' current use of e-cigarettes, cigarettes, cigars, smokeless tobacco, hookah, blunts, marijuana, and alcohol. We first examined past-month use rates of each product within the analytic sample (i.e., the sample of adolescents who had non-missing past-month substance use data for all substances). Latent class analysis was then used to determine profiles of past-month product use. Within the same model, multinomial logistic regression was used to evaluate the extent to which demographic characteristics (i.e., age, sex, race) were associated with class membership. Consistent with prior research, we hypothesized that one of the identified latent classes would represent students who engaged in little or no past month substance use (i.e., abstainers) and that one group would represent users of multiple substances. However, given the relative novelty of the current study, we did not outline any additional hypotheses regarding what substance use profiles may be identified via LCA or how the demographic variables would relate to the identified classes.

2. Material and methods

2.1. Participants

In November 2013, adolescents attending 4 HSs ($N = 3614$) in Southeastern CT completed an anonymous survey assessing attitudes toward and use of e-cigarettes and other tobacco products. Due to a request from the administration of one HS that questions explicitly assessing the quantity and frequency of alcohol and marijuana use be omitted from the survey, 2737 students received questions assessing tobacco, e-cigarette, marijuana, and alcohol use. Given the aims of the current study, the analytic sample comprised data from 2241 students who had non-missing past-month data for all products assessed. The analytic sample was 54.4% female and 65.1% White with a mean age of 15.60 (SD = 1.19) years.[1] Students were distributed evenly across grades 9–12.

2.2. Procedures

The Institutional Review Board of Yale University and the local school administrators and superintendents approved the study. Passive parental permission was obtained prior to survey administration. For students, completing the survey indicated consent/assent. Prior to completing the survey, students were informed that the survey was anonymous and that their responses would be kept confidential. Students completed the survey during their homeroom periods.

2.3. Measures

2.3.1. Demographic information. Students reported on their age, sex, and race/ethnicity.

2.3.2. E-cigarette, cigar, smokeless tobacco, hookah, and blunt use. Current e-cigarette, cigar, smokeless tobacco, hookah, and blunt use was determined via the following question: "During the past 30 days, on how many days did you [use the respective product]?" (open-ended response). Those who reported using a product at least once in the past 30 days were classified as current users.

2.3.3. Cigarette use. Current cigarette smoking was determined based on the following question, "During the past 30 days, on how many days did you smoke cigarettes?" Answer choices included 0–28, and everyday. Students who reported smoking cigarettes on at least 1 day in the past month were classified as current smokers.

2.3.4. Alcohol and marijuana use. Current alcohol and marijuana use status, respectively, were determined based on the following question: "During the past 30 days, on how many days did you use alcohol/marijuana?" Answer choices included, "I have never tried alcohol/marijuana, I have tried alcohol/marijuana but did not use it in the past 30 days, 1–28, and everyday." Students who reported using alcohol/marijuana on at least 1 day in the past month were classified as current users.

[1] The analytic sample differed significantly from the sample of 496 students who had missing past-month substance use data. Specifically, the analytic sample included more females (54.4% vs. 44.2%), more White students (65.1% vs. 54.4%), fewer Black students (9.1% vs. 14.8%), fewer Latino students (14.3% vs. 18.9%), fewer cigarette smokers (7.2% vs. 14.5%), fewer marijuana users (14.5% vs. 26.4%), and fewer alcohol users (20.7% vs. 38.1%). However, the full set of analyses described in the manuscript also was run within the total sample ($N = 2737$). The pattern of findings regarding latent class structure and demographic differences observed between latent classes directly mirrored that reported in the paper.

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