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Prospective predictors of flavored e-cigarette use: A one-year longitudinal study of young adults in the U.S

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ABSTRACT

Introduction: E-cigarettes with fruit and candy flavors are appealing among young adults. This study examined the prospective predictors of young adults' flavored e-cigarette use to inform regulation and prevention efforts. **Methods:** We used the wave 1 (2013–2014) and wave 2 (2014–2015) data of the Population Assessment of Tobacco and Health (PATH) Study, a nationally representative cohort study of U.S. youth and adults. We analyzed a sample of young adults aged 18–34 ($n = 12,383$) to identify wave 1 prospective predictors (i.e., socio-demographic characteristics, mental health symptoms, marijuana use, tobacco use, and e-cigarette harm perceptions) of wave 2 flavored e-cigarette use.

Results: At wave 2, 8.0% of young adults used e-cigarettes, and 2.5% and 5.5% used tobacco and menthol (TM) and non-tobacco and non-menthol flavors (NTM) flavors, respectively. In the multivariable model, significant prospective predictors (wave 1) of NTM flavored e-cigarette use compared to TM flavored e-cigarette use (wave 2) were younger age (18–24 years) ($AOR = 1.82, p < 0.001$), female gender ($AOR = 1.81, p < 0.001$), education attainment of high school graduate and higher ($AOR = 1.60, p = 0.024$), marijuana use ($AOR = 1.96, p < 0.001$), ever but non-past-month cigarette smoking ($AOR = 2.75, p < 0.001$), never cigarette smoking ($AOR = 5.08, p = 0.016$), and lower harm perception of e-cigarettes ($AOR = 1.59, p = 0.005$).

Conclusion: This study highlights high rates of NTM flavor use and specific predictors of NTM flavored e-cigarettes use among young adults in the U.S. Regulation and prevention efforts for curbing flavored e-cigarette use among young adults should focus on these risk factors and high-risk groups (e.g., 18–24 years, female, and never cigarette smokers).

1. Introduction

In recent years, electronic cigarettes, or e-cigarettes, have increased in popularity among young adults in the U.S. In 2013, 21.6% of 12–24 year-olds had experimented with e-cigarettes and 5.1% were current users (Schoenborn and Gindi, 2015). Flavored e-cigarettes, enhanced to taste like fruit, candy, chocolate, and other sweet flavors, are particularly appealing to young adults (Bonhomme et al., 2016; Choi et al., 2012) and might be a primary reason for this age group to initiate e-cigarette use (Shiplo et al., 2015). During 2013–2014, among 18–24 and 25–29 year-old current e-cigarette users in the U.S., 85% and 73% used flavored e-cigarettes, respectively (Bonhomme et al., 2016).

Despite their popularity, flavored e-cigarette use might lead to adverse health consequences. First, e-cigarette flavoring ingredients might be toxic to inhale (Leigh et al., 2016) and result in harm to the respiratory system (Allen et al., 2016; Behar et al., 2013; Callahan-Lyon, 2014). Second, e-cigarettes with attractive flavors could potentially

increase nicotine addiction by enhancing the rewarding and reinforcing properties associated with vaping (Audrain-McGovern et al., 2016) as well as promote regular and more frequent e-cigarette use (Chen, 2018; Huang et al., 2016; Morean et al., 2018). Third, flavored e-cigarette use among young, non-cigarette smokers might escalate cigarette smoking intentions (Chen et al., 2017), leading to increased cigarette initiation in the future. Finally, young adult users of flavored tobacco generally may be more likely to develop persistent tobacco use patterns compared to non-using peers (Villanti et al., 2013).

Due to the numerous negative health impacts of flavored e-cigarette use among young adults, efforts are much needed to further understand the sub-groups at risks of using flavored e-cigarettes to design prevention and intervention strategies for this group. Many studies have explored the demographic and psychosocial correlates of using flavored tobacco products including cigarettes, little cigars, and cigarillos. These studies found that correlates and predictors of flavored tobacco use include: young age (King et al., 2013; Kostygina et al., 2016; Rath et al.,

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2016; Smith et al., 2016; Villanti et al., 2013), female gender (Delnevo et al., 2015; King et al., 2013; Kostygina et al., 2016; Smith et al., 2016; Villanti et al., 2013), African American race (Delnevo et al., 2015; Kostygina et al., 2016; Smith et al., 2016; Sterling et al., 2016; Villanti et al., 2013), sexual identity (Rath et al., 2016), anxiety symptoms (Rath et al., 2016), and low income (King et al., 2013; Sterling et al., 2016). Evidence for education levels as a predictor of flavored tobacco use is mixed; one study found that lower levels of education predicted flavored tobacco products (Smith et al., 2016), whereas another study identified higher education as a predictor (Villanti et al., 2013). One study also identified marijuana use as a correlate of using flavored, non-cigarette tobacco products among young adults (Rath et al., 2016). Additionally, tobacco harm perceptions influence consumers' choice towards tobacco flavors; individuals who consider tobacco use less harmful or with more beneficial outcomes are more likely to use non-tobacco flavored products compared to those who perceive tobacco use more negatively (Ashare et al., 2007; Czoli et al., 2015; Thrasher et al., 2015).

Studies that examined the correlates and predictors of flavored e-cigarette use in specific have mostly focused on tobacco use as risk factors. Combustible tobacco use was found to be associated with flavored e-cigarette use (Chen, 2018; Farsalinos et al., 2013; Harrell et al., 2017; Tackett et al., 2015). This could be because e-cigarettes have been marketed and frequently used as a smoking cessation aid by adult cigarette smokers (Giovenco et al., 2014). Pertaining to e-cigarette flavors, never and former adult cigarette smokers are more likely to use fruity and candy flavored e-cigarettes than current smokers; while current smokers tend to use tobacco and menthol flavored e-cigarettes (Farsalinos et al., 2013; Harrell et al., 2017) potentially due to taste similarities between tobacco and menthol flavored e-cigarettes and cigarettes. Additionally, studies found e-cigarette use history to be an important risk factor for using flavored e-cigarettes; long-time e-cigarette users, as opposed to novice users, appear to be more likely to use fruity and candy flavored e-cigarettes (Chen, 2018; Tackett et al., 2015). These studies, however, were limited by their use of convenience samples and cross-sectional study designs.

No research has been conducted to investigate multiple predictors of U.S. young adults' flavored e-cigarette use, encompassing both risk factors previously shown to influence flavored tobacco use in general and flavored e-cigarette use in specific. Thus, this study was designed to fill this critical knowledge gap and used the wave 1 and wave 2 data of the Population Assessment of Tobacco and Health (PATH) Study, a nationally representative longitudinal study of U.S. adults and youth. Unlike previous research that categorized tobacco flavors as "flavored" versus "non-flavored", this study categorized e-cigarette flavors as tobacco and menthol (TM) flavors and non-tobacco and non-menthol (NTM) flavors. The distinction was important predominantly because of the sensory similarities between TM flavored e-cigarettes and regular and menthol cigarettes. Previous research has shown that TM flavored e-cigarette users might be different from users of NTM flavors in regards to their tobacco use history and socio-demographic characteristics (Farsalinos et al., 2013; Tackett et al., 2015; Yingst et al., 2015). Moreover, most of the U.S. localities that have restricted the sale of flavored e-cigarettes only banned NTM flavors and exempted TM flavors (Tobacco Control Legal Consortium, 2017). Thus, studies that distinguish users of TM versus NTM flavors hold great potential to inform the advancement and evaluation of regulations related to flavored e-cigarette products. The aim of this study was to identify prospective predictors of TM and NTM flavored e-cigarette use among young adults to identify those who would be most affected by tobacco flavor regulations and to inform prevention efforts in terms of who should be targeted for programming and what potential risk factors should be addressed by these efforts.

2. Methods

2.1. Sample

The PATH Study is a nationally representative, longitudinal cohort study of civilian, non-institutionalized adults and youth in the U.S. The PATH study used audio computer-assisted self-administered interviews in English and Spanish to collect information on tobacco use and health status and more information on the study design can be found elsewhere (Hyland et al., 2017). Waves 1 and 2 of the adult surveys of the PATH Study were collected between 2013–2014 and 2014–2015, respectively. For this prospective analysis, the sample was restricted to the 12,383 18–34-year-old respondents who completed both waves (retention rate = 81.8%). The subsample of past-month e-cigarette users at wave 2 ($n = 1421$) was used to identify the predictors of e-cigarette use with TM versus NTM flavors.

2.2. Measures

2.2.1. E-cigarette use status (wave 2)

E-cigarette use status was categorized as: Non-E-cigarette Use, E-cigarette Use with TM Flavors, and E-cigarette use with NTM Flavors. The respondents who did not report using e-cigarettes in the past 30 days were considered non-e-cigarette users. The respondents who used e-cigarettes that are "flavored to taste like menthol, mint, clove, chocolate, alcoholic drinks, candy or other sweets" were then asked which specific flavors they used. Response options included: (1) "Menthol/mint," (2) "Clove/spice," (3) "Fruit," (4) "Chocolate," (5) "An alcoholic drink," (6) "Candy/other sweets," and (7) "Some other flavor." Since tobacco flavors were not listed as one of the flavor options in the PATH Study but were one of the popular flavors used by young adult e-cigarette users (Harrell et al., 2017), those who did not select any of the flavor options were considered as using tobacco flavors. Respondents who considered as using tobacco flavors and respondents who only selected "Menthol/mint" flavors were categorized as "E-cigarette Use with TM Flavors." Respondents who selected one flavor other than "Menthol/mint" and more than one flavor including or not including "Menthol/mint" were categorized as "E-cigarette Use with NTM Flavors."

2.2.2. Sociodemographic characteristics (wave 1)

The following sociodemographic characteristics were included as potential predictors of flavored e-cigarette use at wave 2: age, sex, race, household income, education, and sexual identity (see Table 1 for variable categories).

2.2.3. Past-month mental health symptoms (wave 1)

A mental health symptom variable was constructed by using four questions from the Global Appraisal of Individual Needs—Short Screener (GAIN-SS) (Conway et al., 2017; Dennis et al., 2008). These questions have shown moderate to high reliability among youth and adult samples (Titus et al., 2008). Specifically, respondents were asked to identify the time period when they last experienced: (1) "Feeling very trapped, lonely, sad, blue, depressed, or hopeless about the future?" (2) "Sleep trouble, such as bad dreams, sleeping restlessly, or falling asleep during the day?" (3) "Feeling very anxious, nervous, tense, scared, panicked, or like something bad was going to happen?" and (4) "Becoming very distressed and upset when something reminded you of the past?" Response categories were: "Past month," "2 to 12 months ago," "Over a year ago," and "Never." Respondents who experienced at least one of the four symptoms during the past month were coded as having mental health symptoms (yes/no).

2.2.4. Past-month marijuana use (wave 1)

For individuals answering affirmatively to using "marijuana, hash, THC, grass, pot or weed" during their lifetime, they were further asked

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