



## Substances used in electronic vapor products among adults in the United States, 2017



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### ABSTRACT

**Introduction:** Electronic vapor products (EVPs), including e-cigarettes, can be used to aerosolize many substances. Examination of substances used in EVPs by US adults has been limited; we assessed past-year use of EVPs to deliver various substances.

**Methods:** Data came from the 2017 *SummerStyles* Survey, a web-based survey of US adults (N = 4107). Ever EVP users were asked if they had used nicotine, marijuana, flavors or “something else” in an EVP during the past year. Weighted estimates for any, exclusive, and combined EVP substance use were calculated among ever (n = 586) and current (past 30-day; n = 121) EVP users.

**Results:** Past-year use of nicotine, flavors, and marijuana in EVPs was 30.7%, 23.6%, and 12.5% among ever EVP users, respectively; and 72.3%, 54.6%, and 17.8% among current EVP users. Among ever EVP users, the most commonly used substances were nicotine only (29.6%), nicotine plus flavors (27.2%), flavors only (16.4%), and marijuana only (14.9%). Among current EVP users, the most common substances used were nicotine plus flavors (39.1%), nicotine only (29.6%), and flavors only (11.2%). Among ever users, males and 18–29 year olds were more likely to report use of flavors than females and respondents  $\geq 30$  years.

**Conclusions:** Approximately 7 in 10 current EVP users reported nicotine use, about 1 in 2 used flavors, and nearly 1 in 6 used marijuana. These findings suggest that EVPs are used to consume a variety of substances and could guide efforts to address tobacco and non-tobacco substance use.

### 1. Introduction

Electronic vapor products (EVPs), including e-cigarettes, can be used to aerosolize a variety of substances, including nicotine, flavors, and marijuana. Regardless of the substances used in EVPs, EVP aerosol can contain harmful and potentially harmful constituents, including heavy metals, volatile organic compounds, and cancer-causing agents (U.S. Department of Health and Human Services, 2016). Nicotine is highly addictive, toxic to fetuses, and can harm brain development, which occurs into the mid-20s (U.S. Department of Health and Human Services, 2016). Nicotine concentrations in EVP liquids can vary widely (Farsalinos et al., 2014), may be inconsistently or inaccurately labeled (Lisko, Tran, Stanfill, Blount, & Watson, 2015) and some devices deliver nicotine more effectively than others (U.S. Department of Health and

Human Services, 2016). Nicotine-containing e-cigarettes may have the potential to benefit nonpregnant adult cigarette smokers if used as a complete substitute for combustible tobacco products (U.S. Department of Health and Human Services, 2016).

Compared to nicotine, less is known about the health effects of using marijuana and cannabinoids. Use of marijuana plants or plant components are associated with some therapeutic benefits, including the management of chronic pain in adults, chemotherapy-induced nausea and vomiting, and patient-reported symptoms from multiple sclerosis (National Academies of Sciences Engineering and Medicine, 2017). Adverse health effects associated with marijuana use include: increased risk of respiratory problems; declines in memory, attention, and learning; increased occurrence of schizophrenia and other psychoses; increased dependence on cannabis and other substances; and increased

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risk of low birth weight among babies exposed *in utero* (National Academies of Sciences Engineering and Medicine, 2017). Although smoked marijuana contains many of the same toxins, and carcinogens as tobacco smoke (Moir et al., 2008), there is insufficient data about the specific health effects when vaporized. Users who vaporize marijuana typically use concentrates that can contain substantially higher THC levels than levels found in dried marijuana plant material, presenting additional potential risk of dependence and acute adverse health effects (Aston, Farris, Metrik, & Rosen, 2019; Murray, Quigley, Quattrone, Englund, & Di Forti, 2016). The use of multiple substances is common, as well. For example, most past-month marijuana users are tobacco product users, too, (Schauer, Berg, Kegler, Donovan, & Windle, 2016) although it is not known how much overlap exists between adults who vape nicotine and those who vape marijuana. As states consider legalizing marijuana sales to and use by adults, shifts in the acceptability of policies related to e-cigarettes could occur.

Flavors are a common constituent of EVPs, with almost 8000 unique marketed flavors (Zhu et al., 2014), but their health effects are not well understood. Flavors appeal to youth (U.S. Department of Health and Human Services, 2016) and young adults (those aged approximately 18–24 years) (Chen, Green, Arria, & Borzekowski, 2018; Harrell et al., 2017). EVP flavors may contain potentially harmful chemical constituents which can cause declines in respiratory function and airway epithelial damage when inhaled (U.S. Department of Health and Human Services, 2016). In addition, the risks of inhaling certain flavorings are unknown (National Academies of Sciences Engineering and Medicine, 2018) and flavor additives are now appearing in hash oils for vaping (Peace, Butler, Wolf, Poklis, & Poklis, 2016). Some suggest that flavored EVP use could help adult smokers quit conventional cigarette smoking; however, the scientific data about the efficacy of e-cigarettes are inconclusive, and the extent to which flavors may affect cessation is uncertain (Brandon et al., 2019; Chen, 2018).

There is limited recent national data examining the substances used in EVPs among US adults (Chen et al., 2018; Coleman et al., 2017; Harrell et al., 2017; Jones, Hill, Pardini, & Meier, 2016; Kenne, Fischbein, Tan, & Banks, 2017; Marynak et al., 2017; Morean, Lipshie, Josephson, & Foster, 2017; Schauer, King, Bunnell, Promoff, & McAfee, 2016; Schneller et al., 2018). Few studies have examined the breadth of substances used in EVPs among a sample of adults with a wide age range, and more recent data are needed given the rapidly changing tobacco and marijuana product landscape. To our knowledge, no studies have previously estimated the use of common combinations of substances, particularly flavors, among adults. Monitoring all substances used in EVPs is important to understand usage patterns and substance use overlap. This study assessed the prevalence of self-reported past-year use of EVPs to deliver nicotine, marijuana, flavors, and other substances among adults in the United States.

## 2. Methods

### 2.1. Data source

Data were from the 2017 *SummerStyles* Survey, a web-based panel survey of US adults aged 18 years or older ( $N = 4107$ ) conducted by using Growth from Knowledge's KnowledgePanel product. Participants to KnowledgePanel ( $n \approx 55,000$ ) were randomly recruited by using probability-based address sampling. Surveys for *SpringStyles* were sent to a random sample of KnowledgePanel participants. Participants in *SummerStyles* were selected from *SpringStyles* respondents; 74% of *SpringStyles* participants responded to *SummerStyles*.

### 2.2. Measures

Ever and current EVP use statuses were respectively determined by a response of *Electronic Vapor Products* to the questions, "The next few questions are about nicotine. Have you ever tried any of the following

products, even just one time?" and "In the past 30 days, which of the following products have you used at least once?" Ever or current EVP users then were asked, "In the past year, have you used an electronic vapor product (e.g., e-cigarette, e-hookah, e-cigar, e-pipe, hookah pen, vape pen, or some other electronic vapor product) with any of the following substances?" Responses options included: *nicotine; marijuana, THC, hash oil, BHO, THC wax, or dabs; flavor; something else; or I have not used an electronic vapor product in the past year*. Respondents could select multiple substance response options.

### 2.3. Statistical analyses

Data were weighted to match US current population survey distributions on gender, age, household income, race or ethnicity, household size, education, US Census region, and metropolitan status. Weighted prevalence estimates of any EVP substance use during the past year were calculated separately among ever ( $n = 586$ ) and current ( $n = 121$ ) EVP users. Patterns of past-year EVP substance use, including exclusive use of each substance (e.g., nicotine only), and common substance combinations (e.g., nicotine and flavors) were examined. Analyses were conducted by using SAS callable SUDAAN version 11. Past-year use of each EVP substance was examined by socio-demographic characteristics; differences were determined by the chi square test. ( $P < 0.05$  was considered statistically significant.)

## 3. Results

Among ever EVP users, 30.7% reported any past-year use of nicotine, 23.6% reported any flavor use in EVPs, and 12.5% reported any marijuana use. Current EVP users reported a prevalence of any past-year nicotine use of 72.3%, any flavor use (54.6%), and any marijuana use (17.8%) (Table 1). In addition, among ever EVP users, males (28.3%) and respondents aged 18–29 years (31.7%) had a higher prevalence of reporting flavor use than females (17.8%) and respondents aged 30 years or older (20.4%), respectively ( $P < 0.05$ ). Among current EVP users, a higher proportion of males (63.2%) reported flavor use than females (38.5%;  $P < 0.05$ ). No other sociodemographic differences in use of nicotine, marijuana, or flavors were observed among ever or current EVP users.

Among ever EVP users, 29.6% reported using only nicotine in an EVP during the past year, 27.2% used nicotine and flavors, 16.4% used only flavors, 14.9% used only marijuana, and 7.8% used nicotine and marijuana (Table 2). Among current EVP users, the most common substances and substance combinations used during the past year were nicotine and flavors (39.1%), followed by nicotine only (29.6%), and flavor only (11.2%).

## 4. Discussion

Among adult EVP users, nicotine was the most commonly reported substance used in EVPs. More than 3 in 10 ever EVP users and 7 in 10 current EVP users reported using EVPs with nicotine in the past year. Among current EVP users, more than 1 in 2 reported using devices with flavors, and nearly 1 in 6 reported use for marijuana.

These findings reflect the complexity of EVP use surveillance and suggest that the devices are used for a variety of substances. Our findings that nicotine and flavors are the most commonly used substances in EVPs are consistent with previous studies, although estimates of use differ across studies (Coleman et al., 2017; Harrell et al., 2017; Jones et al., 2016; Marynak et al., 2017; Schneller et al., 2018). Retail sales data indicate that almost all e-cigarette products sold in assessed channels contained nicotine (Marynak et al., 2017). However, these data do not include tobacco specialty shops, vape shops, or online retailers; thus, they could be underestimated. About 90% of established adult e-cigarette users report using an EVP that contains nicotine (Coleman et al., 2017). Among college students, 37% reported ever use

**Table 1**Any past-year use<sup>1</sup> of nicotine, flavors, and marijuana in electronic vapor products among US adults, 2017.

	Ever Electronic Vapor Product Users (n = 586)			Current (past 30-day) Electronic Vapor Product Users (n = 121)				
	n	Nicotine % (95% CI)	Flavors % (95% CI)	Marijuana % (95% CI)	n	Nicotine % (95% CI)	Flavors % (95% CI)	Marijuana % (95% CI)
Overall	586	30.7 (26.7–35.1)	23.6 (19.9–27.9)	12.5 (9.7–15.9)	121	72.3 (62.4–80.4)	54.6 (44.4–64.4)	17.8 (11.5–26.5)
<i>Sex</i>								
Male	313	31.6 (26.0–37.7)	28.3 (22.8–34.5)	15.1 (11.1–20.2)	73	75.5 (63.0–84.8)	63.2 (49.9–74.8)	15.0 (8.2–25.9)
Female	273	29.7 (24.0–36.0)	17.8 (13.4–23.4)*	9.2 (6.0–13.9)	48	66.4 (49.7–79.8)	38.5 (25.0–54.0)*	23.1 (12.4–39.1)
<i>Age (y)</i>								
18–29	120	28.8 (20.7–38.5)	31.7 (23.2–41.7)	13.1 (7.9–20.9)	31	59.3 (40.0–76.1)	67.3 (47.6–82.4)	23.6 (11.6–42.0)
≥ 30	466	31.5 (27.0–38.5)	20.4 (16.7–24.7)*	12.2 (9.2–16.1)	90	78.8 (68.0–86.7)	48.2 (36.8–59.8)	14.9 (8.5–24.9)
<i>Race or ethnicity</i>								
White, non-Hispanic	442	31.3 (26.7–36.3)	22.5 (18.3–27.3)	12.9 (9.8–16.9)	88	77.1 (66.1–85.3)	56.6 (45.0–67.5)	14.5 (8.5–23.7)
Non-white	144	29.5 (21.9–38.5)	26.2 (18.9–35.0)	11.5 (6.7–18.9)	33	62.6 (42.9–78.9)	50.5 (31.9–68.9)	24.6 (11.9–44.0)
<i>Annual household income</i>								
< \$60,000	295	33.8 (27.9–40.2)	26.5 (21.0–32.7)	12.2 (8.4–17.4)	69	72.0 (58.2–82.7)	55.8 (42.2–68.7)	**
≥ \$60,000	291	27.3 (22.0–33.4)	20.5 (15.7–26.3)	12.8 (9.1–17.5)	52	72.7 (58.3–83.6)	52.6 (37.9–66.9)	24.5 (14.1–39.1)
<i>Education</i>								
≤ High school/GED <sup>2</sup>	254	33.2 (26.9–40.2)	26.5 (20.6–33.4)	11.8 (7.9–17.4)	61	75.1 (61.3–85.2)	55.7 (41.3–69.2)	**
> High school	332	28.5 (23.5–34.1)	21.1 (16.6–26.3)	13.1 (9.6–17.6)	60	69.0 (54.2–80.7)	53.2 (39.3–66.7)	19.8 (10.8–33.6)
<i>US Census region<sup>3</sup></i>								
Northeast	107	31.0 (22.2–41.4)	25.4 (17.3–35.8)	12.3 (7.0–20.7)	23	61.6 (37.1–81.4)	44.7 (24.2–67.2)	**
Midwest	135	27.3 (19.6–36.7)	24.2 (16.4–34.2)	**	30	77.8 (56.5–90.5)	58.5 (38.3–76.2)	**
South	195	34.0 (26.9–42.0)	25.0 (18.8–32.4)	9.2 (5.1–15.9)	35	71.3 (53.7–84.1)	70.0 (52.5–83.2)	**
West	149	29.6 (22.1–38.5)	20.4 (14.0–28.9)	18.9 (13.0–26.7)	33	75.8 (57.7–87.8)	46.1 (28.6–64.6)	29.2 (15.9–47.2)

<sup>1</sup> Substance groups are not mutually exclusive.<sup>2</sup> GED = General Educational Development.<sup>3</sup> Northeast (Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey); Midwest (North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio); South (Delaware, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas); West (Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona, Washington, Oregon, Nevada, California, Hawaii, Alaska).\* Chi-square test statistically significant ( $P < 0.05$ ) for differences.\*\* Estimate is suppressed (relative standard error is  $\geq 30\%$ ).

of nicotine in EVPs (Jones et al., 2016). Consumers, especially young adults who do not see a product label or who view a label that does not clearly disclose contents, may not be aware of the presence of nicotine in EVPs.

Marijuana use in EVPs has not been explored in detail. Our results indicate that almost 18% of current EVP users used marijuana in their

EVP device during the past year, which is higher than the previously reported estimate of lifetime marijuana vaporization (17.8%) among current e-cigarette or vape pen users (Morean et al., 2017). In addition, a national study found that in 2014, 7.6% of current adult marijuana users report using a vaporizer or other electronic device as their mode of use (Schauer, King, et al., 2016). Marijuana use in EVPs appears to be

**Table 2**Patterns of past-year use of nicotine, flavors, and marijuana in electronic vapor products among US adults, 2017<sup>1</sup>.

	Ever Electronic Vapor Product Users (n = 277)		Current (past 30-day) Electronic Vapor Product Users (n = 116)	
	n	% (95% CI)	n	% (95% CI)
Nicotine only	86	29.6 (24.0–36.0)	34	29.6 (21.1–39.9)
Nicotine + flavors	75	27.2 (21.6–33.6)	46	39.1 (29.6–49.6)
Flavors only	43	16.4 (11.9–22.3)	13	11.2 (6.1–19.6)
Marijuana only	42	14.9 (10.7–20.4)	*	*
Nicotine + marijuana (with or without flavors)	21	7.8 (4.8–12.2)	*	*
Other combination	*	*	*	*

<sup>1</sup> Analyses limited to past-year electronic vapor product users.\* Estimate is suppressed (relative standard error is  $\geq 30\%$ ).

more common among adults aged < 25 years than older adults; about 29% of college students report ever marijuana use in EVPs (Jones et al., 2016). In another study, approximately 7% of college students reported ever use of non-nicotine substances in EVPs, with 78% of them reporting marijuana use (Kenne et al., 2017). However, differences in question wording, year of survey administration, and the population (e.g., ever and current e-cigarette users) limit comparability of estimates across studies.

Previous work has found that 65% of current adult e-cigarette users reported using flavors (Schneller et al., 2018). Consistent with our results, flavors are more commonly reported among younger people; 71% of adults aged 18–29 years nationwide reported that their first e-cigarette was flavored, compared with 44% of all adults nationwide (Harrell et al., 2017). In another study, adults aged 18–24 years and males were more likely to report nontobacco or menthol-flavored e-cigarette use (Chen et al., 2018). Moreover, findings of flavored use from the present study of adults were markedly lower than rates of flavored use from studies of youth during a comparable period (Ambrose et al., 2015).

This study has limitations. First, the small sample of current users limited examination of some subgroup differences. Second, self-reported use of substances in EVPs may be subject to bias, especially among young adults (Willett et al., 2019) and self-reported use of substances may not reflect the actual contents used in EVPs. Third, we only assessed past-year use of substances in EVPs, which is possibly an underestimation of lifetime use. Finally, potential measurement bias may have resulted from survey question wording given the reference to ‘nicotine’ in the ever EVP use question. Also, the term “electronic vapor product” may not have resonated with marijuana users, since they may refer to marijuana vaping using other terms (e.g., dab pen, vape) (Pearson, Reed, & Villanti, 2018).

#### 4.1. Conclusions

The changing landscape of tobacco and marijuana use necessitates comprehensive surveillance of substances used in EVPs. Although there are long-standing, validated survey questions available for tobacco product use, fewer questions are available for EVPs, particularly to examine the breadth of substances used in these devices. Additionally, surveillance methods to track retail sales data could also be expanded to identify sales for these and other EVP substances through other channels, including specialty shops, vape shops, or online retailers. As the product use landscape diversifies, tobacco and non-tobacco substance use control efforts can be guided by national, systematically collected data from population-based samples and by further exploration of the frequency and patterns of using various substances with EVPs.

#### Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

#### Contributors

Example: All authors contributed to the study concept and design. Dr. Gentzke and Ms. Phillips conducted statistical analyses. Dr. Trivers wrote the first draft of the manuscript and all authors contributed to interpreting the results and providing critical revisions for important intellectual content. All authors contributed to and have approved the final manuscript.

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#### Declaration of Competing Interest

There are no conflicts of interest by any author.

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