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# JUUL and other e-cigarettes: Socio-demographic factors associated with use and susceptibility in California

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ABSTRACT

This study examined which socio-demographic factors are associated with susceptibility (lack of commitment to avoid future use), past-12-month and past-30-day use of JUUL and other e-cigarettes, and reasons for and against using JUUL. An online survey of 3,075 Californians ages 15–29, including 24.3% who identified as LGBTQ, were recruited via social media in January-March 2019. Multi-level weighted logistic regression models suggest that LGBTQ participants were more likely to be susceptible to JUUL [AOR = 2.11 (1.60, 2.79) (parentheses include 95% Confidence Intervals)] and other e-cigarettes [AOR = 2.31 (1.75, 3.05)], and more likely to use JUUL [AOR = 1.27 (1.02, 1.58)] and other e-cigarettes [AOR = 1.66 (1.35, 2.05)] in the past 12 months. Susceptibility to using JUUL was more likely among adolescents (ages 15–17) [AOR = 1.72 (1.30, 2.28)] and young adults (ages 18–20) [AOR = 1.26 (1.00,1.58)] than adults (ages 21–29). At the community level, living in jurisdictions with higher median household income was associated with a higher likelihood of being susceptible to using JUUL and other e-cigarettes. Compared to non-Hispanic Whites, Asian/Pacific Islanders were less likely to use JUUL [AOR = 0.68 (0.54, 0.86)] and other e-cigarettes [AOR = 0.60 (0.48, 0.76)] in the past 12 months. Past-30-day JUUL use was more likely among males than females [AOR = 1.44 (1.11, 1.88)]. Common reasons for using JUUL were: friends' use, flavors, "safer" than cigarettes, no one will notice, and nicotine rush is greater than other devices. Common reasons against using JUUL were: harmful to self/others, contains nicotine and is addictive. E-cigarette prevention and cessation efforts should include tailored messaging for people who identify as LGBTQ and reinforce reasons for not vaping nicotine.

## 1. Introduction

Rates of e-cigarette use among U.S. adolescents and young adults have increased dramatically over the past few years, with data from the 2020 National Youth Tobacco Survey showing that 19.6% of high school students had used an e-cigarette in the past 30 days (Wang et al., 2020). Considerable evidence shows that e-cigarettes contain harmful chemicals known to have negative health consequences for the lungs, heart, and blood vessels (Perrine et al., 2019; Alzahrani et al., 2018; Chaumont et al., 2018). Further, nicotine interferes with and changes the developing brain, resulting in greater likelihood of becoming nicotine dependent (Yuan et al., 2015; Leslie, 2020).

A substantial increase in e-cigarette use among adolescents and young adults has been attributed to JUUL, which commanded 75% of the U.S. e-cigarette market in 2019 (Jackler and Ramamurthi, 2019). JUUL Labs' salt-based nicotine e-cigarette device results in less throat hit (Jackler and Ramamurthi, 2019; Goniewicz et al., 2019). Further, JUUL's wide-ranging marketing that includes youthful models and colors as well as product characteristics including the ability to use discretely, aesthetic appeal, social acceptability, and range of flavors appeal to youth (Jackler and Ramamurthi, 2019; Keamy-Minor et al., 2019; McKelvey et al., 2018; Leavens et al., 2019; Ramamurthi et al., 2019). Given that brand recognition for JUUL is the highest among e-cigarettes, with the term "JUULing" used synonymously with using an e-cigarette or vaping, there is a need to assess e-cigarette-related behaviors by using JUUL-specific terminology (Willett et al., 2018; Huang et al., 2019).

Multiple socio-demographic factors are associated with use and susceptibility to using e-cigarettes; however, socio-demographic factors specifically associated with JUUL use have not been well-studied. First,

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adolescents are a group at risk of e-cigarette use since e-cigarette marketing targets adolescents (McKelvey and Halpern-Felsher, 2018; Chen-Sankey et al., 2019) and contributes to perceptions that e-cigarettes pose limited health risks (Jackler and Ramamurthi, 2017; Kim et al., 2019; Pierce et al., 2017). Although adolescents susceptible to using e-cigarettes are 4.2 times more likely to initiate e-cigarette use after six months (Bold et al., 2017), current national data on susceptibility to using e-cigarettes do not report susceptibility specifically to JUUL (Nicksic and Barnes, 2019; Nodora et al., 2014). Second, multiple studies show higher prevalence of tobacco use among sexual and gender minorities compared to their heterosexual peers (Lee et al., 2009; Wheldon et al., 2018; Agaku et al., 2014; Creamer et al., 2020). Youth identifying as lesbian, gay, bisexual, transgender, queer or questioning (LGBTQ) are targeted by e-cigarette advertising (Garcia et al., 2021), with LGBTQ people reporting higher exposure to such content (Soneji et al., 2019). In a U.S. survey of adolescents ages 13–17, sexual minorities were 1.5 times more likely to have ever used e-cigarettes and 1.6 times more likely to be susceptible to using e-cigarettes than heterosexual adolescents (Garcia et al., 2021). However, it remains unknown, if similarly, JUUL use is higher among youth who identify as LGBTQ compared to those using other e-cigarettes. Third, data using national samples provide inconsistent evidence concerning whether JUUL use differs by race/ethnicity. One study found that Black 15- to 21-year-olds had significantly lower odds of ever and past-30-day JUUL use compared with White participants (Vallone et al., 2019). In addition, youth (ages 12–17) who identified as "other" race/ethnicity were 1.6 times more likely to use a flavored e-cigarette compared to Non-Hispanic White participants (Schneller et al., 2019). Another study found no racial/ethnic differences in past-30-day JUUL among participants (ages 16–19) (Hammond et al., 2020). Finally, although adolescents' reasons for using JUUL (Jackler and Ramamurthi, 2019; Keamy-Minor et al., 2019; Leavens et al., 2019; McKelvey and Halpern-Felsher, 2018, 2020; Ramamurthi et al., 2019) and other e-cigarettes (Gorukanti et al., 2017; Roditis et al., 2016) are well-documented, and a previous study included reasons for discontinuing e-cigarette use (Kong et al., 2015), there is a gap in our understanding of reasons not to use JUUL specifically, since both reasons for and against using underlie decisions to use.

To address these gaps, we used an online survey among a large, diverse sample of Californians (ages 15–29) residing in policy jurisdictions with local sales restrictions on flavored tobacco and in the rest of California (Feld et al., 2021). The current analyses assess which socio-demographic factors, including self-identification as LGBTQ, age group, race/ethnicity, and household finances, are associated with susceptibility to future use (among non-users), past 12-month use and past-30-day use, as well as reasons for and against using JUUL and other e-cigarettes. By assessing which socio-demographic groups are using or susceptible to using JUUL and other e-cigarettes, we will identify groups that may benefit most from targeted prevention and cessation messaging.

## 2. Methods

### 2.1. Procedures

From January through March 2019, we recruited a sample of California adolescents (15–17 years), young adults (18–20 years) and adults (21–29 years) to complete an online survey. Paid advertisements on Facebook and Instagram targeted participants based on policy jurisdiction, i.e., living in one of nine jurisdictions with policies that restricted sales of flavored tobacco products by January 1, 2019 or living in the rest of California, age (15–29 years), and language (English-speaking). Quota sampling by age and jurisdiction was used to achieve a sample proportional to the population distribution, maximize the number of respondents under 21 years (the minimum legal sales age for tobacco), and to recruit priority subgroups specified by the California Tobacco Control Program (i.e., Black or African American participants and current users of flavored tobacco products) (Program and Priority Population, 2021). A screener questionnaire contained questions about age and race/ethnicity, and participants indicated their county and city/town of residence in order to assign them to a policy jurisdiction or the rest of California. A longer Qualtrics survey (approximately 80 items) was completed by 83.2% of those who were screened for eligibility. This study was reviewed and approved by the RTI International Institutional Review Board.

Previous analyses of these data compared normative beliefs about flavored tobacco and policy support for residents who lived in policy jurisdictions versus the rest of the state (Feld et al., 2021). Leveraging a large sample of LGBTQ participants, this secondary analysis examines socio-demographic and community-level correlates of susceptibility to use, past-12-month and past-30-day use of JUUL and other e-cigarettes, separately.

### 2.2. Measures

#### 2.2.1. Socio-demographic data

Participants reported their age and household finances (just meet/don't meet basic expenses; meet needs with a little left over; live comfortably). Responses to ethnicity as Hispanic or Latino (yes, no, prefer not to answer) and race (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White; Other (specify) and prefer not to answer) were collapsed as Black or African American (Black/AA), both Hispanic and non-Hispanic; Asian/ Pacific Islander, non-Hispanic; Other/multiracial, non-Hispanic; Hispanic, non-Black/AA; and White, non-Hispanic. Responses to gender identity (male, female, trans male/trans man, trans female/trans woman; genderqueer/gender non-conforming; different identity and prefer not to answer) were collapsed into male, female and other. LGBTQ identity included those who reported their sexual identity as lesbian, gay, bisexual, or a write-in response that indicated another sexual minority; and/or those whose gender identity was coded as other. Community-level covariates for nine jurisdictions and the rest of state were median household income obtained from the California Tobacco and Health Assessment Tool (California Community Health Assessment Tool, 2020) and percent of rural population obtained from the American Community Survey (2006–2010), using Census 2010 definitions and 2013 rural–urban continuum codes from the Economic Research Service (United States Census Bureau, 2020, 2010; Economic Research Service, 2013).

#### 2.2.2. Susceptibility to use JUUL and other e-cigarettes

The Enhanced Susceptibility Index (Nodora et al., 2014) measures the absence of a firm decision not to use a tobacco product, applied to e-cigarettes in our survey with four items asked to never-users: (1) "Do you think you will try an e-cigarette soon or experiment in the future?;" (2) "If one of your best friends were to offer you an e-cigarette, would you smoke it?;" (3) "Do you think you will be using an e-cigarette in the next year?;" and (4) "Have you ever been curious about using an e-cigarette?" Response options ranged from 1 = definitely not to 4 = definitely yes. Participants who answered "definitely not" to questions 1–3 and "not at all" to question 4 were classified as committed never users; all other responses were classified as susceptible (Nodora et al., 2014).

#### 2.2.3. Past use of JUUL and other e-cigarettes

Participants were provided a product description and images to ensure that they understood which products were referred to in our survey (supplemental material). Past-12-month JUUL use was assessed by asking, "In the past 12 months, did you use JUUL, even just one or two puffs?" and other e-cigarette use by asking, "In the past 12 months, did you use vaping products not including JUUL?" Individuals who responded yes to either question were considered past-12-month users. Next, we asked about the number of days they used in the past month (from 0 to 30 days); any non-zero response was categorized as a past-30-

day user. Past-12-month use of JUUL and other e-cigarettes was ascertained for: (1) Virginia tobacco or classic tobacco, (2) mint or menthol, (3) fruit, mango, cucumber, or crème and (4) Don't know.

#### 2.2.4. Reasons for and against using JUUL

JUUL users were asked to select all reasons for using: (1) trying to quit cigarettes, (2) it comes in flavors that taste good, (3) less harmful than cigarettes, (4) easy to use without anyone noticing, (5) more nicotine rush than other vaping devices, (6) auto-subscription service is convenient, (7) promotions/coupons, (8) refill pods are easy to find at stores where I live, (9) my friends use it, (10) it looks cool, and (11) other. JUUL non-users were asked to select all reasons for not using: (1) flavored pods not sold in my town, (2) it contains nicotine, (3) it's addictive, (4) saw ads about harms from vaping, (5) I know someone who is addicted to JUUL, (6) it's harmful to my health, (7) it's harmful to other people's health, (8) my friends don't use it, and (9) other.

### 2.3. Analysis

Propensity score weights were generated based on age group, race/ethnicity, gender, and parents' education. These weights were then applied to the survey data to balance demographic differences between respondents in policy jurisdictions with restricted sales of flavored tobacco (including e-cigarettes) and the rest of California. Unweighted descriptive statistics and weighted statistics with 95% confidence intervals were calculated. Chi-square analyses examined bivariate associations between using flavors of JUUL and other e-cigarettes and participant characteristics. Multi-level weighted logistic regression models examined individual and community-level differences in susceptibility and use of JUUL and other e-cigarettes in the past 12 months and past 30 days. We included individual-level covariates of age, gender, identifying as LGBTQ, race/ethnicity, household finances. At the community-level, covariates for nine jurisdictions and the rest of state were median household income and percent of rural population. Data were analyzed using two-tailed statistical tests in Stata 15.1.

## 3. Results

The 3,075 participants were comprised of 517 adolescents (age 15–17), 1,038 young adults (ages 18–20), and 1,520 adults (ages 21–29). Participants who identified as LGBTQ (n = 725) comprised 24.3% of the sample. Two-thirds of participants (2,044) were recruited from Instagram and the remaining from Facebook.

### 3.1. Susceptibility and use of JUUL and other e-cigarettes

Among never-users, 62.5% (95% CI 60.2, 64.7) were susceptible to using JUUL and 51.9% (95% CI 49.6, 54.3) were susceptible to using other e-cigarettes (weighted). In the total sample (n = 3,075), 30.9% (95% CI 29.1, 32.7) had used JUUL and 36.3% (95 %CI 34.5, 38.2) had used other e-cigarettes in the past 12 months. Among those who used a JUUL in the past 12 months, 64.3% (95% CI 60.9, 67.5) used a JUUL in the past 30 days; and 69.6% (95% CI 66.6, 72.4) of those who used other e-cigarettes in the past 12 months used other e-cigarettes in the past 30 days. Table 1 describes unweighted participant characteristics by susceptibility to using JUUL and other e-cigarettes as well as past-12-month use and past-30-day use. See Table 2 for weighted data by participant characteristics and JUUL and other e-cigarette use status, which were calculated among respondents residing in policy jurisdictions restricting flavored tobacco sales and the rest of California.

**Table 1**
Participant characteristics by product use, unweighted % (n = 3,075).

| | Never users | | Susceptibility to use among never-users | | Past-12-month users | | Past-30-day users (among past-12-month users) | |
|---|---|---|---|---|---|---|---|---|
| | JUUL (n = 2138) | Other e-cigarettes (n = 1971) | JUUL (n = 1342) | Other e-cigarettes (n = 1029) | JUUL users (n = 937) | Other e-cigarettes (n = 1104) | JUUL users (n = 602) | Other e-cigarettes (n = 764) |
| Age* | | | | | | | | |
| Adolescents | 18.9 | 20.0 | 20.9 | 21.4 | 11.8 | 11.1 | 10.0 | 10.5 |
| Young adults | 31.5 | 33.9 | 31.4 | 34.1 | 38.8 | 33.3 | 38.7 | 30.6 |
| Adults | 49.4 | 45.9 | 47.6 | 44.5 | 49.3 | 55.6 | 51.3 | 58.9 |
| LGBTQ (n = 2,984)[α] | | | | | | | | |
| Yes | 22.5 | 20.5 | 26.9 | 25.8 | 28.2 | 31.0 | 26.9 | 32.1 |
| No | 77.4 | 68.9 | 73.1 | 74.2 | 71.8 | 69.0 | 73.1 | 67.9 |
| Gender (n = 3,052)[α] | | | | | | | | |
| Male | 32.0 | 32.4 | 31.8 | 34.5 | 34.7 | 33.5 | 38.3 | 34.4 |
| Other | 3.4 | 3.2 | 4.0 | 3.6 | 5.6 | 5.7 | 5.0 | 5.7 |
| Female | 64.4 | 64.2 | 64.2 | 61.9 | 59.7 | 60.8 | 56.7 | 59.9 |
| Race/Ethnicity (n = 3,008)[α] | | | | | | | | |
| Black/AA (both Hispanic and Non-Hispanic (NH)) | 8.2 | 7.7 | 8.0 | 7.4 | 7.2 | 8.1 | 8.4 | 9.1 |
| Asian/ Pacific Islander, NH | 30.8 | 33.2 | 30.5 | 34.1 | 26.0 | 22.4 | 26.2 | 21.0 |
| Other/multiracial, NH | 5.4 | 5.3 | 5.3 | 5.4 | 6.8 | 6.7 | 6.0 | 6.0 |
| Hispanic, non-Black/AA | 29.0 | 27.7 | 28.7 | 26.7 | 27.9 | 30.3 | 27.6 | 30.8 |
| White, NH | 26.4 | 25.8 | 27.3 | 25.2 | 32.1 | 32.3 | 31.7 | 33.1 |
| Household finances | | | | | | | | |
| Just meet/don't meet basic expenses | 26.6 | 25.7 | 25.5 | 23.7 | 24.6 | 26.4 | 24.4 | 26.7 |
| Meet needs with a little left over | 31.6 | 30.5 | 33.8 | 33.4 | 32.3 | 34.1 | 32.7 | 33.9 |
| Live comfortably | 41.7 | 43.6 | 40.7 | 42.9 | 43.0 | 39.4 | 42.9 | 39.4 |
| Community-level characteristics (N = 10) | | | | | | | | |
| Median household income (S.D.) (n = 3,057)[α] | $68,617 (27,258) | $70,449 (28,988) | $69,328 (28,841) | $72,122 (32,343) | $71,928 (36,435) | $68,162 (32,806) | $71,274 (30,122) | $66,686 (25,937) |
| Percent rural (n = 2,998)[α] | 30.8 | 28.7 | 38.1 | 26.2 | 15.4 | 21.4 | 16.9 | 21.5 |

*Adolescents refer to 15–17-year-olds, Young adults to 18–20-year-olds and Adults to 21–29-year-olds.

[α] n in parentheses indicates the number of responses available for specific participant characteristics, where fewer than 3,075 responses are available due to missing data.

**Table 2**
Participant characteristics by product use, weighted % and 95% Confidence Intervals (CI): California, 2019.

| | Never users | | Susceptibility to use among never-users | | Past-12-month users | | Past-30-day users (among past-12-month users) | |
|---|---|---|---|---|---|---|---|---|
| | JUUL | Other e-cigarettes | JUUL | Other e-cigarettes | JUUL users | Other e-cigarettes | JUUL users | Other e-cigarettes |
| Age* | | | | | | | | |
| Adolescents (95% CI) | 18.8 (17.1,20.7) | 19.7 (17.9,21.6) | 31.8 (29.1,34.5) | 21.7 (19.1,24.6) | 12.5 (10.3,15.0) | 11.9 (9.8,14.2) | 10.9 (8.3,14.1) | 11.6 (9.3,14.5) |
| Young adults (95% CI) | 31.6 (29.5,33.8) | 34.1 (31.9,36.4) | 21.4 (19.1,23.9) | 34.1 (31.1,37.2) | 39.6 (36.2,43.0) | 34.0 (31.0,37.1) | 39.2 (35.0,43.5) | 31.0 (27.5,34.7) |
| Adults (95% CI) | 49.5 (47.2,51.8) | 46.1 (43.8,48.5) | 46.8 (43.9,49.6) | 44.2 (40.9,47.4) | 47.9 (44.5,51.4) | 54.1 (50.9,57.3) | 49.9 (45.6,54.2) | 57.4 (53.5,61.1) |
| LGBTQ | | | | | | | | |
| Yes (95% CI) | 22.7 (20.8,24.7) | 20.4 (18.5,22.4) | 27.4 (24.5, 29.3) | 26.0 (23.1, 29.0) | 28.1 (25.1,31.4) | 31.3 (28.4,34.5) | 27.8 (24.0, 32.0) | 32.2 (28.7, 36.0) |
| No (95% CI) | 77.3 (75.3,79.2) | 79.6 (77.6, 81.5) | 72.6 (69.8, 75.1) | 74.0 (70.9, 76.8) | 71.9 (68.6,74.9) | 68.7 (65.5,71.6) | 72.2 (68.0, 76.0) | 67.8 (63.9,71.3) |
| Gender | | | | | | | | |
| Male (95% CI) | 31.7 (29.6,33.8) | 32.2 (30.0,34.4) | 31.8 (28.9,34.3) | 34.2 (31.1, 37.3) | 34.2 (31.0,37.6) | 33.0 (30.1,36.1) | 38.3 (34.2,42.6) | 33.9 (30.4,37.7) |
| Other (95% CI) | 3.5 (2.7,4.4) | 3.3 (2.5,4.3) | 4.1 (3.1, 5.5) | 3.7 (2.6, 5.1) | 5.4 (4.0, 7.1) | 5.3 (4.1, 6.9) | 5.0 (3.4, 7.2) | 5.2 (3.7, 7.1) |
| Female (95% CI) | 64.8 (62.6,67.0) | 64.5 (62.2,66.8) | 64.1 (61.3, 66.9) | 62.1 (58.9, 65.3) | 60.4 (57.0,63.7) | 61.7 (58.5,64.7) | 56.7 (52.3, 60.9) | 60.9 (57.1, 64.6) |
| Race/Ethnicity | | | | | | | | |
| Black/AA (both Hispanic and Non-Hispanic (NH)) (95% CI) | 8.4 (7.2,9.8) | 8.0 (6.8,9.3) | 8.2 (6.7,9.9) | 7.4 (5.9,9.3) | 7.3 (5.7,9.2) | 8.2 (6.6,10.1) | 8.7 (6.5,11.6) | 9.3 (7.2,11.7) |
| Asian/ Pacific Islander, NH (95% CI) | 31.0 (28.9,33.2) | 33.3 (31.0,35.5) | 30.3 (27.8,33.1) | 33.4 (30.4,36.6) | 25.2 (22.3,28.3) | 22.1 (19.5,24.8) | 25.5 (21.8,29.5) | 20.9 (17.9,24.3) |
| Other/multiracial, NH (95% CI) | 5.6 (4.6,6.7) | 5.3 (4.3,6.5) | 5.3 (4.1,6.6) | 5.3 (4.0,6.9) | 6.2 (4.8,8.0) | 6.6 (5.2,8.3) | 5.4 (3.8,7.5) | 5.9 (4.3,7.9) |
| Hispanic, non-Black/AA (95% CI) | 28.0 (26.0,30.2) | 27.3 (25.2,29.6) | 28.1 (25.5,30.8) | 26.9 (24.1,30.0) | 29.6 (26.4,32.9) | 30.6 (27.6,33.7) | 29.1 (25.2,33.3) | 30.9 (27.4,34.7) |
| White, NH (95% CI) | 27.0 (24.9,29.1) | 26.1 (24.0,28.2) | 28.1 (25.5,30.8) | 27.0 (24.0,29.9) | 31.7 (28.5,35.0) | 32.5 (29.6,35.6) | 31.3 (27.4,35.5) | 33.0 (29.4,36.7) |
| Household finances | | | | | | | | |
| Just meet/don't meet basic expenses (95% CI) | 26.5 (24.5,28.5) | 25.9 (23.9,28.1) | 25.1 (22.7,27.7) | 23.7 (21.1,26.6) | 25.8 (22.8,29.0) | 26.8 (24.1,29.8) | 25.4 (21.8,29.4) | 27.4 (24.0,31.0) |
| Meet needs with a little left over (95% CI) | 31.8 (29.7,34.0) | 30.7 (28.6,32.9) | 34.8 (32.1,37.6) | 34.5 (31.4,37.7) | 32.8 (29.6,36.2) | 34.7 (31.7,37.8) | 33.7 (29.7,37.9) | 34.6 (31.0,38.4) |
| Live comfortably (95% CI) | 41.7 (39.4,43.9) | 43.4 (40.9,45.7) | 40.1 (37.2,42.8) | 41.8 (38.6,45.0) | 41.4 (38.0,44.8) | 38.5 (35.5,41.6) | 40.9 (36.7,45.1) | 38.0 (34.3,41.8) |
| Community-level characteristics | | | | | | | | |
| Median household income ($10,000) (95% CI)* | $6.8 (6.7,6.9) | $7.0 (6.9,7.1) | $6.9 (6.8,7.0) | $7.2 (7.0,7.3) | $7.2 (7.0,7.3) | $6.8 (6.7,7.0) | $7.2 (7.0,7.3) | $6.7 (6.6,6.9) |
| Percent rural (95% CI) | 26.5 (16.5,36.5) | 24.6 (14.0,35.3) | 32.1 (16.2,47.9) | 23.1 (7.7,38.4) | 15.0 (11.4,18.6) | 19.9 (15.2,24.6) | 16.8 (11.7,21.8) | 20.1 (15.1,25.2) |

### *3.2. Socio-demographic factors associated with susceptibility and use of JUUL and other e-cigarettes*

As shown in Table 3, non-users of JUUL who identified as LGBTQ were 2.1 times (95% CI 1.60,2.79) more likely to be susceptible to using JUUL and non-users of other e-cigarettes who identified as LGBTQ were 2.3 times (95% CI 1.75,3.05) more likely to report being susceptible to using other e-cigarettes. Age group was associated with susceptibility to using JUUL, with adolescents (AOR = 1.72, 95% CI 1.30, 2.28) and young adults (AOR = 1.26, 95% CI 1.00,1.58) being more likely to be susceptible to using JUUL than adults (ages 21–29). However, this pattern was unique to JUUL. Compared to participants who lived comfortably, those who reported household finances as "a little left over after basic expenses" were more susceptible to using JUUL (AOR = 1.46, 95% CI 1.15,1.86) and other e-cigarettes (AOR = 1.42, 95% CI 1.12, 1.81). At the community level, higher median household income was associated with higher odds of susceptibility to using JUUL and other e-cigarettes.

As shown in Table 3, participants who identified as LGBTQ were 1.3 times (95% CI 1.02,1.58) more likely to have used JUUL in the past 12 months and 1.7 times (95% CI 1.35,2.05) more likely to have used other e-cigarettes in the past 12 months. Compared to adults, adolescents were less likely (AOR = 0.63, 95% CI 0.48,0.83), but young adults were more likely (AOR = 1.25, 95% CI 1.03,1.52) to have used JUUL in the past 12 months. Compared to adults, adolescents were also less likely to have used other e-cigarettes in the past 12 months (AOR = 0.49, 95% CI 0.38,0.64). Compared to Non-Hispanic White participants, Asian/Pacific Islanders were only 0.68 times (95% CI 0.54, 0.86) as likely to use JUUL and 0.60 times (95% CI 0.48,0.76) as likely to use other e-cigarettes in the past 12 months. At the community level, higher median household income was associated with higher odds of using JUUL in the past 12 months (AOR = 1.10 95% CI 1.05, 1.14), but this finding was unique to JUUL.

Among past-12-month users, past-30-day use of JUUL and other e-cigarettes was not more common among LGBTQ participants than others. Compared to adults, young adults were 1.4 times (95% CI 1.05,1.80) more likely to have used JUUL in the past 30 days and 0.71 times (95% CI 0.54,0.93) less likely to have used other e-cigarettes in the past 30 days. Males were 1.4 times (95% CI 1.11,1.88) more likely than females to have used JUUL in the past 30 days. At the community level, living in jurisdictions with higher median household income was associated with higher odds of using JUUL in the past 30 days (AOR = 1.08, 95% CI 1.01, 1.15), but lower odds of using other e-cigarettes (AOR = 0.89, 95% CI 0.83, 0.95).

### *3.3. Socio-demographic factors associated with use of flavors and dependence*

Among 937 participants who used JUUL in the past 12 months, 66.7% (95% CI 63.2, 69.8) used fruit, mango, crème or cucumber

**Table 3**
Multi-level models to determine socio-demographic factors associated with susceptibility to use and actual use of JUUL and other e-cigarettes: California, 2019

| | Susceptibility to future use among never users | | Past-12-month use among all participants | | Past-30-day use among past-12-month users | |
|---|---|---|---|---|---|---|
| | JUUL | Other e-cigs | JUUL | Other e-cigs | JUUL | Other e-cigs |
| Age | | | | | | |
| Adolescents (ages 15–17) | **1.72 [1.30,2.28]** | 1.30 [0.99,1.71] | **0.63 [0.48,0.83]** | **0.49 [0.38,0.64]** | 0.98 [0.65,1.47] | 0.85 [0.56,1.28] |
| Young adults (ages 18–20) | **1.26 [1.00,1.58]** | 1.11 [0.88,1.40] | **1.25 [1.03,1.52]** | 0.85 [0.70,1.02] | **1.38 [1.05,1.80]** | **0.71 [0.54,0.93]** |
| Adults (ages 21–19) | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* |
| LGBTQ | | | | | | |
| Yes | **2.11 [1.60,2.79]** | **2.31 [1.75,3.05]** | **1.27 [1.02,1.58]** | **1.66 [1.35,2.05]** | 0.86 [0.64,1.17] | 1.22 [0.91,1.65] |
| No | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* |
| Gender | | | | | | |
| Male | 0.96 [0.77,1.19] | 1.15 [0.92,1.44] | 1.11 [0.92,1.34] | 1.08 [0.90,1.29] | **1.44 [1.11,1.88]** | 1.07 [0.82,1.40] |
| Other | 0.95 [0.52,1.74] | 0.73 [0.39,1.35] | 1.40 [0.90,2.18] | 0.91 [0.59,1.39] | 1.35 [0.75, 2.43] | 0.79 [0.44,1.42] |
| Female | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* |
| Race/Ethnicity | | | | | | |
| Black/AA (both Hispanic and Non-Hispanic (NH)) | 0.89 [0.60,1.34] | 0.91 [0.60,1.38] | 0.75 [0.53,1.07] | 0.80 [0.57,1.11] | 1.33 [0.83,2.14] | 1.23 [0.76,1.98] |
| Asian/ Pacific Islander, NH | 0.88 [0.67,1.16] | 0.97 [0.74,1.27] | **0.68 [0.54,0.86]** | **0.60 [0.48,0.76]** | 1.21 [0.87,1.69] | 0.80 [0.57,1.13] |
| Other/multiracial, NH | 0.82 [0.51,1.30] | 1.02 [0.62,1.68] | 0.96 [0.66,1.40] | 1.08 [0.75,1.56] | 0.79 [0.47,1.32] | 0.79 [0.48,1.30] |
| Hispanic, non-Black/AA | 0.99 [0.75,1.32] | 1.01 [0.75,1.34] | 0.91 [0.72,1.15] | 0.95 [0.75,1.19] | 0.99 [0.72,1.36] | 0.99 [0.72,1.36] |
| White, NH | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* |
| Household finances | | | | | | |
| Just meet/don't meet basic expenses | 0.97 [0.75,1.26] | 0.96 [0.73,1.25] | 0.96 [0.76,1.21] | 1.05 [0.84,1.30] | 0.91 [0.67,1.26] | 1.18 [0.86,1.64] |
| Meet needs with a little left over | **1.46 [1.15,1.86]** | **1.42 [1.12,1.81]** | 1.01 [0.82,1.24] | 1.14 [0.93,1.39] | 0.92 [0.69,1.22] | 1.07 [0.81,1.43] |
| Live comfortably | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* | *Ref* |
| Community-level factors | | | | | | |
| Median household income | **1.05 [1.00,1.10]** | **1.07 [1.02,1.13]** | **1.10 [1.05,1.14]** | 1.00 [0.96,1.04] | **1.08 [1.01,1.15]** | **0.89 [0.83,0.95]** |
| Percent rural | 1.08 [0.96,1.22] | 0.99 [0.96,1.03] | 0.85 [0.72,1.01] | 0.98 [0.96,1.01] | 0.98 [0.85,1.15] | 1.06 [0.84,1.34] |

*Cell entries are adjusted odds ratios [95% confidence intervals] from propensity score weighted multilevel models (participants clustered in 9 policy jurisdictions or rest of California.

flavors; 39.6% (95% CI 36.3, 43.0) used mint/menthol; 13.7% (95% CI 11.4, 16.2) used classic or Virginia tobacco; and 17.5% (95% CI 15.0, 20.4) did not know which flavor they used. Use of JUUL mint/menthol differed significantly by race/ethnicity: 37.9% (95% CI 32.7, 43.3) of non-Hispanic White, 22.5% (95%CI 18.3, 27.3) of Asian/ Pacific Islander, 25.9% (95% CI 21.2, 31.2) of Hispanic non-Black/AA, 6.7% (95% CI 4.6, 9.7) of Other/ multiracial and 7.0% (95% CI 4.6, 10.3) of Black/AAs (both Hispanic and non-Hispanic) used mint/menthol flavors ($\chi^2 = 11.9$; $p = 0.031$). There were also racial/ethnic differences in use of JUUL's Virginia or classic tobacco flavor: 42.8% (95% CI 33.6, 52.6) of non-Hispanic White, 25.1% (95%CI 17.6, 34.4) of Hispanic non-Black/AA, 18.2% (95% CI 11.8, 26.8) of Asian/Pacific Islander, 10.4% (95%CI 6.0, 17.1) of Other/multiracial and 3.5% (95% CI 1.2, 9.9) of Black/AAs (both Hispanic and non-Hispanic) used Virginia tobacco or classic tobacco flavors ($\chi^2 = 16.1$; $p = 0.009$). For other e-cigarettes, use of tobacco flavors increased with age: 7.5% (95% CI 3.8,14.4) of adolescents (15–17 years), 25.3% (95% CI 18.4, 33.8) of young adults (18–20 years), and 67.2% (95% CI 58.1, 74.8) of adults (21–29 years) used tobacco flavors ($\chi^2 = 12.1$; $p = 0.010$).

### 3.4. Reasons for using and not using JUUL

As shown in Table 4, the most common reasons for using JUUL were that friends use it, looking cool, and flavors. Other reasons for using JUUL were convenience of using without anyone noticing and getting a higher nicotine rush than other products. Perceived harmfulness to self and others, nicotine content, and addictiveness were the most common reasons for not using JUUL. Seeing ads about harms of JUUL were also cited as a reason for not using JUUL. Although seeing JUUL or e-cigarette-related advertisements were not cited as a reason for using JUUL, other forms of marketing, such as promotions and coupons, easy access to refill pods and auto-subscriptions were reported as reasons for JUUL use.

**Table 4**
Participants' reported reasons for and against using JUUL

| Reason for using JUUL (n = 937) | % | Reason against using JUUL (n = 2138) | % |
|---|---|---|---|
| Friends use it | 48.5 | Harmful to health | 71.0 |
| Come in flavors that taste good | 42.9 | Contains nicotine | 62.7 |
| Less harmful than cigarettes | 31.2 | It's addictive | 58.8 |
| Easy to use without anyone noticing | 29.4 | Harmful to other's health | 47.0 |
| Look cool | 19.8 | Saw ads about harms | 34.4 |
| More nicotine rush than other vaping devices | 16.6 | My friends don't use it | 26.6 |
| Trying to quit cigarette smoking | 14.0 | Know someone who is addicted | 16.9 |
| Refill pods easy to find at stores where I live | 10.5 | Other | 14.2 |
| Other – relax and reduce stress | 8.1 | Flavored pods not sold in my town | 2.2 |
| Promotions/coupons | 4.2 | | |
| Auto-subscription service is convenient | 2.3 | | |

## 4. Discussion

In this California survey, several socio-demographic factors were associated with susceptibility and use of JUUL and other e-cigarettes. Compared to participants who did not identify as LGBTQ, those identifying as LGBTQ were twice as likely to be susceptible to using JUUL and other e-cigarettes, and more likely to have used JUUL and other e-cigarettes in the past 12 months, but not in the past 30 days. The current findings follow a similar pattern among sexual minority adolescents in a U.S. survey (Garcia et al., 2021), and extend this pattern to JUUL use. In this California sample, adolescents (ages 15–17) had lower odds of using JUUL and other e-cigarettes in the past 12 months, compared to adults (ages 21–29). Compared to adults, however, past-30-day use among adolescents was not significantly different and their susceptibility to using JUUL was nearly double. Asian/Pacific Islander respondents had

lower odds of using JUUL and other e-cigarettes compared to Non-Hispanic Whites. Similar to another study (Harlow et al., 2019), Black/AAs, Hispanic, and participants who identified as other/multi-racial were not more likely than Non-Hispanic Whites to report using JUUL and other e-cigarettes. Previously, financial comfort has been associated with higher use of e-cigarettes (Vallone et al., 2019), and the current study found that self-reported household finances were similarly associated with higher odds of susceptibility to use JUUL and other e-cigarettes.

Overall, past-year and past-30-day use rates of JUUL were slightly lower than other e-cigarettes. Although the current survey was conducted prior to the proliferation of disposable JUUL-like devices (Williams, 2019), we estimate that a shift in youth usage had already begun (Miech et al., 2021), with pressure from the FDA for JUUL to halt its social media marketing to underage youth and withdraw selected flavored e-cigarettes from stores (Kaplan and Hoffman, 2018). However, JUUL sales remained constant during the survey period, and consumption likely shifted to available mint/menthol and tobacco flavors (Liber et al., 2020).

Similar to national data (Tsai et al., 2018; Vallone et al., 2020) and other studies in California on pod-based e-cigarettes (McKelvey and Halpern-Felsher, 2018, 2020), we found that peer use and flavors were the most common reasons to use JUUL, and that fruit and mint/menthol flavors were the most widely used. Overall, given that adolescents and young adults (15–20 years) in our sample used JUUL and that most Internet vendors do not adequately verify age (Soneji et al., 2016), policies that limit youth access are recommended. The recent policy change under the federal Prevent All Cigarette Trafficking (PACT) Act addresses some of these concerns, requiring Internet vendors to verify customers' age for all purchases, an adult with a valid ID to be present at the time of delivery, shipped packages to show they contain tobacco products, and prevents the United States Postal Service from delivering e-cigarettes (Consolidated Appropriations Act, 2021).

This study highlighted that perceived harmfulness was the main reason that participants did not use JUUL, potentially because of a rising awareness of health and safety concerns. From 2015 to 2018, 2,600 health-related consumer complaints attributed to JUUL were logged by youth and adults on an internal JUUL database (Etter, 2020). E-cigarette or Vaping Use-Associated Lung Injury (EVALI) cases were first reported in the summer of 2018 and for a period of time it was under investigation as to whether these cases were associated with e-cigarette use. Notably, participants endorsed seeing advertisements on health harms of e-cigarettes as a reason not to use JUUL.

### 4.1. Strengths and limitations

This survey includes a large sample of people who identify as LGBTQ, using assessment items that are required by California law for state-funded research (California Legislative Information, 2015). This study is one of the few to compare those under and over the minimum legal sales age for tobacco. Using the Enhanced Susceptibility Index to assess susceptibility to using JUUL and other e-cigarettes was instrumental in assessing the role of curiosity in addition to intent and willingness to use if a friend offered the product. Further, by asking about JUUL as a specific brand, we improved comprehension and recall of product use instead of asking about e-cigarettes generally. By investigating reasons for not using JUUL, this study provides novel information that may aid in developing effective prevention and cessation messages.

This study is cross-sectional and derived from a convenience sample, although Black/AA participants and current users of flavored tobacco were oversampled in order to better address priority populations. Although the survey assessed use of e-cigarettes other than JUUL, participants were not asked to specify products/brands they used, and which were most used or most popular. While we asked participants to identify reasons for using and not using JUUL, we did not assess relative importance of these reasons, which may be useful to develop prevention and cessation messaging. By asking about JUUL specifically, we were limited in our ability to generalize our findings to the entire class of products, especially the newer single-use, JUUL-like devices. Finally, we asked participants to provide information on mint/menthol as a single category because few California localities have exemptions for this category, and none differentiate mint from menthol; however, separating these flavors would provide insight for future regulation of youth e-cigarette use.

### 4.2. Conclusion and implications

Our findings suggest that tobacco control program planners, policymakers, and prevention and cessation experts might want to focus on targeted messaging for people who identify as LGBTQ and to reinforce reasons for not using JUUL in prevention messaging. Recognizing a shift towards disposable JUUL-like devices (e.g., Puff Bar and SMOK), research is needed to determine how reasons for and against using these devices differ from JUUL. Given robust evidence that susceptibility predicts future use of e-cigarettes (Bold et al., 2017), there is a compelling need to focus efforts to reduce susceptibility among never users. Future research may investigate the role of marketing in influencing LGBTQ youth to use JUUL and other e-cigarettes. Our finding that use of tobacco- and mint/menthol-flavored JUUL and tobacco-flavored other e-cigarettes differed significantly by race/ethnicity requires further investigation. Further, evidence-based e-cigarette prevention and cessation programs should highlight the harmful effects and addictiveness of JUUL and improve refusal self-efficacy in an effort to prevent and stop youth use of these products (Office of the Surgeon General, 2016; Liu et al., 2020).

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## CRediT authorship contribution statement

**Shivani Mathur Gaiha:** Formal analysis, Writing - original draft, Writing - review & editing. **Bonnie Halpern-Felsher:** Conceptualization, Writing - review & editing. **Ashley L. Feld:** Conceptualization, Data curation, Writing - review & editing. **Jennifer Gaber:** Data curation, Writing - review & editing. **Todd Rogers:** Conceptualization, Data curation, Writing - review & editing. **Lisa Henriksen:** Conceptualization, Writing - review & editing, Funding acquisition.

## Declaration of Competing Interest

Dr. Halpern-Felsher is an expert for some e-cigarette litigation and tobacco-related policies. All other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

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