



The social patterning of electronic nicotine delivery system use among US adults

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ARTICLE INFO

Keywords:

ENDS
E-cigarettes
Vaping
Socioeconomic status
Social patterning
A-TRAC

ABSTRACT

There is little research examining the social patterning of electronic nicotine delivery system (ENDS) use. This study investigated the association between socioeconomic status (SES) (education, income, and employment status) and current and former ENDS use. Data were collected from 2561 participants from the American Heart Association Tobacco Regulatory and Addiction Center (A-TRAC) online survey. Participants were 18–64 years old and reported demographic, SES, and ENDS use. Poisson regression was used to estimate prevalence ratios (PR 95% confidence interval-CI) of participants' current and former (vs. never) ENDS use. Models were adjusted for age, sex, sexual orientation, race/ethnicity, marital status, and reasons for ENDS use. In the unadjusted analysis, ENDS use was primarily patterned by education and employment status. College educated persons (vs. those with less than a high school diploma) had a 37% greater prevalence of current ENDS use (PR 1.37, 95% CI 1.20–1.55), and a 16% greater prevalence of former ENDS use (PR 1.16, 95% CI 1.06–1.28) in the fully-adjusted model. Persons with household incomes above \$90 K (vs. less than \$20,000) had a greater prevalence of current (PR 1.30, 95% CI 1.19–1.41) and former (PR 1.17, 95% CI 1.05–1.30) ENDS use. Those who were employed (vs. not employed) had a 13% greater prevalence of current ENDS use (PR 1.13, 95% CI 1.07–1.19) after full adjustment. Higher SES (vs. lower SES) persons were more likely to use ENDS.

1. Introduction

Cigarettes are decreasing in use, but e-cigarettes or electronic nicotine delivery systems (ENDS) are becoming more popular in the U.S. population (Dai, 2017; Riggs and Pentz, 2016). The Centers for Disease Control and Prevention estimates that 12.6% of US adults have experimented with e-cigarettes (Schoenborn and Gindi, 2015). Additionally, half of people who identify as current cigarette smokers have experimented with ENDS, and 22% of former cigarette smokers also reported experimenting with ENDS (Schoenborn and Gindi, 2015). Although ENDS may be perceived as safer alternatives to traditional cigarettes, the evidence is mixed, and significant concerns have been raised (Palazzolo, 2013). For example, experimental studies have found that the liquid in ENDS promotes pro-inflammatory responses in animal

and human airway cells (Lerner et al., 2015; Wu et al., 2014). ENDS also often contain nicotine, and prolonged use could increase nicotine dependence (Mello et al., 2016). In addition to suggested harms of ENDS use, there is no current standard or regulation of the range of ingredients included in ENDS (Cobb et al., 2010).

Given the potential dangers and growing interest in e-cigarettes, it is important to examine the social patterning of ENDS use in order to understand the extent to which social determinants of health impact ENDS use. Social patterning of cigarette smoking has been evident in the U.S. population for decades (Lawrence et al., 2007; Margerison-Zilko and Cubbin, 2013; Vijayaraghavan et al., 2014). Higher rates of tobacco smoking typically are found among those who are less educated and those with lower income (Gilman et al., 2008; Stewart et al., 2014). The mechanisms likely associated with these disparities are varied,

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<https://doi.org/10.1016/j.ypmed.2018.08.038>

Received 1 March 2018; Received in revised form 23 August 2018; Accepted 28 August 2018

Available online 29 August 2018

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including social context (e.g. friends and family who smoke) (Roberts et al., 2015), limited accessibility to cessation resources (Browning et al., 2008) and exposure to stressors, which may promote the maintenance of smoking as a coping mechanism (Sims et al., 2017). Studies have not specifically examined the social patterning of ENDS use; however, there are reports of demographic characteristics of ENDS users. For instance, Adkison et al. (2013) found ENDS use to be more common among those who were white, younger, and had higher-incomes. Other studies have found ENDS use to be more prevalent among men and former cigarette smokers (Choi and Forster, 2013; Etter and Bullen, 2011).

The association between socioeconomic status (SES) and ENDS use is unclear. Therefore, we investigated the association between SES (education, income, and employment status) and ENDS use status (current, former, never) among participants from the American Heart Association Tobacco Regulatory and Addiction Center (A-TRAC) adult vaping survey, which included a racially diverse sample of U.S. adults 18–64 years old. We hypothesized there would be an inverse association between SES and ENDS use, similar to that of cigarette smoking.

2. Methods

Participants of the A-TRAC adult vaping survey were selected randomly through a marketing research vendor, who screened for participants who were willing to answer questions about knowledge, perception, and behaviors regarding ENDS during the period of June–August 2016. The vendor estimated a 20% response rate, so they sent the survey to approximately 13,000 persons in order to achieve the 2561 respondents.

The initial screening criteria for participants included being 18 years and older, meeting criteria for one of the tobacco use categories, and willingness to report socio-demographics (e.g. sex, race, education, income, and sexual orientation). Recruitment techniques (i.e., randomization, exclusion, sampling) assured there was sufficient representation from key subgroups based on age, race, ethnicity, sex, and smoking status. Survey weights were not applied, as this was not designed to be a nationally representative sample.

Tobacco product use categories were: (a) Current ENDS User: individuals who have vaped within the past week, have vaped for 6 months or longer, have vaped at least 20 times; (b) Current Cigarette Smoker: individuals who have smoked within the past week, have smoked for 6 months or longer, have smoked at least 100 cigarettes, may have vaped historically but not within the past 6 months; and (c) Experimenter: have smoked or vaped in the past; have not vaped or smoked within the past 6 months, have vaped < 20 times and/or smoked fewer than 100 cigarettes. Identifying information (i.e., name, place of residence) was neither required nor obtained. Individuals meeting initial screening criteria completed the full ENDS survey. Quality control checks were performed to ensure data reliability and quality. Ultimately, 2561 participants completed the A-TRAC online survey. This study was approved by the IRB of the following institutions: the University of Mississippi Medical Center, Northwestern University, University of Louisville and the American Heart Association (Chesapeake IRB).

2.1. Data variables

2.1.1. Electronic nicotine delivery systems

The outcome of interest for this study was e-cigarette or vaping device use (i.e., ENDS). Participants were asked “How recently have you used an e-cigarette or another device to vape?” If participants had used an ENDS device within the past 30 days, they were considered “Current ENDS users.” If participants had ever used an ENDS device but not in the past 30 days, they were considered “Former ENDS users.” Participants who had never tried an ENDS device or had minimally experimented with ENDS (i.e., never engaged in regular use and have

been abstinent for at least 1 year) were classified as “Never ENDS users.”

2.1.2. SES measures

SES measures included self-reported responses from the online questionnaire. Education categories were restricted to: less than high school diploma, general equivalency diploma (GED), high school diploma, some college and college degree or higher. Income categories were based on self-reported total annual household income, which included all members of the participant's home. Income was categorized as: 1) < \$20,000; 2) \$20K–\$49,999; 3) \$50K–\$64,999; 4) \$65K–\$89,999; and 5) \$90K and above. Employment status was categorized as “not employed” and “employed” (full and part time). The referent groups were the lowest categories for each SES measure (e.g. less than high school diploma, less than \$20,000, and not employed).

2.1.3. Covariates

Demographic variables for this study included age, sex, marital status (single, married, divorced/separated, or widowed), race-ethnicity (Non-Hispanic White, Hispanic White, Non-Hispanic Black, Hispanic Black, and Other), and sexual orientation (heterosexual, lesbian/gay, bisexual, transgendered, or questioning/other). In addition to demographic variables, we added reasons for ENDS use as a covariate because it could be a potential confounder. Participants were asked to select up to three responses to, What was the primary reason you started using your vaping device? The most common reasons for ENDS use were categorized as: alternative to smoking cigarettes, liked the flavors used in the e-cigarette device, and healthier or less harmful than other tobacco products.

2.1.4. Statistical analyses

Sample characteristics by ENDS use were examined via percentages within the ENDS categories.

Because the prevalence of ENDS use was greater than 10%, Poisson regression was used to estimate prevalence ratios (PRs, 95% confidence interval-CI) of current (vs. never) and former (vs. never) ENDS use by SES (Spiegelman and Hertzmark, 2005). Model 1 was unadjusted. Model 2 adjusted for age, sex, sexual orientation, race-ethnicity, and marital status. Model 3 adjusted for Model 2, and reasons for vaping. Analyses were conducted using SAS 9.2 (SAS Institute, Cary, NC).

3. Results

Table 1 presents the distribution of sample characteristics by ENDS use. Most were current ENDS users (58.3%), between 25 and 34 years of age (34.8%), female (57.9%), identified as “Other” race-ethnicity (39.1%), single (53.3%), and heterosexual (80.9%). Approximately 70.1% reported that they had at least some college education or higher, 50% reported household incomes greater than \$50,000, and most participants were employed (70.6%). The highest percentage of current and former ENDS users were between 25 and 34 years of age (39% and 32%, respectively), whereas never ENDS users were predominantly between 45 and 64 years of age (53.4%). A greater percentage of current and former ENDS users identified as ‘other’ race followed by non-Hispanic Blacks and then non-Hispanic Whites. Participants with some college or more reported greater current, former and never ENDS use. Participants who earned between \$20,000 and \$49,999 were more likely to be current, former, and never ENDS users than the other income classes. Participants who were employed were also more likely to be current, former, and never ENDS users.

Table 2 presents the associations of SES with current (vs. never) and former (vs. never) ENDS use status. In the unadjusted model, having a GED was not significantly associated with current or former ENDS use. The PR of current ENDS use was 1.18 (95% CI 1.03–1.37) for those who had a HS diploma (vs. no HS diploma) in the unadjusted model; the PR increased to 1.21 (95% CI 1.06–1.37) in the fully-adjusted model.

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