



Published in final edited form as:

J Adolesc Health. 2018 October ; 63(4): 407–412. doi:10.1016/j.jadohealth.2018.04.010.

Polytobacco Use Among a Nationally Representative Sample of Adolescent and Young Adult E-Cigarette Users

Jessica L King, Ph.D.^{a,*}, David Reboussin, Ph.D.^b, Jennifer Cornacchione Ross, Ph.D.^a, Kimberly D Wiseman, M.S.^a, Kimberly G Wagoner, Dr.P.H.M.P.H.^a, and Erin L Sutfin, Ph.D.^a

^aDepartment of Social Sciences and Health Policy, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, North Carolina

^bDepartment of Biostatistical Sciences, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, North Carolina

Abstract

Purpose: Electronic nicotine delivery systems (ENDS) are adolescents' most commonly used tobacco product and young adults' second most used. Little is known about ENDS use alongside other tobacco products (polytobacco use) and whether exclusive ENDS users differ from polytobacco ENDS users.

Methods: In spring 2016, we surveyed a nationally representative sample of 3,517 13–25-year olds (36.9% 13–17-year olds), and examined sociodemographic and relative risk perceptions between two groups of past 30-day ENDS users: exclusive (only ENDS) and polytobacco (ENDS and at least one other tobacco product).

Results: 4.5% of adolescents and 10% of young adults reported past 30-day ENDS use (n = 281; analytic sample). ENDS users were 38.8% female and 70.6% white. Over half (55.9%) were polytobacco ENDS users. The most common patterns of polytobacco ENDS use were ENDS and cigarettes (11.5%), ENDS and cigars (7.7%), and ENDS, cigars, and waterpipe (5.2%). Those who perceived ENDS to be less harmful than cigarettes were more likely to be exclusive ENDS users than those who perceived ENDS to be as or more harmful than cigarettes (adjusted odds ratio = 2.6, confidence interval = 1.2, 5.7). There were no differences between ENDS groups on age, race, sex, parental education, sexual orientation, or ENDS use frequency.

Conclusions: Just over half of ENDS users also used other tobacco products, increasing their risk for nicotine addiction and other health harms. The Food and Drug Administration is responsible for communicating product risk to consumers and should consider common patterns of use and relative risk perceptions in its ENDS public education efforts.

Keywords

E-cigarette; Adolescence; Epidemiology; Polytobacco use

*Address Correspondence to: Jessica L King, Ph.D., Department of Social Sciences and Health Policy, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, North Carolina 27157.

Conflict of interest: No authors have conflicts of interest to report.

Tobacco use remains the leading preventable cause of disease and death, contributing to over 480,000 deaths annually within the U.S. [1]. Decades of prevention and policy efforts have reduced cigarette smoking rates, but the introduction of non-cigarette tobacco products has led to increased use of multiple tobacco products, or polytobacco use [2]. Polytobacco use is common among U.S. adolescents and young adults; 63% of tobacco users reported past 30-day polytobacco use in the 2014 National Youth Tobacco Survey [3].

Polytobacco use is common for several potential reasons. First, tobacco companies continue to introduce products that are appealing to youth. Often, these products come in a variety of flavors and are perceived as less harmful than cigarettes, which make them more attractive to young people [4–6]. Second, non-cigarette tobacco products such as electronic nicotine delivery systems (ENDS) and waterpipe tobacco have relatively weak regulations in the U.S. compared to cigarettes. While the Food and Drug Administration (FDA) regulations for noncigarette products are expanding, many, including those for warning labels, do not go into effect until late 2018 [7]. Other laws such as smoke-free air laws, taxes, and advertising restrictions often do not cover all tobacco products [8–10]. Finally, tobacco marketing promotes multiple product uptake by encouraging users to switch products or to use some products in conjunction with others [11–13]. For example, the Marlboro Snus slogan “when you choose not to smoke, reach for Marlboro Snus” is interpreted by some individuals as encouraging people to use snus, a form of smokeless tobacco, when unable to use cigarettes [11]. Similarly, ENDS use is often promoted for use in places where cigarette smoking has been prohibited [14]. For example, one ENDS advertisement promotes “the freedom to enjoy the personal pleasures associated with smoking in places where traditional smoking has been banned [12].”

There are several harms associated with polytobacco use, including increased risk for nicotine dependence, substance use disorders, chronic diseases, and cancers, and decreased quit intentions compared to single tobacco product users [15–19]. Further, polytobacco use could indicate a heavy addiction to nicotine that leads users to seek nicotine via different delivery systems [15,20]. Although adolescence and young adulthood are characterized by tobacco product experimentation, which is often thought to be driving high polytobacco rates, polytobacco use may continue into later adulthood. For example, in a longitudinal study of smokeless tobacco use trajectories from adolescence into young adulthood, Kaufman and colleagues found the majority of smokeless tobacco users who also used other products continued polytobacco use in adulthood [6].

Polytobacco research has predominantly focused on products used in conjunction with cigarettes, as cigarettes have historically been the most commonly used tobacco product within the U.S. However, ENDS use is increasing among U.S. adolescents and young adults. ENDS are now the most commonly reported tobacco product used among adolescents, and rates are increasing among young adults [21]. Acknowledging ENDS use may occur alongside other tobacco product use, the recent Surgeon General’s Report on ENDS highlights the importance of identifying patterns of ENDS use among youth [21]. Evidence thus far suggests ENDS are often used concurrently with other tobacco products [22].

The purposes of this study were to identify patterns of tobacco use among ENDS users, and to identify ENDS users most at risk for polytobacco ENDS use by comparing sociodemographic characteristics of adolescent and young adult exclusive ENDS users and polytobacco ENDS users. Research comparing polytobacco users and single tobacco users has identified group differences in both demographic and behavioral characteristics [23–25]. For example, adolescent and young adults who use cigarettes along with other tobacco products are more likely to be male than female [17,26,27] and white than other races [17,20,26]. Additionally, cigarette polytobacco use is more common among younger than older adults, which is often attributed to a cohort effect or users committing to a single product [27]. Frequency of use may also vary among exclusive and polytobacco users; research suggests individuals who use ENDS more often are more likely to be polytobacco users [3,18]. Finally, other polytobacco use research suggests polytobacco users may respond differently than single product users to health risk messages [6], perhaps due to differences in risk perceptions [15,17,28]. To our knowledge, this is the first nationally representative US sample to compare adolescent and young adult polytobacco ENDS users to exclusive ENDS users. By identifying whether ENDS users typically use the product exclusively or in conjunction with other tobacco products, and identifying specific characteristics of those who do use ENDS alongside other tobacco products, we can provide information to allow for more applicable/relevant public health education efforts.

Methods

Sample

Data were collected from a nationally representative sample of adolescents and young adults ages 13–25 from all 50 states. GfK Custom Research administered the survey through their online KnowledgePanel, a probability-based web panel designed to be representative of the United States. KnowledgePanel members are recruited through address-based sampling, which improves population coverage and more effectively recruits hard-to-reach populations such as young adults and individuals from various minority groups. GfK contacted KnowledgePanel members between the ages of 18 and 25 and invited them to participate in the survey. To recruit 13–17-year olds and additional 18–25-year olds, GfK contacted adult KnowledgePanel members with a 13–25 year old in their household and randomly selected a 13–25-year old from the household to participate in the survey. Consent (participants ages 18–25) or assent (participants ages 13–17) was obtained for each participant, and parental consent was also obtained for adolescents ages 13–17. Of 8,665 individuals invited to participate in the survey, 4,506 individuals completed the screener survey (52.0% screener completion rate). A total of 861 individuals were ineligible (e.g., outside the age range or did not provide consent for youth to complete) after completing the screener, resulting in 3,645 qualified individuals. Of those, 3,517 completed surveys (96.5% survey completion rate). The screener survey completion rate is slightly lower than GfK's typical screener completion rate (65%), likely due to the recruiting strategies used to reach the adolescent age group. Surveys were completed between March and April 2016, and participants who completed the survey were paid a \$10 cash-equivalent incentive for their participation. Wake Forest School of Medicine Institutional Review Board approved the study.

Measures

All measures were adapted from Population Assessment for Tobacco or Health study items that were previously tested by our team using an iterative process [29].

Tobacco Use.—We assessed current tobacco use of the most commonly used products among adolescents and young adults with the question stem, “In the past 30 days, on how many days did you,” for the following: “smoke cigarettes,” “use an e-cigarette or other vaping device,” “smoke a cigarillo,” or “smoke tobacco in a hookah.” We asked about each of these products separately and included a brief product description along with an image to increase clarity. Participants completed these items by entering the number of days they used each product. To measure additional tobacco products, we used the question, “We’ve already asked you about your use of cigarettes, electronic cigarettes and other vaping devices, cigarillos, and hookah. Which of the following other tobacco products have you used in the past month?” with response options “large premium cigars,” “little filtered cigars,” “roll-your-own cigarettes,” “chewing tobacco, most snuff/dip, or snus,” “some other new tobacco products not listed here,” and “I have not used any of the products listed above in the past month.” For analyses, we combined large cigars, little cigars, and cigarillos into “cigars.” Respondents who reported use on any of the past 30 days or in past month were considered current users for that tobacco product.

We categorized ENDS users (those who reported past 30-day use) into two mutually exclusive groups: (1) exclusive ENDS users (no use of any other tobacco products in the past month), and (2) polytobacco ENDS users (those who used ENDS and at least one other tobacco product within the past month).

ENDS Use Frequency.—We assessed ENDS use frequency as the number of days used in the past month using the following item: “In the past 30 days, on how many days did you use an e-cigarette or other vaping device”? We treated this as a continuous variable for analyses.

Relative Risk Perception.—We assessed relative risk perception for ENDS compared to cigarettes using a single item: “Compared to cigarettes, e-cigarettes, and other vaping devices are...” with response options “much less harmful,” “a little less harmful,” “as harmful,” “a little more harmful,” and “much more harmful.” Categories were collapsed into less harmful (1) and as or more harmful (2) for analyses.

Demographic Characteristics.—We examined age (13–17, 18–25), race (white, black, other), sex (male, female), father’s education as a proxy for socioeconomic status (high school diploma or less, some college or more), sexual orientation for 18–25-year olds (heterosexual, other), and attraction for 13–17-year olds (attracted to opposite sex, other) across ENDS use groups, using standard demographic items.

Analyses

To describe the sample of exclusive ENDS users, polytobacco ENDS users, and patterns of use, we used unweighted frequencies and weighted percentages. Weights were applied using

KnowledgePanel's patented methodology, which uses the Current Population Survey and American Community Survey to determine study-specific weights. We modeled the probability of being an exclusive ENDS user using logistic regression, while incorporating the sample weights (Proc SURVEYLOGISTIC in SAS). We estimated unadjusted and adjusted odd ratios for exclusive ENDS use compared to polytobacco ENDS use for age, race, ethnicity, sex, paternal education (proxy for socioeconomic status), sexual orientation/attraction, relative risk perception, and ENDS use frequency. We performed all analyses using SAS Version 9.4.

Results

Four and a half percent of adolescents and 10% of young adults reported past 30-day ENDS use, resulting in an analytic sample of 281 adolescent and young adult current ENDS users. ENDS users were 38.8% female, 70.6% white, and 21.9% Hispanic. See Table 1 for sample demographics. Frequency of ENDS use during the past 30 days ranged from 1 to 30 days, with an average 9.5 days (standard error = .8).

Just under half (44.1%) were exclusive ENDS users, and 55.9% were polytobacco ENDS users. There were 27 different combinations of ENDS use and use of other tobacco products. The most common patterns of use were ENDS and cigarettes (11.5%), ENDS and cigars (7.7%), and ENDS, cigars, and waterpipe (5.2%; see Figure 1). Among polytobacco ENDS users, the number of other tobacco products used ranged from one to five. Most used ENDS and one other product (50.3%) or two other products (32.3%), though nearly one in seven (13.4%) used three other products. Use of four or more other products was less common (4 other products = 2.8%; 5 other products = 0.7%).

In multivariable analyses, we found group differences based on relative risk perceptions of ENDS compared to cigarettes (Table 1). Those who perceived ENDS as less harmful than cigarettes were more likely to be exclusive ENDS users than those who perceived ENDS to be as or more harmful than cigarettes (adjusted odds ratio = 2.6; confidence interval = 1.2, 5.7). We did not find differences between groups for age, race, sex, paternal education (proxy for socioeconomic status), sexual orientation/attraction, or ENDS use frequency, after adjusting for covariates. Bivariate results (not presented) were similar and are available upon request.

Discussion

This study presents findings from a nationally representative sample on patterns of ENDS polytobacco use and characteristics of adolescent and young adult exclusive ENDS users and polytobacco ENDS users. Estimates indicate just over half of adolescent and young adult ENDS users use multiple tobacco products. We found most polytobacco ENDS users typically used ENDS and one or two other tobacco products. In addition to ENDS, participants most often used cigarettes, cigars, and waterpipe, which are the most commonly reported products used by this age group in other national surveys [2,3]. The past 30-day polytobacco use rates among ENDS users reported in this study (55.9%) are similar to those reported in other national tobacco studies that focused on general polytobacco use. The 2014

National Youth Tobacco Survey identified 63% of tobacco users as polytobacco users [3], and the 2013–2014 Population Assessment of Tobacco and Health Study identified 43% as polytobacco users [2]. This suggests ENDS users are using multiple tobacco products at rates similar to all tobacco product users. The high rate of polytobacco ENDS use is significant because while ENDS may expose users to lower health risk than combustible tobacco product use, polytobacco ENDS use represents increased risks for nicotine addiction and negative health effects [15–19]. This has implications for communicating tobacco product harm to adolescents. Public education campaigns focused on ENDS use alongside other tobacco product use may be more applicable to youth, as a large number are using ENDS alongside other tobacco products.

Although exclusive ENDS users may not have as great of health risks compared to polytobacco ENDS users, it is important to educate this group on the harms of nicotine and other risks associated with ENDS use. The 2016 Surgeon General’s Report on ENDS use among youth and young adults and the recent National Academy of Science, Engineering, and Medicine Report each highlight the need for communication on ENDS regarding the negative effects of nicotine on brain development [21,30]. In addition, exclusive ENDS users are also at increased risk for using more harmful tobacco products. Recent research suggests ENDS use may lead to other tobacco product use, including cigarette use [31]. Thus, educational messaging targeting exclusive ENDS users is also important.

We also sought to identify differences between exclusive ENDS users and polytobacco ENDS users. Distinct from other polytobacco research and ENDS research, we did not find differences between groups of users for age, race, sex, socioeconomic status (paternal education), or sexual orientation/attraction. It is possible our sample was not large enough to detect associations, or that differences do not exist among the subgroups of ENDS users we compared.

However, we did note a key difference in relative risk perception of ENDS compared to cigarettes. Those who perceived ENDS as less harmful than cigarettes were more likely to be exclusive ENDS users compared to those who perceived ENDS to be as or more harmful than cigarettes. This finding could be reflective of two groups of exclusive ENDS users: those who have transitioned to ENDS from other tobacco use and those who have only used ENDS. ENDS users who have switched from other tobacco use to exclusive ENDS use may be doing so to reduce health risks associated with combustible tobacco use. This finding could also represent those who have chosen to use ENDS instead of other tobacco products because they perceive ENDS as a lower risk option. Because risk perceptions are predictive of initiation [32], monitoring trends in relative risk perception can provide useful information to design campaigns targeted for specific user groups.

In 2009, Congress passed the Family Smoking Prevention and Tobacco Control Act, which provided the U.S. FDA regulatory authority over tobacco products [33]. In 2016, the FDA extended its regulatory authority to include ENDS. As part of regulating tobacco, the FDA is responsible for communicating product risk information to consumers. One way the FDA does this is through its “The Real Cost” public education campaign, which recently

expanded to include information on ENDS. This new campaign aims to inform teens about nicotine's impact on brain development [34].

Our findings suggest public education campaigns should also consider messages on the relative risk of ENDS compared to cigarettes. This approach reflects FDA's comprehensive regulatory plan that places various tobacco products on a risk continuum, in order to encourage strongest regulation for the most harmful tobacco products [35,36]. However, research is needed to understand the implications of relative risk messaging. For example, a campaign that focuses on relative risk of ENDS compared to cigarettes could lead to increased use of ENDS among smokers, but it could also lead to youth using ENDS who may not have otherwise used tobacco products. Research on the impact of relative risk messages will be critical to avoid unintended consequences.

These findings should be considered with regard to limitations. Data were collected using the KnowledgePanel from GfK, which is often used in tobacco research. Participants may be biased due to overexposure to tobacco-related survey items and therefore have risk perceptions dissimilar from the general population. Second, our use of past 30-days and past month to identify current users may not accurately reflect patterns of adolescent and young adult tobacco use. How best to identify current use is an ongoing discussion within tobacco control research [37], and we acknowledge there are potential limitations to using this approach (e.g., overestimate users who tried once in the past 30 days or underestimate by missing those who use sporadically but not within the past 30 days). Additionally, we did not collect data on reasons for ENDS use. Although patterns of use are important, data on reasons for use are important for interpreting findings. We do not know whether youth within this sample were using ENDS when convenient (e.g., in situations when cigarette smoking not allowed), for harm reduction, or to experiment. Future research should consider patterns alongside reasons for polytobacco ENDS use. Finally, there are a number of different factors related to tobacco use among youth and young adults, including peer norms, peer use, personality characteristics, which were not explored by this study. Future studies should include these factors and others related to tobacco use to better understand how sociodemographic factors influence patterns of ENDS use.

Because there are increased health risks with the number of tobacco products used, it is important to be aware of who may be at greater risk, to target messaging and regulatory efforts. We found few differences between groups of ENDS users; however, polytobacco use was common among ENDS users, most often coupled with cigarettes, cigars, and waterpipe. Given the high rates of polytobacco use among ENDS users, prevention efforts should consider focusing on ENDS alongside other tobacco products or on the harms of polytobacco use.

Acknowledgments

This work was supported by the National Cancer Institute and the FDA Center for Tobacco Products (P50 CA180907). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the Food and Drug Administration. The study sponsor did not have any role in study design; data collection, analysis, or interpretation; writing the report; or the decision to submit the manuscript for publication. All who contributed significantly to the work have been acknowledged. None of the authors have any

conflicts to disclose. Preliminary findings were presented at the Society for Research on Nicotine and Tobacco Annual Meeting in March 2017, in Florence, Italy.

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IMPLICATIONS AND CONTRIBUTION

Over half of ENDS users also used other tobacco products, most often cigarettes, cigars, and waterpipe; however, the study identified few sociodemographic differences between exclusive ENDS users and polytobacco ENDS users. Prevention efforts should consider educating about ENDS alongside other tobacco products and prioritize educating adolescents and young adults about the harms of polytobacco use.

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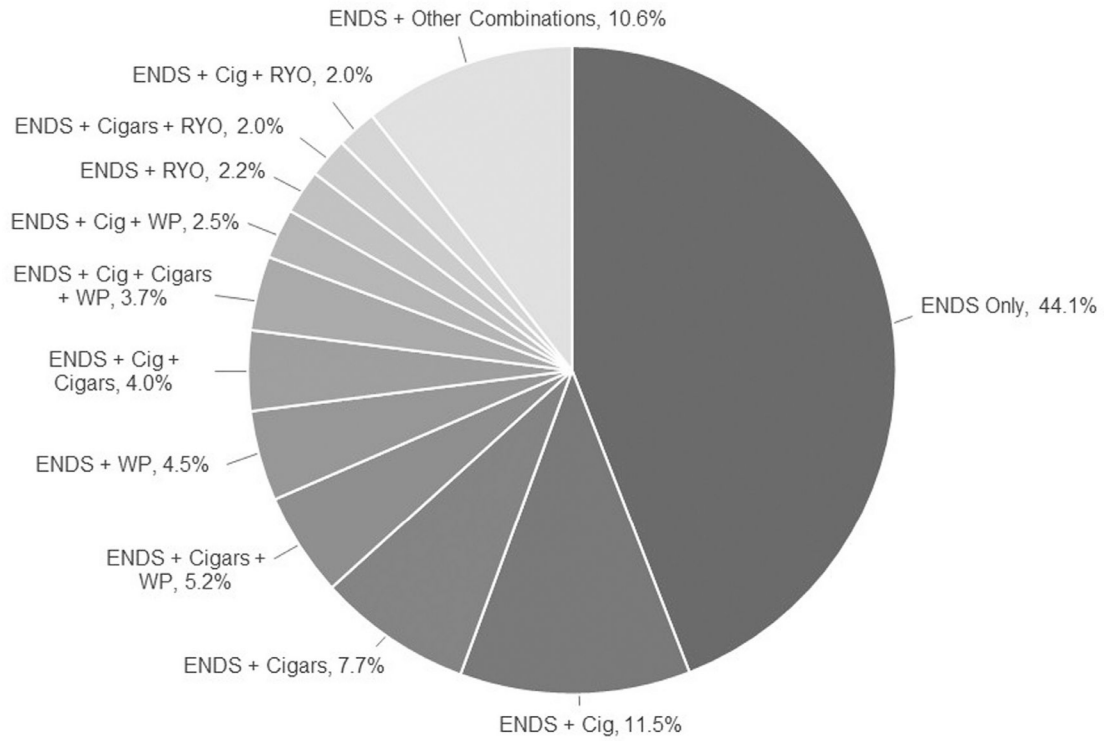


Figure 1.

Tobacco use patterns among ENDS Users (n = 281).

Cig = cigarettes; Cigars = cigars, little cigars, and cigarillos; ENDS = electronic nicotine delivery systems; RYO = roll your own; WP = waterpipe.

ENDS + other combinations include 17 different product combinations, each with less than 2% of users.

Frequency and weighted prevalence of demographic and psychosocial variables by group, and odds for being an exclusive ENDS user

Table 1

	Full sample N = 281 N(%) / Mean(SE)	ENDS exclusive N = 125 (44.1%) N (%) / Mean (SE)	ENDS polytobacco N = 156 (55.9%) N (%) / Mean (SE)	Multivariable odds ratio ^b
Age				
18–25 ^a	223 (79.6)	94(75.7)	129(82.8)	
13–17	58(20.4)	31(24.3)	27(17.2)	1.8(.8, 4.0)
Sex				
Male ^a	150 (61.2)	59(55.9)	91(65.5)	
Female	131(38.8)	66(44.1)	65 (34.5)	1.5(.8, 3.1)
Race				
White ^a	210 (70.6)	98(74.8)	112(67.4)	
Black	22(11.8)	7(8.4)	15(14.4)	0.5 (.2, 1.8)
Other	46(17.6)	19(16.8)	27(18.2)	1.1(.5, 2.6)
Ethnicity				
Hispanic ^a	58 (21.9)	20(18.1)	38(25.0)	
Non-Hispanic	223(78.1)	105(81.9)	118(75.0)	1.7(.7, 3.8)
Father's education				
High school diploma or less ^a	137 (56.1)	59(52.1)	78(59.2)	
Some college or more	143(439)	65(47.9)	78(40.8)	1.1(.6,2.2)
Sexual Orientation/Attraction				
Heterosexual/Opposite Sex ^a	240 (84.4)	112(87.3)	128(82.1)	
Other	41(15.6)	13(12.7)	28(17.9)	0.4 (.2, 1.3)
ENDS relative risk				
As or more harmful than cigarettes ^a	65 (24.5)	19(14.5)	46(32.2)	
Less harmful than cigarettes	213(75.5)	104(85.5)	109(67.8)	2.6 (1.2, 5.7)
ENDS use frequency				
	9.5 (.8)	10.4(1.3)	8.8(1.1)	1.2(.8, 1.6)

ENDS = electronic nicotine delivery systems.

^aReference group.
^b*p* value for ENDS Relative Risk = 0.013; all other *p* values > .05.

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