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The aims of the study were to determine whether ENDS device types (i.e., disposable devices, replaceable cartridges, and refillables) at initial, or first ENDS use is longitudinally associated with subsequent initiation of combustible tobacco products (cigarettes, hookah, cigars) and continued, past 30-day use of combustible and ENDS products. This study is a secondary analysis of data from the Texas Adolescent Tobacco and Marketing Surveillance system (TATAMS) study, a longitudinal cohort study of students who were in the 6th, 8th, and 10th grades (n = 3907) during the 2014-2015 academic year. Data were collected every 6 months, from 2014-2018. Using data from all 8 waves of the study, descriptive statistics were computed for initial ENDS device type (disposables, cartridges, and refillables), initial and past 30-day use of combustible tobacco products (subsequent to ENDS use), and past 30-day ENDS use (among ever ENDS users). Unadjusted and adjusted logistic regression models were computed to assess the likelihood of (a) initiation of combustible tobacco products in

subsequent waves, (b) continued use of combustible tobacco products (past 30-day use) and (c) continued use of ENDS products (past 30-day use) in the same or subsequent waves, by initial ENDS device type. After adjusting for the sociodemographic variables, compared to participants initiating with Refillables, participants initiating ENDS use with Cartridges and Disposables were 58% (AOR = 0.42; 95% CI = 0.18 – 0.98; p = 0.05) and 53% (AOR = 0.47; 95% CI = 0.21-1.07; p = 0.07) less likely to initiate combustible tobacco use in a subsequent wave. Compared to participants initiating with Disposables, participants initiating ENDS use with Cartridges were 12% (AOR = 0.89; 95% CI = 0.32 – 2.50; p = 0.89) less likely to initiate combustible tobacco use in a subsequent wave. Compared to participants initiating with Disposables, participants initiating ENDS use with Cartridges were 12% (AOR = 0.88; 95% CI = 0.21 – 3.68; p = 0.86) less likely to have reported combustible tobacco use in the past 30-days. Compared to participants initiating with Disposables, participants initiating ENDS use with Cartridges were 62% (AOR = 0.38; 95% CI = 0.16 – 0.92; p = 0.03) less likely to have reported ENDS use in the past 30-days. The study provides an insight into the impact device types can have on future smoking behavior and the implication it can have on policy and regulation.

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BACKGROUND

Literature Review

Over centuries, the world of tobacco has seen an extensive evolution and innovation. Tobacco consumption has evolved from chewing, to smoking and inhaling a variety of products ranging from cigarettes, cigars, hookahs, including most recently electronic devices. Aggressive marketing and glamorization of smoking resulted in an exponential rise in the per-capita tobacco consumption in the United States, which saw a decline only after the 1960s.[1] For instance, prevalence of daily smoking among 12th graders in 2006 was half of the prevalence in 1999.[1] Although the 2011-2017 National Youth Tobacco Surveys (NYTS) reported an overall decrease in tobacco use from 24.2% to 19.6%, approximately 2.95 million high school and 0.67 million middle school students still smoked in the United States.[2,3]

Electronic cigarettes, also known as Electronic Nicotine Delivery Systems (ENDS), are used at particularly high rates among U.S. youth.[5-7] Data from the NYTS demonstrated that in 2016, ENDS were the most commonly used tobacco product among high school and middle school students (11.3% and 4.3% of these students were past 30-day users, respectively).[6] ENDS use among high school students increased from 1.5% in 2011 to 20.8% in 2018 with 78% of the increase occurring in 2017-2018.[7] ENDS use in middle school students increased from 0.6% in 2011 to 4.9% in 2018; 48% of this increase occurred in the 2017-2018 school year.[7] Historically trends in tobacco use behaviors among youth have shown greater

fluctuation than trends in adults [1]; the rapid increase in the use of ENDS since their entry into the United States market in 2007 underscores the possibility that recent declines in combustible tobacco consumption among youth will be counteracted by the increase in the use of ENDS.[4]

Evidence indicates an association between ENDS use and subsequent use of other combustible tobacco products among adolescents.[8-13] A systematic review and meta-analysis of longitudinal studies with participants' ages ranging from 14 to 30 years at baseline reported that ever ENDS users were 3.5 times more likely to initiate cigarette smoking as compared to never ENDS users.[9] The same study reported that past 30-day ENDS users were 4.28 times more likely to be past 30-day cigarette smokers as compared to non-past 30-day ENDS users. Leventhal et al[8] reported higher frequency of past 6 month use of any combustible product (cigarettes, cigars, and hookah) in longitudinal repeated assessments of 14-year-old adolescents who were ENDS users at baseline as compared to those who were not. In 2019, a study that analyzed the Population Assessment of Tobacco and Health (PATH) data waves 1 through 3 reported similar trends in youth aged between 12-15 years, the association of ENDS and combustible products being stronger in low-risk youth.[13] Another longitudinal study of 9th, 10th and 11th graders showed ENDS use as a risk factor for smoking onset with the association being stronger among low-risk participants with lower levels of rebelliousness and willingness and higher parental control.[11] The evidence clearly indicates

that ENDS use is a strong risk factor for using combustible products across age groups and especially in low-risk groups.

In August 2016, FDA finalized a rule to regulate all tobacco products including ENDS.[14] Among other rules, it called for a sale ban for minors under the age of 18. Despite the rule, ENDS use remains prevalent among adolescents. FDA regulations are difficult to establish due to a wide range of ENDS device types (e.g. disposables, cartridges, and refillables), countless flavors available commercially, the varied terminology used to describe ENDS, and the limited data available on the ENDS types used by youth.[6,15-17] It is unclear, for example, whether youth who use a particular ENDS device type(s) are more likely to initiate or continue combustible tobacco product use, compared to another device type(s), or whether one device type over another is related to continued past 30-day ENDS use (over quitting).

ENDS are available in a variety of designs, including first generation 'closed' systems that are disposable after use and generally resemble cigarettes ('cigalikes'); and second generation, 'open,' modifiable systems, which can be recharged with a cartridge or refilled with a liquid.[15,18] Greater preference for second generation ENDS device types like refillables may be related to their ability to deliver nicotine to the bloodstream more effectively than first generation devices, the greater satisfaction derived from use of these newer devices, more powerful battery with longer battery life and faster battery charge, and wider choice of liquid flavors.[19-21] Existing research shows evidence for ENDS users transitioning from first

generation to second generation but the subsequent status of ENDS users based on the ENDS device types is lacking.

The study addresses important research gaps by examining the longitudinal association between ENDS use and combustible tobacco product use by ENDS device type, in a population-based cohort of Texas adolescents. Specifically, this study examined whether use of disposable, rechargeable, and/or refillable ENDS devices are related to the onset and continued use of combustible tobacco product use and/or continued ENDS use, over time. Exploring ENDS device type highlights the specific types that pose a higher risk for combustible tobacco and ENDS use over others. This is the first study to explore the association between ENDS device type and combustible tobacco use, longitudinally.

Public Health Significance

Responsible for more than 7 million deaths per year worldwide[22] tobacco use, particularly combustible tobacco use (e.g., cigarette smoking) remains the most preventable cause of death in Texas, the US, and globally. Smoking related illness costs the US more than $300 billion per year.[23] Although Healthy People 2020 tobacco use prevalence objectives[24] have been met for combustible tobacco products, given the increase in ENDS use and the variation in trends in adolescents, the proposed research may inform Healthy People 2030 goals about ENDS use. The study addressed the gap in research about the impact of ENDS device types on subsequent use of combustible tobacco products. The results of the study

can contribute to a valuable foundation for specific interventions and generate evidence for policies and regulations governing the marketing and sale of these products.

Specific Aims

The aims of the study were to determine whether ENDS device types (i.e., disposable devices, replaceable cartridges, and refillables) at initial, or first ENDS use is longitudinally associated with: (a) subsequent initiation of combustible tobacco products (cigarettes, hookah, cigars), (b) continued, past 30-day use of combustible tobacco products and (c) continued, past 30-day use of ENDS products.

METHODS

Study Design, Setting, Population

The study is a secondary analysis of data collected by The Texas Adolescent Tobacco and Marketing Surveillance (TATAMS) study. TATAMS is a longitudinal surveillance study of youth recruited in 2014 from the 6th, 8th and 10th grades in 79 middle and high schools in 5 counties surrounding the 4 largest cities in Texas: Houston, Dallas-Fort Worth, San Antonio and Austin.[25] The study used data from Waves 1-8 of TATAMS, which were collected every 6 months from 2014-2018. The study design was case-cohort.

Recruitment Strategy

Participants were recruited in 2014 using a complex multi-stage probability design.[25] From 2014-2018, 8 waves of a web-based survey were collected every 6 months, over 4 years

of follow-up. Retention across these waves ranged from 64-85%, consistent with similar longitudinal studies of youth.[26]

Consent Process

Active, informed consent to participate in all eight waves of the study was obtained from parents and students.

Inclusion and Exclusion Criteria

The eligible sample for the proposed study included any student who reported ever using an ENDS product, at any of the 8 waves.

Data Collection

Measures in the TATAMS study were developed from those used in national surveillance studies like the Population Assessment of Tobacco and Health (PATH) and the National Youth Tobacco Survey (NYTS).[27, 28] To establish face validity, the survey items were reviewed by a panel of tobacco control experts. To ensure comprehension, cognitive interviews were conducted with 27 youth. The survey instrument, first administered in 2014, consists of over 400 items, and uses full color photographs of ENDS and other tobacco products to help participants accurately report use. Participants could take surveys via their phone, computer, or tablet.

Data Handling and Record Keeping

TATAMS data is stored on a secure drive and accessible only to personnel working on the project. Human subjects were assigned unique identification numbers, and cannot be identified directly or indirectly from the dataset.

Measures

Sociodemographic Factors

Grade in school (6th, 8th, 10th) at onset of the survey, gender (male and female), race/ethnicity (non-Hispanic white, Hispanic, non-Hispanic black, Asian, multi-racial or another race/ethnicity), and socioeconomic status (SES) are included in the analyses as covariates. The survey questions are presented in Table 1 in detail.

ENDS Use

Participants who reported ever ENDS use in any of the 8 waves of the survey were asked what device type they used at first ENDS use. Responses included disposable devices, replaceable cartridges, and refillable devices, as well as a "don't remember" category; participants could choose only one response.[15, 18, 29] Ever ENDS users were also asked about their past 30-day use of ENDS and the specific device type they "usually" used; here, participants could check all responses that applied. The survey questions are presented in Table 1.

Combustible Tobacco Product Use

Ever use of a combustible tobacco (cigarettes, hookah, cigars) at any of the 8 waves after a student reported first ENDS use was used to represent onset of combustible tobacco use. Ever combustible tobacco product (cigarettes, hookah, cigars) users were asked about their past 30-day use of these products. The survey questions are presented in Table 1.

Data Analysis

Derived datasets and variables were created from the original data using R Version 3.4.1 (Boston, MA) and STATA 15.1 (College Station, TX). Descriptive and analytical statistics were computed using STATA 15.1 (College Station, TX). Wave 1 Sampling weights were created specifically for these data and applied to account for the complex survey design.[25] Using data from all 8 waves of the study, descriptive statistics were computed for initial ENDS device type (disposables, cartridges, and refillables), initial and past 30-day use of combustible tobacco products and past 30-day ENDS use. Unadjusted and adjusted logistic regression models were computed to assess the likelihood of (a) initiation of combustible tobacco products in subsequent waves, (b) continued use of combustible tobacco products (past 30-day use) and (c) continued use of ENDS products (past 30-day use) in the same or subsequent waves, by initial ENDS device type.

Human Subjects Considerations

The Human Subjects approval number for the TATAMS study is HSC-SPH-13-0377.

RESULTS

Table 2 provides information about the sociodemographic details, combustible tobacco product use (ever use, past 30-day use), and ENDS use (past 30-day use) of participants who reported ever ENDS use across Waves 1-8, from 2014 to 2018.

Sociodemographic Characteristics

Out of 3,907 study participants (N = 461,069), 32.9% reported initiating ENDS across Waves 1-8, from 2014 to 2018 (n = 1,324; N = 151,784), the proportion of male and female being almost equal. Over half of the ever ENDS users belonged to the middle socioeconomic status (59.5%) while the least number of participants belonged to the high socioeconomic status (18.4 %). Over half of the ever ENDS users were from Grade 10 (52.8%), followed by Grade 8 (33.9 %) and Grade 6 (13.4 %). Ever ENDS users were mostly Hispanic (55.4%), followed by White (19.4 %), African American (14.5 %) and other (10.7%). Among ever ENDS users, 34.9% reported using Refillables as their first ENDS device type used, 8.3% reported using Cartridges, 7.9% reported using Disposables and the rest either reported as 'Don't Remember' (11.7%) or did not report an initial device type (37.2%).

Ever Combustible Tobacco Product Use

Among the 1,324 participants (N=151,784) who initiated ENDS use across Waves 1-8, 852 or 67.6% (N=102,576) participants also initiated combustible use across Waves 1-8, from 2014 to 2018. Among these 852 participants, 266 or 19.4% initiated combustible tobacco use in a wave subsequent to the wave in which they initiated ENDS use (Group A; N=29,443), 465

or 39.1% initiated combustible tobacco use in the same wave in which they initiated ENDS use (Group B; N=29,443) and 121 or 9.1% initiated combustible tobacco use in a wave prior to their ENDS initiation (Group C; N=13,756). In all three Groups, regardless of the sequence of ENDS and combustible tobacco initiation, Refillables were more often reported as the first ENDS device used compared to Cartridges and Disposables.

Past 30-day Combustible Tobacco Product Use and ENDS Use

Among the 1,324 participants who initiated ENDS across Waves 1-8, 146 or 15.7% (N=23,837) reported past 30-day combustible tobacco use in at least one of these Waves. Refillables (2.5%; n=31, N=3,827) were more often reported as the first ENDS device used compared to Cartridges (0.8%; n=10; N=1,614) and Disposables (1.5%; n=12; N=2,259) among past 30-day combustible tobacco users. The rest either reported 'Don't Remember' (1.1%; n=8; N=1,153) or did not report an ENDS device type (9.9%; n=106; N=19,134).

Among the 1,324 participants who initiated ENDS across Waves 1-8, 261 or 22.5% (N=34,073) reported past 30-day ENDS use in at least one of these Waves. Refillables (4.5%; n=62, N=6,824) were more often reported as the first ENDS device used compared to both Cartridges (0.6%; n=12; N=968) and Disposables (1.8%; n=20; N=2,674) among past 30-day ENDS users. The rest either reported 'Don't Remember' (1.3%; n=12; N=1,844) or did not report an ENDS device type (14.3%; n=155; N=21,716).

Relationship between Initial ENDS Device Type and Tobacco Product Use

Table 3 provides information regarding the association between initial ENDS device types and tobacco use. In Group A, compared to participants initiating with Refillables, the crude odds ratio for initiating combustible tobacco use after initiating ENDS use (Group A) was 0.41 (95% CI = 0.17-0.98; p = 0.05) and 0.42 (95% CI = 0.19 – 0.89; p = 0.03) among participants initiating ENDS use with Cartridges and Disposables, respectively. After adjusting for the sociodemographic variables, compared to participants initiating with Refillables, participants initiating ENDS use with Cartridges and Disposables were 58% (AOR = 0.42; 95% CI = 0.18 – 0.98; p = 0.05) and 53% (AOR = 0.47; 95% CI = 0.21-1.07; p = 0.07) less likely to initiate combustible tobacco use, respectively. Compared to participants initiating with Disposables, participants initiating ENDS use with Cartridges were 12% (AOR = 0.89; 95% CI = 0.32 – 2.50; p = 0.89) less likely to initiate combustible tobacco use.

In Group B, compared to participants initiating with Refillables, the crude odds ratio for initiating combustible tobacco use (at the same Wave as initiating ENDS use) was 1.88 (95% C = 0.87 – 4.07; p = 0.11) and 2.01 (95% CI = 1.01 – 4.03; p = 0.05) among participants initiating ENDS use with Cartridges and Disposables, respectively. After adjusting for the sociodemographic variables, compared to participants initiating with Refillables, participants initiating ENDS use with Cartridges and Disposables were 2.31 (95% CI = 1.05 – 5.10; p = 0.04) and 1.98 (95% CI = 0.97 – 4.04; p = 0.06) times more likely to initiate combustible tobacco use, respectively. Compared to participants initiating with Disposables, participants initiating

ENDS use with Cartridges were 1.17 (95% CI = 0.49 – 2.80; p = 0.73) times more likely to initiate combustible tobacco use.

Compared to participants initiating with Refillables, the crude odds ratios for past 30-day combustible tobacco use among participants initiating ENDS use with Cartridges and Disposables were 1.88 (95% CI = 0.70 – 5.04; p = 0.21) and 2.96 (95% CI = 1.03 – 8.46; p = 0.04), respectively. After adjusting for the sociodemographic variables, compared to participants initiating with Refillables, participants initiating ENDS use with Cartridges and Disposables were 2.15 (95% CI = 0.91 – 5.10; p = 0.08) and 2.44 (95% CI = 0.80 – 7.41; p = 0.11) times more likely to have used combustible tobacco in the past 30-day. Compared to participants initiating with Disposables, participants initiating ENDS use with Cartridges were 12% (AOR = 0.88; 95% CI = 0.21 – 3.68; p = 0.86) less likely to have reported combustible tobacco use in the past 30-day.

Compared to participants initiating with Refillables, the crude odds ratios for past 30-day current ENDS use among participants initiating ENDS use with Cartridges and Disposables were 0.57 (95% CI = 0.22 – 1.47; p =0.24) and 1.94 (95% CI = 0.91 – 4.16; p = 0.09), respectively. After adjusting for the sociodemographic variables, compared to participants initiating with Refillables, participants initiating ENDS use with Cartridges were 34% (AOR = 0.66; 95% CI = 0.24 – 1.78; p =0.41) less likely to have used ENDS in the past 30-day while participants initiating ENDS use with Disposables were 1.74 (95% CI = 0.81 – 3.75; p = 0.16) times more likely to have used ENDS in the past 30-day. Compared to participants initiating

with Disposables, participants initiating ENDS use with Cartridges were 62% (AOR = 0.38; 95% CI = 0.16 – 0.92; p = 0.03) less likely to have reported ENDS use in the past 30-day.

DISCUSSION

The sample had a higher number of participants reporting 'second generation' or 'open systems' (refillables) as their first ENDS device type (41.1%) compared to Cartridges (8.6%) and Disposables (7.0%), which can be categorized as 'First generations,' 'cigalikes' or 'closed systems.'

Compared to those reporting 'second generation' (Refillables) devices as their initial ENDS device type, those reporting 'first generation' devices as their initial ENDS device type (Cartridges and Disposables), were less likely to initiate combustible tobacco product use in a subsequent wave, but more likely to initiate combustible tobacco product use at the same wave as they initiated ENDS use. Since data collection occurred every six months, ENDS and combustible initiation occurring in the same wave indicates that the uptake of use of these two types of products occurred within six months of one another. Thus, study findings suggest that if youth begin ENDS use with Cartridges and Disposables (rather than Refillables), they are more likely to also have begun using combustible tobacco within a six-month time of initiating ENDS. However, if youth begin ENDS use with Refillables, they are more likely to have begun using combustible tobacco use at a later wave (i.e., greater than six-months).

Cartridges and Disposables are 'first generation' ENDS, and more closely resemble combustible cigarettes[21] which may explain why youth begin using with first generation ENDS experiment with these devices and combustible tobacco at the same time, or at least within a very short period of time (i.e., no more than six-months). One study reported that second generation ENDS were more satisfying to smokers than first generation ENDS.[21] Greater satisfaction with second generation devices may explain why youth who initiated with Refillables in our study delayed initiating combustible until subsequent waves. Future research should explore reasons, including satisfaction, for delaying and preventing combustible use from occurring, especially since recent studies show that ENDS use may lead to combustible tobacco use.[8-13]

In addition, the first-generation initiators (Cartridges, Disposables) reported higher past 30-day combustible tobacco use compared to second generation (Refillables) initiators. This finding is in line with results from the PATH study, which reported higher current use of combustible products and daily smokers among closed system users (first generation) as compared to open system users (second generation).[30]

Among the participants who initiated ENDS use, 19.7% reported using ENDS in the past 30-days at a wave subsequent to initiation. The PATH study reported that open system users (second generation) were more likely to be current (i.e., past 30-day) ENDS users than closed system users (first generation).[30] Our study builds on this research by delineating

between types of first generation devices, and we showed that Disposable initiators were more likely than Cartridge initiators to be current past 30-day ENDS users.

CONCLUSION

There are certain limitations to the study. While we used pictures to facilitate recognition of the device type used, the data are self-reported, and as such are open to recall and response bias. Secondly, the participants were sampled from schools in Texas, which excludes other adolescents and young adults such as school dropouts, home-schooled youth, youth in detention centers. Thirdly, segregating ENDS users into categories based on device type reduced the sample size, as a large number of participants had not reported their device type. Nevertheless, the study follows the biggest cohort of adolescents in Texas with surveys specific to tobacco and can generalize the findings to the population with sampling weights, given TATAMS' use of a probability-based sampling design.

There are many future directions to this research. Previous research has shown transition from first generation device to second-generation device and a higher current use of second-generation device.[10] This study can further follow the participants to examine their currently used device and the transitions.

Notably, nearing the end of data collection for this study, the popular e-cigarette brand, JUUL, came on the market. JUUL sale increased from 2% to 13% during 2016-2017 having the highest market share. [32] Future research should include a wider array of device

types, including JUUL and other pod devices, to see whether use of these devices is associated with combustible initiation and continued ENDS use.

Another area to examine can be the reasons for the transition. A qualitative study conducted among 18 and older participants found distinct reasons for preferences and satisfaction with the device.[31] In an online survey, participants reported switching to advanced generation device as it provided a 'more satisfying hit.'[10] These users were also less likely to be using combustible products compared to first generation users. Hence, an interaction with combustible use is another factor to explore. Another aspect to consider is nicotine knowledge of different device users. Through their survey and focus groups, the qualitative study also reported higher nicotine and flavor knowledge among tank users (second generation) as compared to 'cigalike' users (first generation).[31] With the increasing use and rapid innovation of ENDS products, it is an imperative to understand the trends to address regulations and interventions.

TABLE 1. RELEVANT MEASURES IN TATAMS STUDY	
Construct	Survey Measures
Sociodemographic Factors	
Socioeconomic Status (SES)[1]	In terms of income, what best describes your family's standard of living in the home where you live most of the time? Would you say your family is: 1 Very well off 2 Living comfortably 3 Just getting by 4 Nearly poor 5 Poor
Gender	What is your gender? 1 Male 2 Female
Grade	What Grade are you in? 6th 7th 8th 9th 10th 11th 12th I do not attend school Post high school program, such as college or technical or trade school
Race/ Ethnicity	Are you Hispanic or Latino/a? 0 No 1 Yes, I am Mexican, Mexican American, or Chicano/a. 2 Yes, I am some other Hispanic or Latino/a not listed here. What race or races do you consider yourself to be? CHECK ALL THAT APPLY. 1 White 2 Black or African American 3 Asian 4 American Indian or Alaska Native 5 Native Hawaiian or Other Pacific Islander 6 Other

[1] "Very well off" classified as "High SES"; "Living comfortable" and "Just getting by" classified as "Middle SES"; and "Nearly poor" and "Poor" classified as "Low SES"

Table 1 (contd.). Relevant Measures in TATAMS Study	
Construct	**Survey Measures**
Electronic Nicotine Delivery Systems (ENDS) use	
Ever use	Have you EVER used an electronic cigarette, vape pen, e-hookah, MOD, or tank system, even one or two puffs? Remember, marijuana DOES NOT count. 1 Yes 0 No
Current use	DURING THE PAST 30 DAYS, did you use an electronic cigarette, vape pen, e-hookah, MOD or tank system? Remember, marijuana DOES NOT count. 01 Yes 00 No
ENDS Device Type	
Device type at first use	Think back to the FIRST electronic cigarette, vape pen, or e-hookah you tried. What type was it? Refer to the photo above for examples. 01 A disposable electronic cigarette that you throw out when it is empty. 02 A rechargeable electronic cigarette used with replaceable cartridges. 03 A rechargeable electronic cigarette used with refillable e-juice/e-liquid. 04 I don't remember
Combustible Tobacco Use	
Current use	DURING THE PAST 30 DAYS, did you smoke…? …a cigarette …a little filtered cigar …a large cigar or cigarillo …hookah 01 Yes 00 No

TABLE 2. SOCIODEMOGRAPHIC CHARACTERISTICS, COMBUSTIBLE TOBACCO USE (EVER, PAST 30-DAY), AND ENDS USE (PAST 30-DAY) AMONG EVER ENDS USERS IN TATAMS WAVES 1-8 (2014-2018); (N=1324, N=151784)

Variables	n	N	%	95% CI	
Sociodemographic Characteristics					
Socioeconomic Status (SES)					
High SES	284	27895	18.38	14.73	22.70
Middle SES	793	90370	59.53	55.67	63.29
Low SES	243	33197	21.88	18.17	26.10
Gender					
Male	628	74878	50.66	45.01	56.29
Female	696	76906	49.34	43.71	54.99
Grade					
6th Grade	140	20333	13.40	8.20	21.15
8th Grade	428	51317	33.82	22.38	47.52
10th Grade	756	80088	52.78	38.25	66.85
Race/ Ethnicity					
African American	195	21993	14.48	10.74	19.24
Hispanic	513	84145	55.44	47.57	63.04
Other	181	16184	10.67	8.41	13.44
White	435	29462	19.41	13.93	26.40
Initial ENDS Device Type					
Cartridges	114	12541	8.25	5.80	11.63
Disposables	94	12034	7.92	6.00	10.38
Refillables	545	52931	34.89	30.64	39.38
Don't Remember	157	17756	11.70	9.75	13.98
Not Reported/Missing	414	56527	37.24	31.74	43.09
Ever Combustible Tobacco Product Use	852	102576	67.58	63.73	71.21
Group A: Initiated ENDS in a Wave prior to Initiating Combustible Use	266	29443	19.40	16.15	23.13
Cartridges	20	1743	1.15	0.56	2.36
Disposables	16	1853	1.22	0.65	2.27
Refillables	125	12225	8.05	6.39	10.11
Don't Remember	28	3483	2.29	1.10	4.38
Not Reported	77	10140	6.68	4.38	10.06
Group B: Initiated Combustible Use in the Same Wave as ENDS Initiation	465	59368	39.12	34.63	43.79
Cartridges	39	5134	3.38	2.25	5.07

Disposables	39	5519	3.64	2.50	5.27
Refillables	146	13667	9.00	7.06	11.42
Don't Remember	29	3815	2.51	1.57	4.00
Not Reported	212	31234	20.58	16.34	25.58
Group C: Initiated Combustible Use in a Wave prior to Initiating ENDS	121	13756	9.06	6.84	11.92
Cartridges	17	2113	1.39	0.70	2.76
Disposables	14	2014	1.33	0.67	2.61
Refillables	63	7051	4.65	3.22	6.67
Don't Remember	26	2539	1.67	0.98	2.85
Not Reported	1	40	0.03	0.00	0.19
Past 30-day Combustible Use among EVER ENDS Users	146	23837	15.70	12.51	19.52
Cartridges	10	1614	1.06	0.39	2.84
Disposables	12	2259	1.49	0.71	3.10
Refillables	31	3827	2.52	1.49	4.26
Don't Remember	8	1153	0.77	0.37	1.59
Not Reported	106	19134	9.85	7.08	13.54
Past 30-day ENDS Use	261	34073	22.46	18.93	26.44
Cartridges	12	968	0.64	0.31	1.33
Disposables	20	2674	1.77	0.95	3.27
Refillables	62	6824	4.51	3.04	6.63
Don't Remember	12	1844	1.23	0.58	2.57
Not Reported	155	21716	14.32	11.67	17.44

TABLE 3. ODDS RATIOS FOR THE ASSOCIATION BETWEEN ENDS DEVICE TYPE AND INITIATING COMBUSTIBLE TOBACCO PRODUCT USE, PAST 30-DAY COMBUSTIBLE TOBACCO PRODUCT USE, AND PAST 30-DAY ENDS USE AMONG EVER ENDS USERS IN TATAMS WAVES 1-8 (2014-2018); (N=1324, N=151784)

	Odds Ratio	p	95% CI[2]		Adjusted Odds Ratio[3]	p	95% CI	
Group A: Initiating ENDS Before Initiating Combustible Use								
Cartridges (Ref: Refillables)	0.41	0.05*	0.17	0.98	0.42	0.05*	0.18	0.98
Disposables (Ref: Refillables)	0.42	0.03*	0.19	0.89	0.47	0.07	0.21	1.07
Cartridges (Ref: Disposables)	0.98	0.97	0.35	2.70	0.89	0.83	0.32	2.50
Group B: Initiating Combustible Use in the Same Wave as ENDS Initiation								
Cartridges (Ref: Refillables)	1.88	0.11	0.87	4.07	2.31	0.04*	1.05	5.10
Disposables (Ref: Refillables)	2.01	0.05*	1.01	4.03	1.98	0.06	0.97	4.04
Cartridges (Ref: Disposables)	0.93	0.87	0.39	2.22	1.17	0.73	0.49	2.80
Group C: Initiating Combustible Use before ENDS Initiation								
Cartridges (Ref: Refillables)	1.13	0.79	0.46	2.76	0.82	0.66	0.33	2.02
Disposables (Ref: Refillables)	1.00	1.00	0.42	2.39	0.85	0.71	0.36	1.98
Cartridges (Ref: Disposables)	1.12	0.84	0.35	3.57	0.96	0.94	0.33	2.79
Past 30-days Combustible Product Use among Ever ENDS users								
Cartridges (Ref: Refillables)	1.88	0.21	0.70	5.04	2.15	0.08	0.91	5.10
Disposables (Ref: Refillables)	2.96	0.04*	1.03	8.46	2.44	0.11	0.80	7.41
Cartridges (Ref: Disposables)	0.64	0.54	0.15	2.72	0.88	0.86	0.21	3.68

[2] CI: Confidence Interval

[3] Models adjusted for Gender, Grade, Socioeconomic Status, Race, Ethnicity

*Significant

Past 30-days ENDS use								
Cartridges (Ref: Refillables)	0.57	0.24	0.22	1.47	0.66	0.41	0.24	1.78
Disposables (Ref: Refillables)	1.94	0.09	0.91	4.16	1.74	0.16	0.81	3.75
Cartridges (Ref: Disposables)	0.29	0.01*	0.11	0.76	0.38	0.03*	0.16	0.92

FIGURE 1 (A): INITIAL ENDS DEVICE TYPE AMONG EVER ENDS USERS

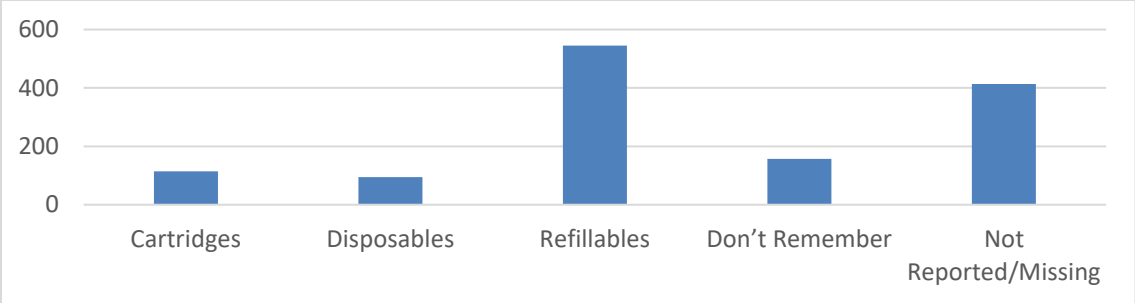


FIGURE 1 (B): EVER COMBUSTIBLE TOBACCO PRODUCT USE (INITIATED COMBUSTIBLE IN A WAVE SUBSEQUENT TO ENDS INITIATION)

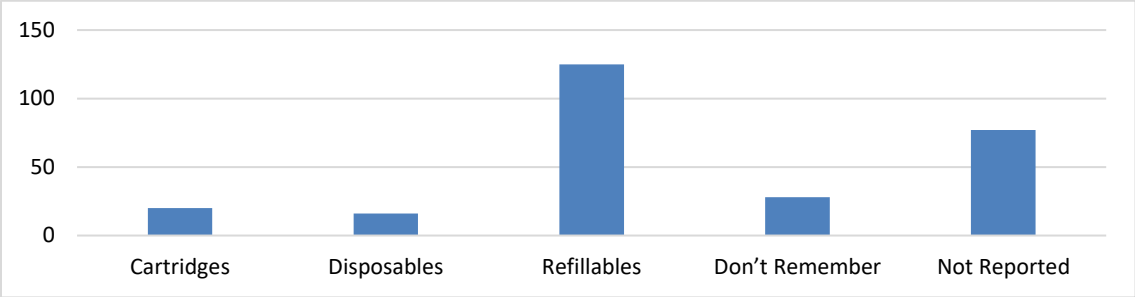


FIGURE 1 (C): EVER COMBUSTIBLE TOBACCO PRODUCT USE (INITIATED COMBUSTIBLE IN THE SAME WAVE AS ENDS INITIATION)

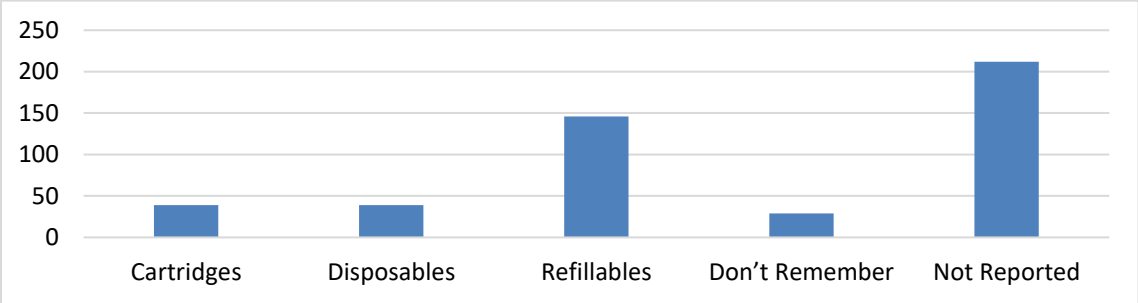


FIGURE 1 (D): CURRENT COMBUSTIBLE TOBACCO PRODUCT USE AMONG EVER ENDS USERS

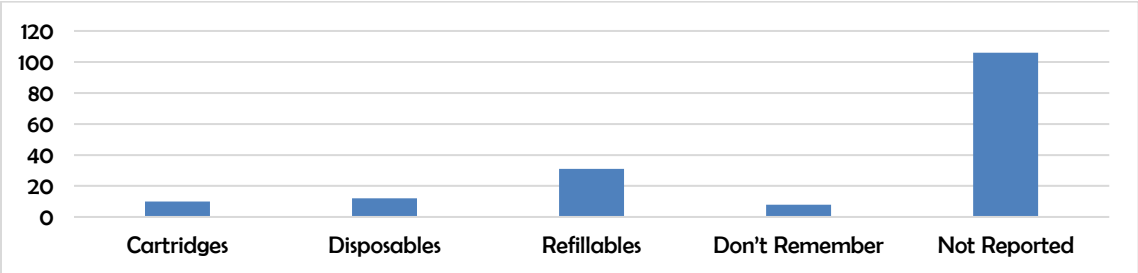


FIGURE 1 (E): CURRENT ENDS USE

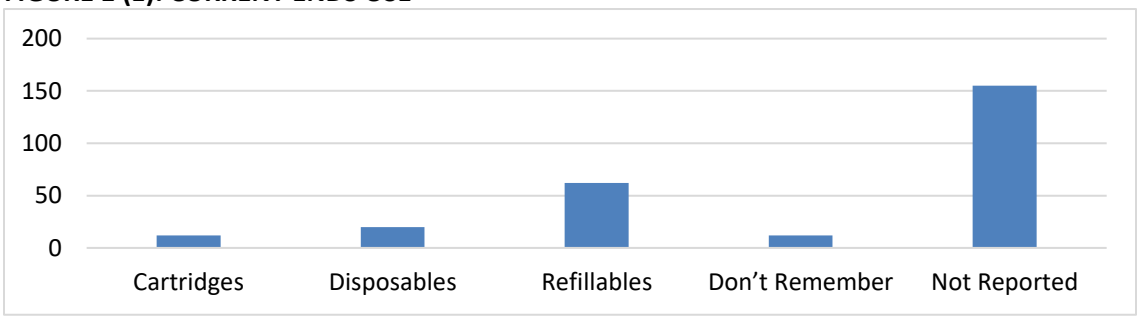


FIGURE 2: ODDS RATIO OF INITIATING COMBUSTIBLE TOBACCO PRODUCT USE AMONG EVER ENDS USERS

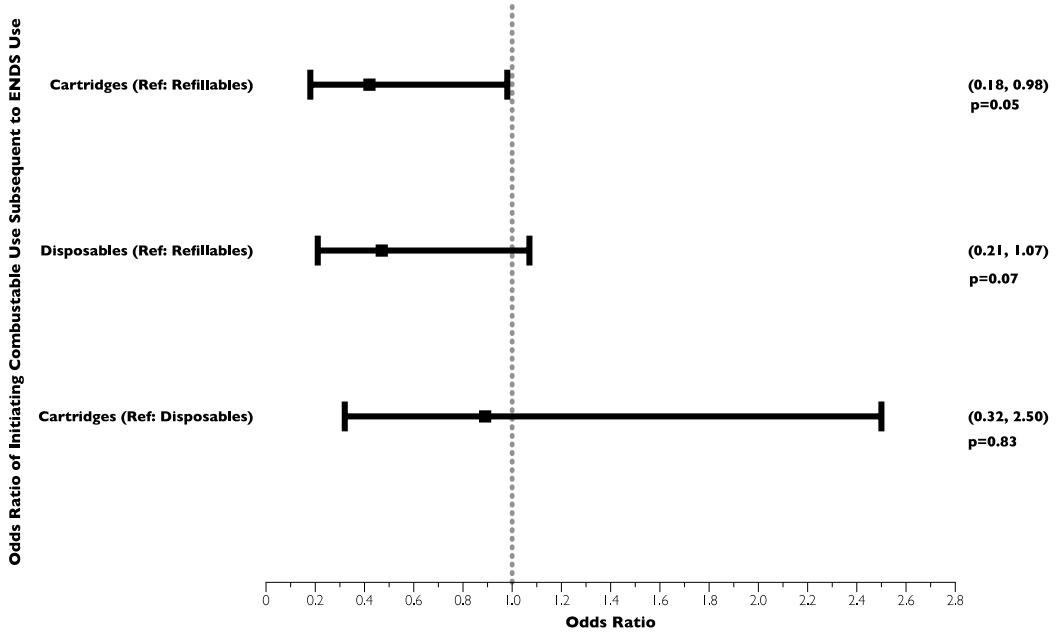


FIGURE 3: ODDS RATIO OF CONTINUED COMBUSTIBLE TOBACCO PRODUCT USE AMONG EVER ENDS USERS

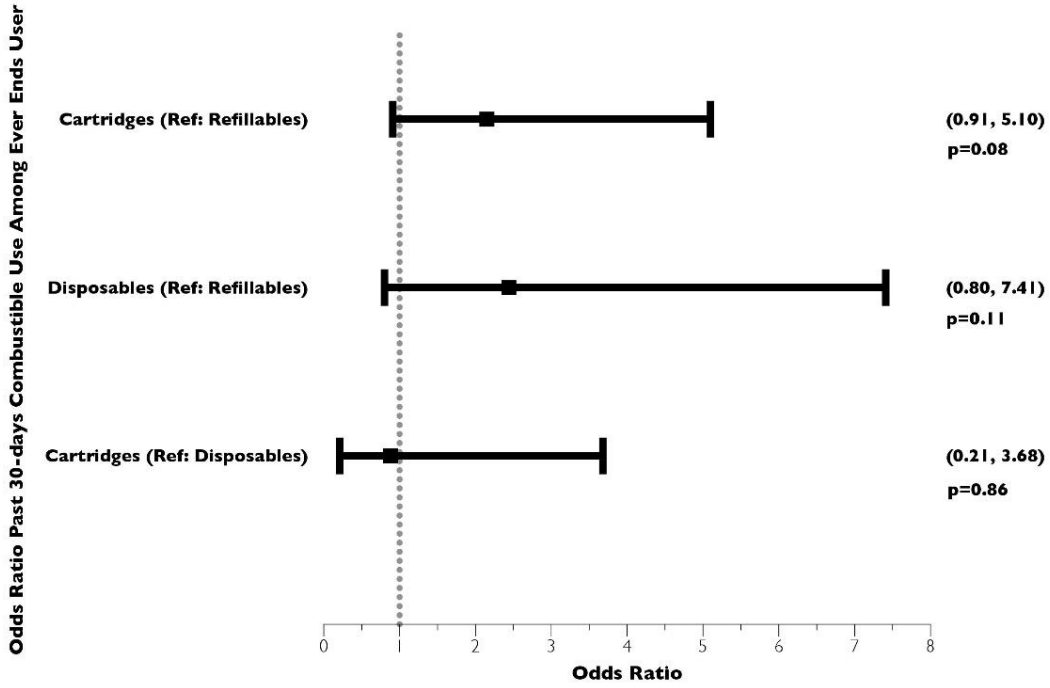
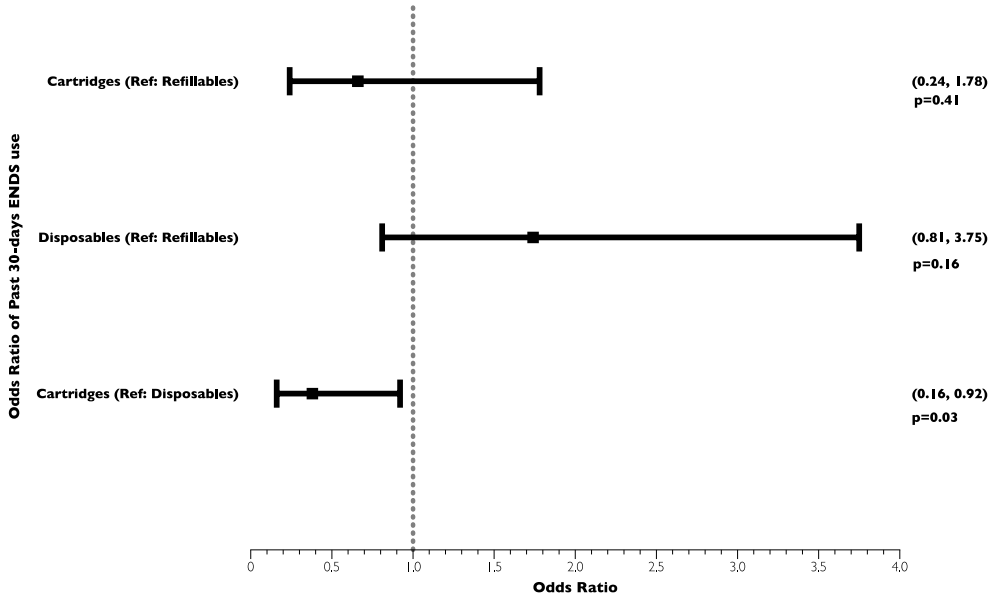


FIGURE 4: ODDS RATIO OF CONTINUED ENDS USE AMONG EVER ENDS USERS



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