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Cigarette and ENDS dual use longitudinal transitions among adults in the Population Assessment of Tobacco and Health (PATH) Study, Waves 4–5 (2016–2019)

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ABSTRACT

Introduction: The study assessed longitudinal transitions among adult (18 and older) past 30-day daily and non-daily dual users of cigarettes and electronic nicotine delivery systems (ENDS).
Methods: Using data from Wave 4 (W4; 2016/17) and Wave 5 (W5; 2018/19) of the Population Assessment of Tobacco and Health (PATH) Study, a nationally representative, longitudinal cohort study of US adults, multivariable regressions were conducted among W4 dual users of cigarettes and ENDS to examine past 30-day cigarette smoking at W5. The study also analyzed changes in frequency of past 30-day smoking and cigarettes smoked per day between W4 and W5, stratified by W4/W5 daily/non-daily ENDS use among W4 daily and non-daily cigarette smokers.
Results: Among W4 dual users, those smoking daily and using ENDS non-daily had higher odds of daily cigarette smoking at W5 than daily users of both products (AOR: 2.32, 95 % CI: 1.38–3.90). W4 daily smokers who used ENDS daily at Wave 5 smoked cigarettes on fewer days at Wave 5 than W4 daily smokers who were either daily ENDS users at Wave 4 ($B = -4.59$; $SE = 1.43$, $p < 0.01$) or non-daily ENDS users at Wave 4 ($B = -4.55$; $SE = 1.24$, $p < 0.001$). Among W4 non-daily cigarette smokers, W4 non-daily ENDS users who used daily at W5 smoked cigarettes on fewer days ($B = -4.04$, $SE = 1.82$) at W5 than those who were non-daily ENDS users at W4 and W5.
Conclusions: Findings highlight the importance of frequency of ENDS use in reducing cigarette smoking and could inform smoking cessation interventions among daily cigarette smokers.

1. Introduction

While current smoking prevalence among US adults (18 and older) decreased slightly from 15.1 % in 2015 to 14.0 % (34.1 million adults) in 2019 (Cornelius et al., 2020), down to almost 11 % in 2022 (National Center for Health Statistics, 2023), the prevalence of current electronic nicotine delivery systems (ENDS) use slightly increased from 3.5 % in 2015 to 4.5 % in 2019 (Cornelius et al., 2020; Phillips et al., 2017) and to almost 6 % in 2022 (National Center for Health Statistics, 2023). However, dual use of cigarettes and ENDS (using both products concurrently) mostly remained consistent, between 2.9 % and 4.5 % from 2015 to 2019 (Owusu et al., 2019). In the rapidly changing tobacco landscape where cigarette use among adults is decreasing and ENDS use is increasing, examining longitudinal transition patterns among those who use cigarettes and ENDS is essential in understanding how and why these products are being used in conjunction (e.g., if those who use

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cigarettes and ENDS are on the path to quit smoking or if they are using ENDS when they cannot smoke) (Gravely et al., 2021).

A large proportion of adults who smoke cigarettes report using ENDS to help with smoking reduction or quitting (Brown & Shahab, 2021; Gravely et al., 2021; Owusu et al., 2019; Patel et al., 2016; Rutten et al., 2015; Wang et al., 2021; Carpenter et al., 2023). Using the 2018–2019 Tobacco Use Supplement to the Current Population Survey (TUS-CPS), Mayer et al. (2020) found that among those who currently use cigarettes and ENDS, 69 % used ENDS to try to quit smoking and among those who formerly smoked, 81 % used ENDS to help them quit smoking. Using National Health Interview Survey data from between 2014 and 2018, Bandi et al. (2021) found that ENDS use increased substantially among those who recently quit cigarettes.

Furthermore, studies have examined the association between frequency of ENDS use and smoking cessation, suggesting an association of ENDS use with greater odds of quitting cigarettes among those who use ENDS daily compared to those who use ENDS non-daily (Levy et al., 2018; National Academies of Sciences, Engineering, and Medicine, 2018). For example, a longitudinal study among adults who use cigarettes and ENDS using Waves 1 and 2 (2013–2015) of the Population Assessment of Tobacco and Health (PATH) Study data showed that those who used ENDS daily at Wave 1 (W1) were more likely than those who used non-daily to abstain from smoking at Wave 2 (W2) (Coleman et al., 2019). Analysis of the first two waves of the PATH Study showed that adults, aged 25 and older, who used ENDS daily were more likely to quit smoking cigarettes or reduce smoking compared to those who used ENDS non-daily (Berry et al., 2019). However, other studies have shown no association between frequency of ENDS use (daily or non-daily) and smoking cessation (Abi Nehme et al., 2022). Overall, high level transitions of cigarette and ENDS dual use have been mixed and while the findings from previous studies are informative (Gravely et al., 2020; Simonavicius et al., 2020; Snell et al., 2020), it is unclear if those who use both cigarettes and ENDS quit or cut down cigarette smoking and continue using ENDS and at what frequency (Krishnan et al., 2022). It is important to try to determine if adults who smoke cigarettes are using ENDS to quit or to cut down on smoking, and if so, by how much. Using more recent PATH Study data, this study aims to examine the transitions among those who use both cigarettes and ENDS over time.

Recently, Baig & Giovenco (Baig & Giovenco, 2020; Smith et al., 2021) proposed a new mutually exclusive classification of dual use of cigarettes and ENDS based on smoking and vaping frequencies: 1) heavy dual use: daily use of cigarettes and ENDS, 2) predominant smoking: daily cigarette use and non-daily ENDS use, 3) predominant vaping: daily ENDS use and non-daily cigarette smoking, and 4) light dual use: non-daily use of cigarettes and ENDS. Using this dual use classification, this study aims to: 1) determine the association of Wave 4 (W4) dual use with Wave 5 (W5) cigarette smoking status stratified by daily and non-daily cigarette smoking status at W4; 2) examine the change in smoking frequency between W4 and W5 by daily or non-daily ENDS use status at each wave, among those who used both cigarettes and ENDS at W4 and continued smoking cigarettes at W5; 3) examine the change in cigarettes smoked per day (CPD) between W4 and 5 by daily or non-daily ENDS use status at W4 and 5, among those who used both cigarettes and ENDS at W4 and smoked cigarettes daily at W5. Consideration of frequency of cigarettes and ENDS use is important in understanding how product use transitions over time, which can ultimately help in understanding the public health impacts of ENDS in cigarette smoking among adults.

2. Methods

2.1. Data source

The current study utilizes longitudinal data from W4 (2016–2017) and W5 (2018–2019) of the PATH Study. The PATH Study is an ongoing, nationally representative, longitudinal cohort study of adults and youth in the US. An in-person screener was used at W1 to randomly select youth (aged 12–17) and adults (aged 18 +) from households for participation in the study. At W4, a probability replenishment sample was selected from the U.S. civilian noninstitutionalized population (CNP) at the time of W4 (December 1, 2016 through January 3, 2018), including persons who were not in the CNP at the time of W1. Members of the W1 Cohort who were in the CNP at the time of W4 were combined with the W4 replenishment sample to form the new W4 Cohort. The weighted W4 response rate for the adult W1 Cohort was 73.5 %. For the W4 Cohort, among adults selected during screening, the weighted response rate was 68.0 %. At W5, the weighted response rate for the W4 Cohort was 88.0 % for adult interview respondents. Full-sample weights were created to adjust for the complex sample design (e.g., oversampling of particular demographic groups) and nonresponse, and replicate weights enabled computation of associated measures of statistical precision. Further details regarding the PATH Study design and methods for the W1 Cohort are published elsewhere (Hyland et al., 2017; Piesse et al., 2021; Tourangeau et al., 2019). Details on interview procedures, questionnaires, sampling, weighting, response rates, and accessing the data are described in the *PATH Study Restricted Use Files User Guide* at https://doi.org/10.3886/Series606. The PATH Study was conducted by Westat and approved by the Westat Institutional Review Board. All respondents ages 18 and older provided informed consent. This study included adult respondents who used cigarettes and ENDS in the past-30 days at W4 and were W5 interview respondents (n = 2,078). For all analyses, dual use could have included use of other tobacco products in the past 30 days; those who could have used other tobacco products were included because the sample size of exclusive dual use (cigarette and ENDS only) was low for analysis.

2.2. Measures

Tobacco Use (Predictor): The PATH Study asks a series of questions about past 30-day tobacco use including cigarettes, ENDS, and other tobacco products such as cigars (including traditional cigars, cigarillos, filtered cigars), pipe tobacco, hookah, smokeless tobacco and snus pouches/loose snus. Among those who used tobacco products in the past 30 days, detailed questions are asked on frequency of use in the past 30 days. In this analysis, frequency of use for each product (cigarette and ENDS) was defined as the number of days respondents reported smoking or using ENDS within the past 30 days (range 1–30). Non-past 30-day use was assigned a value of 0. Based on frequency of use, cigarette and ENDS use was categorized into daily and non-daily past 30-day use. Currently using every day or using on 30 of the past 30 days was categorized as daily use and using some days or using on 1–29 of the past 30 days was categorized as non-daily use. See Appendix A for details.

Tobacco use was defined as described below:

1) Based on the Baig & Giovenco classifications described above (Baig & Giovenco, 2020; Borland et al., 2019) W4 past 30-day dual use was categorized into: i) heavy dual use, ii) predominant smoking, iii) predominant ENDS use, and iv) light dual use.

2) Daily and non-daily ENDS use at W4 and W5: Based on past 30-day daily and non-daily use, ENDS use was categorized as: i) daily use at both waves ii) W4 daily and W5 non-daily use iii) W4 non-daily and W5 daily use iv) non-daily use at both waves.

Outcomes: Several transition outcomes were explored in this study among those who used cigarettes and ENDS at W4: 1) daily cigarette use at W5, 2) no-past 30-day use of cigarettes at W5, 3) no past 30-day use of cigarettes or ENDS at W5 (could be using other tobacco products), 4) mean change in frequency of past 30-day cigarette smoking (number of days) between Waves 4 and 5, and 5) mean change in CPD between Waves 4 and 5 among those who smoked cigarettes daily at W5. All outcomes could include past 30-day use of other tobacco products, as the focus was on the transitions in cigarette and ENDS use between W4 and W5.

Covariates: Sociodemographic variables included age (18–24, 25–39, 40–54, 55 + years), sex (male, female), race/ethnicity (White, non-

Hispanic; Black, non-Hispanic; other race, non-Hispanic; Hispanic), and educational attainment (less than high school/GED, high school graduate, some college/Associate's degree, Bachelor's degree or more). In addition, an indicator of other tobacco use at W4, including cigars, smokeless/snus, hookah, or pipe, was included to account for use of other tobacco products among those who used cigarette and ENDS and to isolate ENDS and cigarette use outcomes at W5. Missing data on sex, race and Hispanic ethnicity were imputed as described elsewhere (PATH Study Restricted Use Files User Guide).

2.3. Statistical analyses

All analyses were weighted using W5 single wave weights for the W4 cohort (including full-sample and 100 replicate weights) to produce nationally representative estimates. Variances were computed using the balanced repeated replication method (BRR) (McCarthy, 1969) with Fay's adjustment set to 0.3 to increase estimate stability (Judkins, 1990). Statistical analyses were performed in SAS 9.4 (SAS Institute, Cary, NC) and Stata version 17 (StataCorp LLC, College Station, TX). Analyses were performed as described below.

1) First, overall transitions of past 30-day tobacco use from W4 to W5 were explored (Fig. 1).

2) Transitions from Waves 4 to 5 by W4 heavy dual use, predominant smoking, predominant ENDS use, and light dual use were examined (Table 1).

3) Separate logistic regression models were tested to examine the main effects of W4 cigarette smoking (daily vs non-daily) and W4 ENDS use (daily vs non-daily) on i) W5 daily cigarette smoking, ii) W5 discontinuation of cigarette smoking, and iii) W5 discontinuation of both cigarette smoking and ENDS use. Analysis was further stratified by W4 daily and non-daily cigarette smoking status across all three W5 outcomes (Table 2).

4) Weighted mean frequency of use was calculated for cigarettes at Waves 4 and 5. Mean change in frequency of cigarette use in the past 30 days was calculated by subtracting W4 frequency of past 30-day smoking from W5 frequency of past 30-day smoking and taking the average of the differences (Pearson et al., 2020). An increase in frequency of past 30-day cigarette use (increased number of days smoking) at W5 was indicated by a positive value, a negative value indicated decrease in frequency at W5, and no change between Waves 4 and 5 was indicated as zero. As shown in Table 3, adjusted linear regression models were tested to examine the associations between combinations of Waves 4 and 5 ENDS use status (daily and non-daily) and change in mean past 30-day cigarette smoking frequency between Waves 4 and 5, among those who smoked cigarettes daily and non-daily.

5) Mean change in CPD in the past 30 days was calculated by subtracting CPD at W4 from CPD at W5 and taking the average of the differences. Similar to change in mean cigarette smoking frequency, a positive value for change in CPD reflects an increase in CPD from W4 to W5 and a negative number reflects a decrease in CPD. Similar to Table 3, linear regression models examined the associations between combinations of W4 and W5 ENDS use status (daily and non-daily) and change in mean CPD between W4 and W5, among adults who smoked cigarettes daily and non-daily at W4, and who smoked daily at W5, adjusting for covariates (Table 4).

3. Results

Characteristics of those who used cigarettes and ENDS at W4 (n = 2,078) are presented in Appendix B and overall transitions in past 30-day tobacco use are presented in Fig. 1.

Table 1 presents past 30-day tobacco use transitions based on frequency of use among those who used cigarettes and ENDS at W4 (n = 1,606).

Heavy dual use transitions: 27.1 % (95 % confidence interval (CI): 19.9, 35.8) transitioned to past 30-day cigarette only smoking at W5, while 23.1 % (95 % CI: 16.7, 31.1) continued heavy dual use, 20.1 % (95 % CI: 14.0, 27.9) transitioned to predominant smoking, and 10.6 % (95 % CI: 6.8, 16.3) switched to predominant ENDS use at W5.

Predominant smoking transitions: At W4, the largest group of those who used both cigarettes and ENDS in the past 30-days

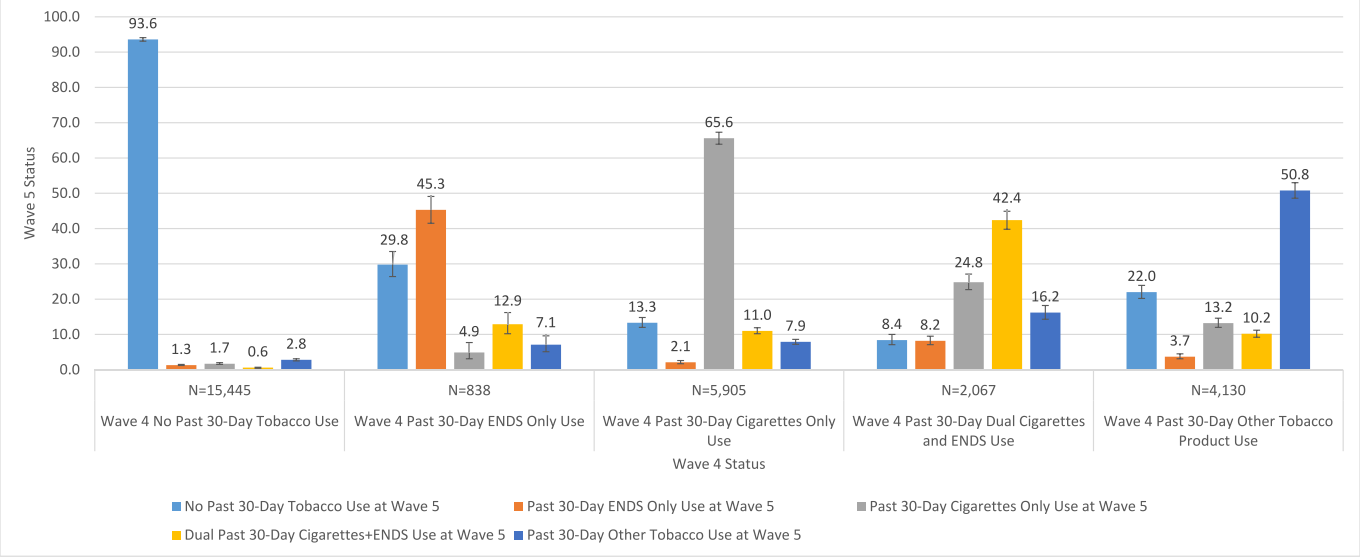

Fig. 1. Transitions in Past 30-Day Tobacco Use in the PATH Study Waves 4–5 (N = 28,385).
Percents are weighted using the Wave 5 single-wave weights for the Wave 4 Cohort (R05_A_S04WGT). To be included in the analysis, respondents must have participated in Waves 4 and 5.
ENDS = electronic nicotine delivery system.
Wave 4 and 5 past 30-day tobacco use categories: no past 30-day use of any tobacco; past 30-day ENDS only use; past 30-day cigarette only use; past 30-day dual use of ENDS and cigarettes (could use other products); past 30-day other tobacco product use, including cigars, pipe, hookah, smokeless tobacco, snus pouches/loose snus (could use ENDS or cigarettes but not both).
Note: 11 Wave 4 adults who used cigarettes and ENDS in the past 30-days did not report their tobacco use status at Wave 5.

Table 1
Transitions in Past 30-Day Tobacco Use Among Wave 4 Adult Dual Users of Cigarettes and ENDS[a] with Data on Wave 5 Past 30-Day Tobacco Use Status (N = 1,606) in the PATH Study (Waves 4–5).

Wave 4 Past 30-day Dual Use Status	Unweighted N	Weighted % (95% CI)	Wave 5 Past 30-day Use Status															
			Tobacco Non-users[b]		ENDS Only Users		Cigarettes Only Smokers		Heavy Dual Users		Predominant Smokers		Predominant ENDS Users		Light Dual Users		Other Tobacco Product Users[c]	
			Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)
Heavy Dual Users (Daily Cigarette and ENDS Users)	170	11.7 (9.8, 13.9)	7	3.7 (1.6, 8.3)†	9	5.7 (2.8 11.2)†	39	27.1 (19.9, 35.8)	36	23.1 (16.7, 31.1)	39	20.1 (14.0, 27.9)	20	10.6 (6.8, 16.3)	6	2.1 (0.8, 5.0)†	14	7.6 (4.0, 13.8)†
Predominant Smokers (Daily Cigarette and Non-daily ENDS Users)	735	46.0 (43.0, 48.9)	35	4.8 (3.2, 7.1)	29	3.6 (2.4, 5.4)	256	35.2 (31.8, 38.8)	46	5.9 (4.4, 8.0)	187	25.2 (21.5, 29.4)	32	4.3 (2.9, 6.4)	23	3.0 (1.8, 5.1)	127	17.8 (14.9, 21.2)
Predominant ENDS Users (Daily ENDS and Non-daily Cigarette Users)	254	16.8 (14.6, 19.2)	13	5.1 (2.6, 9.8)†	64	23.7 (19.1, 29.0)	27	12.3 (8.6, 17.4)	10	3.8 (1.7, 8.0)†	21	8.2 (4.9, 13.5)	72	29.3 (23.8, 35.5)	21	6.8 (4.2, 10.9)	26	10.8 (7.4, 15.6)
Light Dual Users (Non-daily ENDS and Non-daily Cigarette Users)	447	25.5 (23.0, 28.2)	83	18.8 (14.6, 23.9)	49	10.2 (6.8, 15.1)	56	14.1 (10.4, 18.9)	6	1.5 (0.5, 4.0)†	19	4.3 (2.5, 7.2)	33	8.4 (5.7, 12.2)	103	25.1 (20.4, 30.4)	98	17.6 (14.3, 21.5)

† Estimate should be interpreted with caution because it has low statistical precision. It is based on a denominator sample size of less than 50, or the coefficient of variation of the estimate or its complement is larger than 30%.

Percents are weighted using the Wave 5 single-wave weights for the Wave 4 Cohort (R05_A_S04WGT). To be included in the analysis, respondents must have participated in Waves 4 and 5.

ENDS = electronic nicotine delivery system; CI = confidence interval.

[a] 55.7% (65% CI: 53.3, 58.1) of Wave 4 dual users of cigarettes and ENDS used other tobacco products.

[b] Tobacco non-users are past 30-day non-users of any tobacco product.

[c] Past 30 day other tobacco product use is defined as past 30 day use of traditional cigars, cigarillos, filtered cigars, pipe, hookah, smokeless tobacco, or snus pouches/loose snus. Other tobacco product users could also be past 30-day users of cigarettes (69.5%, 95% CI: 62.8, 75.5) or ENDS (16.5%, 95% CI: 12.3, 21.8) but not both.

Table 2
Unadjusted and Adjusted Associations between Past 30-day Dual Cigarette and ENDS Use[a] at Wave 4 and Use Status at Wave 5 (n = 1,711) in the PATH Study (Waves 4–5) Among Wave 4 Adults Who Used Cigarettes and ENDS.

Wave 4 Status (Among Wave 4 adults who used cigarettes and ENDS)		Wave 5 Daily Past 30-Day Cigarette Smoking		Wave 5 No Past 30-Day Cigarette Smoking		Wave 5 No Past 30-Day Cigarette or ENDS Use	
		OR (95 % CI)	AOR[c] (95 % CI)	OR (95 % CI)	AOR[c] (95 % CI)	OR (95 % CI)	AOR[c] (95 % CI)
Main Effects Model (Wave 4 cigarette smoking and Wave 4 ENDS use)[b]							
Daily cigarette smoking (n = 968)		Ref	Ref	Ref	Ref	Ref	Ref
Non-daily cigarette smoking (n = 743)		**0.05 (0.04–0.07)**	**0.06 (0.04–0.08)**	**5.68 (4.17–7.75)**	**4.30 (3.02–6.13)**	**5.07 (3.26–7.88)**	**4.18 (2.57–6.78)**
Daily ENDS use (n = 445)		Ref	Ref	Ref	Ref	Ref	Ref
Non-daily ENDS use (n = 1266)		0.90 (0.58–1.38)	1.12 (0.72–1.74)	1.07 (0.79–1.44)	0.97 (0.70–1.36)	**3.02 (1.68–5.45)**	**2.54 (1.37–4.69)**
Stratified Model (among Wave 4 adults who smoked cigarettes daily)							
Daily cigarette smoking (n = 968)	Daily ENDS use (Heavy dual use) (n = 177)	Ref	Ref	Ref	Ref	Ref	Ref
	Non-daily ENDS use (Predominant cigarette use) (n = 791)	**1.78 (1.10–2.87)**	**2.32 (1.38–3.90)**	0.93 (0.45–1.91)	0.90 (0.42–1.92)	1.14 (0.46–2.84)	1.20 (0.48–3.02)
Stratified Model (among Wave 4 adults who smoked cigarettes non-daily)							
Non-daily cigarette smoking (n = 743)	Daily ENDS use (Predominant ENDS use) (n = 268)	Ref	Ref	Ref	Ref	Ref	Ref
	Non-daily ENDS use (Light dual use) (n = 475)	**0.54 (0.33–0.91)**	0.55 (0.30–1.01)	1.12 (0.78–1.62)	1.05 (0.68–1.61)	**4.02 (2.02–8.01)**	**3.52 (1.71–7.24)**

Note: Statistically significant estimates ($p < 0.05$) are bolded.
ENDS = electronic nicotine delivery system; OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval; Ref = reference group.
[a] Those who used cigarettes and ENDS could use other tobacco products.
[b] Main effects model includes two independent variables of interest: W4 daily/non-daily cigarette smoking and W4 daily/non-daily ENDS use. When each variable is considered separately, the effect of that variable is adjusted for the effect of other variable.
[c] Model also adjusts for age, sex, race/ethnicity, education, past 30-day other tobacco product use.

Table 3
Associations between ENDS Use Status (Daily vs Non-Daily) and Change in Frequency (Number of Days in the Past 30 Days) of Cigarette Smoking at Wave 5 Among Wave 4 and Wave 5 Adults Who Used ENDS and Cigarettes[a] (n = 674) in the PATH Study (Waves 4–5).

Wave 4 and Wave 5 Past 30-day Cigarette and ENDS Use Status		Weighted Mean (SE) Frequency of Past 30-Day Cigarette Use at W4	Weighted Mean (SE) Frequency of Past 30-Day Cigarette Use at W5	Weighted Mean (SE) Change in Cigarette Use Frequency Between W4 and W5	Unadjusted B (SE)	Adjusted B (SE)[b]
W4 past 30-day daily cigarette smoking	W4 daily ENDS use and W5 daily ENDS use	30.00 (0.00)	24.12 (1.34)	−5.88 (1.34)	**−4.14 (1.42)****	**−4.59 (1.43)****
	W4 daily ENDS use and W5 non-daily ENDS use	30.00 (0.00)†	27.70 (1.04)†	−2.30 (1.04)†	−0.57 (1.11)	−0.86 (1.11)
	W4 non-daily ENDS use and W5 daily ENDS use	30.00 (0.00)	22.77 (1.13)	−7.23 (1.13)	**−5.49 (1.30)*****	**−4.55 (1.24)*****
	W4 non-daily ENDS use and W5 non-daily ENDS use	30.00 (0.00)	28.26 (0.46)	−1.74 (0.46)	**Ref**	**Ref**
W4 past 30-day non-daily cigarette smoking	W4 daily ENDS use and W5 daily ENDS use	10.08 (0.87)	10.16 (1.43)	0.08 (1.49)†	−2.71 (1.70)	−2.58 (1.74)
	W4 daily ENDS use and W5 non-daily ENDS use	11.46 (1.25)†	19.20 (2.23)†	7.73 (2.78)†	4.94 (2.81)	4.91 (2.55)
	W4 non-daily ENDS use and W5 daily ENDS use	12.82 (1.48)†	11.83 (2.15)†	−0.98 (1.69)†	−3.78 (1.91)	**−4.04 (1.82)***
	W4 non-daily ENDS use and W5 non-daily ENDS use	8.34 (1.04)	11.13 (1.16)	2.79 (0.86) †	**Ref**	**Ref**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
† Estimate should be interpreted with caution because it has low statistical precision. It is based on a denominator sample size of less than 50, or the coefficient of variation of the estimate or its complement is larger than 30%.
Notes: All estimates are weighted. Frequency of cigarette use = number of days smoked cigarettes within the past 30 days. Weighted means (SEs) for frequency of past 30-day cigarette use at W4 and W5 are shown for those with non-missing data on change in cigarette use frequency between W4 and W5.
W4 = Wave 4; W5 = Wave 5. At Wave 4, among dual users of cigarettes and ENDS at Wave 4 and Wave 5, there were 389 past 30-day daily cigarette smokers and 285 past 30-day non-daily cigarette smokers.
ENDS = electronic nicotine delivery system; B = beta; SE = standard error; Ref = reference group.
Beta coefficients represent change in the number of days of cigarette smoking at Wave 5 among those who used cigarettes and ENDS at Wave 4 and Wave 5.
[a] Those who used cigarettes and ENDS could use other tobacco products.
[b] Model adjusts for age, sex, race/ethnicity, education, past 30-day use of any other tobacco product use.

predominantly smoked at 46.0 % (95 % CI: 43.0, 48.9). Among those, at W5, 35.2 % (95 % CI: 31.8, 38.8) only smoked cigarettes in the past 30 days, followed by 25.2 % (95 % CI: 21.5, 29.4) who continued predominant smoking; only 3.6 % (95 % CI: 2.4, 5.4) used ENDS exclusively, and 4.3 % (95 % CI: 2.9, 6.4) predominantly used ENDS at W5.

Predominant ENDS use transitions: 29.3 % (95 % CI: 23.8, 35.5) continued this status at W5 and 8.2 % (95 % CI: 4.9, 13.5) switched to predominant smoking.
Light dual use transitions: One-fourth of those with light dual use at W4 (25.1 %, 95 % CI: 20.4, 30.4) continued this status at W5 and about 19 % stopped using any tobacco.

Table 4
Associations between ENDS Use Status (Daily vs Non-Daily) and Change in Cigarettes Smoked Per Day Among Wave 4 and Wave 5 Adults Who Used Cigarettes and ENDS[a] and Smoked Daily at Wave 5 (n = 364) in the PATH Study (Waves 4–5).

Wave 4 and Wave 5 Past 30-Day Cigarette and ENDS Use Status		Weighted Mean (SE) Cigarettes Per Day at W4	Weighted Mean (SE) Cigarettes Per Day at W5	Weighted Mean (SE) Change in Cigarettes Per Day (CPD) Between W4 and W5	Unadjusted B (SE)	Adjusted B (SE)[b]
W4 daily cigarette smoking	W4 daily ENDS use and W5 daily ENDS use	13.90 (1.98)†	14.01 (2.14)†	0.11 (1.11)†	−1.20 (1.32)	0.28 (1.50)
	W4 daily ENDS use and W5 non-daily ENDS use	11.59 (1.17)†	15.08 (1.83)†	3.65 (1.61)†	2.33 (1.75)	2.75 (1.77)
	W4 non-daily ENDS use and W5 daily ENDS use	18.77 (2.08)†	18.40 (3.53)†	−0.37 (2.83)†	−1.69 (2.83)	−1.67 (2.56)
	W4 non-daily ENDS use and W5 non-daily ENDS use	15.06 (0.70)	16.38 (1.14)	1.31 (0.76)†	**Ref**	**Ref**
W4 non-daily cigarette smoking	W4 daily ENDS use and W5 daily ENDS use	2.26 (1.02)†	12.79 (2.79)†	10.54 (3.05)†	**7.68 (3.38)***	6.69 (3.86)
	W4 daily ENDS use and W5 non-daily ENDS use	1.85 (0.53)†	10.75 (1.44)†	9.11 (1.63)†	**6.25 (1.92)****	3.84 (2.44)
	W4 non-daily ENDS use and W5 daily ENDS use	3.17 (1.23)†	10.00 (1.98)†	6.84 (1.96)†	3.98 (2.20)	4.77 (3.61)
	W4 non-daily ENDS use and W5 non-daily ENDS use	4.01 (1.39)†	6.87 (0.89)†	2.86 (1.20)†	**Ref**	**Ref**

† Estimate should be interpreted with caution because it has low statistical precision. It is based on a denominator sample size of less than 50, or the coefficient of variation of the estimate or its complement is larger than 30%.
Notes: All estimates are weighted. Weighted means (SEs) for cigarettes per day at W4 and W5 are shown for those with non-missing data on change in cigarettes per day W4 and W5.
W4 = Wave 4; W5 = Wave 5. At W4, among dual users of cigarettes and ENDS at W4 and W5 who smoked cigarettes daily at Wave 5, there were 308 past 30-day daily cigarette smokers and 56 past 30-day non-daily cigarette smokers.
ENDS = electronic nicotine delivery system; B = beta; SE = standard error; Ref = reference group.
Beta coefficients represent change in number of cigarettes per day between Waves 4 and 5 among those who smoked daily at Wave 5.
[a] Those who used cigarettes and ENDS could use other tobacco products.
[b] Model adjusts for age, sex, race/ethnicity, education, past 30-day use of any other tobacco product use.

Associations between past 30-day dual cigarette and ENDS use (daily and non-daily) at W4 and past 30-day use status at W5 (n = 1,711) are presented in Table 2.

2.1 W5 Daily Cigarette Smoking: After adjusting for covariates, those who predominantly smoked at W4 were more likely to smoke cigarettes daily at W5 than those who heavily used both cigarettes and ENDS daily at W5 (adjusted odds ratio (AOR): 2.32, 95 % CI: 1.38, 3.90). However, those who dual used at W4 were less likely than those who predominantly used ENDS to smoke cigarettes daily at W5 (AOR: 0.55, 95 % CI: 0.30, 1.01). The 45 % reduction in odds approached but did not reach statistical significance.

2.2 W5 No Past 30-Day Cigarette Smoking: W4 adults who smoked cigarettes non-daily were more likely than those who smoked daily to not smoke cigarettes in the past 30 days at W5 (AOR: 4.30, 95 % CI: 3.02, 6.13; Table 2), after adjusting for covariates and W4 daily/non-daily ENDS use. ENDS use at W4 was not associated with no past 30-day cigarette smoking at W5.

2.3 W5 No Past 30-Day Cigarette or ENDS Use: W4 adults who smoked non-daily were more likely than those who smoked daily (AOR: 4.18, 95 % CI: 2.57, 6.78), and W4 adults who used ENDS non-daily were more likely than those who used ENDS daily (AOR: 2.54, 95 % CI: 1.37, 4.69) to not use cigarettes or ENDS in the past 30 days at W5. Those who used both products lightly at W4 were more likely than those who predominantly used ENDS to not use cigarettes or ENDS in the past 30 days at W5 (AOR: 3.52, 95 % CI: 1.71, 7.24).

3. Associations between ENDS use status and change in past 30-day frequency (number of days) of cigarette smoking from W4 to W5 among those who used cigarettes and ENDS at W4 and continued smoking at W5 are presented in Table 3.

3.1 Among W4 adults who smoked cigarettes daily: After adjusting for covariates, W4 adults who used ENDS daily and continued daily ENDS use at W5 smoked cigarettes on 4.59 (standard error (SE) = 1.43) fewer days at W5 and similarly, those who used ENDS non-daily at W4 and used ENDS daily at W5 smoked cigarettes on 4.55 (SE = 1.24) fewer days at W5 compared to those who used ENDS non-daily at both Waves 4 and 5 (Table 3).

3.2 Among W4 adults who smoked cigarettes non-daily: In an adjusted model, W4 adults who used ENDS daily and did not use ENDS daily at W5, smoked cigarettes on more days at W5 (beta (B) = 4.91, SE = 2.55) than those who used ENDS non-daily at W4 and W5. This result approached but did not reach statistical significance (p = 0.0576). On the other hand, those who used ENDS non-daily at W4 and used ENDS daily at W5 smoked cigarettes on fewer days (B = −4.04, SE = 1.82) at W5 than those who used ENDS non-daily at W4 and W5.

As shown in Table 4, there were no statistically significant effects for change in mean CPD between W4 and W5 for any of the groups, when adjusted for covariates.

4. Discussion

This study analyzed longitudinal changes in cigarette and ENDS use over a 2-year period (2016/17——2018/19), in a nationally representative sample of US adults who used cigarettes and ENDS. In general, compared to those who used ENDS non-daily at both waves, those who used cigarettes and ENDS and used ENDS daily smoked cigarettes on fewer days by the next wave. This analysis extended findings from a previous PATH Study analysis that explored transitions among those who used cigarettes and ENDS in Waves 1 and 2 (Coleman et al., 2019) by considering the frequency of use of cigarettes and ENDS at both waves. In the current study, slightly less than half (42 %) of adults who used both products continued to use both at the subsequent wave and comparatively few switched to ENDS only or no cigarette use, while

almost a fourth switched to cigarette-only use over time. This is consistent with an earlier study using PATH Study data that showed among adults who used cigarettes and ENDS at W1, 44.3 % continued to maintain dual use while fewer (12.1 %) discontinued cigarette smoking at W2 (Coleman et al., 2019). It is important to understand factors that motivate continued dual use over time. Those who use both products may be using ENDS to reduce or quit smoking cigarettes or may be using ENDS to cope with nicotine withdrawal and cravings when smoking is not permitted (Maglia et al., 2018; Ronayne & Sgroi, 2018); these and other reasons for dual use could be explored in future studies.

In the current study, among those who used both products daily (heavy dual use), almost three quarters (70 %) continued smoking cigarettes in some form, either as heavy dual use (23 %), as cigarette-only smoking (27 %) or as predominant smoking (20 %) at W5. These findings are similar to results from the International Tobacco Control (ITC) Four Country Smoking and Vaping Survey of adults who smoke cigarettes from Wave 1–2 (2016–18), where among those who used both products daily at W1, at W2, 38.5 % used both products daily, 21.4 % smoked cigarettes only, and 18 % smoked cigarettes predominantly (Gravely et al., 2020). Evidence from other longitudinal studies also shows persistent cigarette smoking over time (Caraballo et al., 2014; Dutra et al., 2017; Taylor et al., 2020), which is of concern given the known risks associated with cigarette smoking (Zeller et al., 2018).

Unlike studies that suggested greater odds of quitting cigarettes among those who used ENDS daily compared to non-daily (Levy et al., 2018; National Academies of Sciences, Engineering, and Medicine, 2018), the current study did not find any association between no past 30-day cigarette smoking and daily or non-daily use of ENDS. An earlier PATH Study analysis using Waves 1 and 2 (2013–2015) showed that adults who used ENDS daily at W1 were more likely than those who used non-daily to be abstinent from smoking cigarettes in W2 (Coleman et al., 2019). In another PATH Study analysis (Waves 1–3), those who used ENDS daily or those who had increased their frequency of use to daily, were more likely to stop smoking compared to those who never used ENDS (Glasser et al., 2021). One reason why this study did not find any association between discontinued cigarette smoking and daily ENDS use could be because of slight differences in analytic groups. For example, this study first stratified dual use at W4 based on daily and non-daily use of both cigarettes and ENDS while other studies only considered daily/non-daily use of ENDS at baseline or compared daily ENDS use to never use. The current study did find significant associations between discontinued use of both products and daily/non-daily ENDS use, especially among those who smoked cigarettes non-daily, which has not been shown in other studies and needs to be further explored.

A noteworthy finding of this study was that W4 adults who smoked cigarettes predominantly were more likely than those who used both products daily to smoke cigarettes daily at W5. This indicates that even though daily ENDS use may not help daily cigarette smokers stop smoking altogether, using ENDS daily may help people who smoke transition from daily to non-daily smoking or smoking on fewer days. While the current study did not find any association between no past 30-day cigarette smoking and daily or non-daily use of ENDS, a reduction in smoking frequency could increase the chances of cigarette cessation over time, which should be empirically tested with additional follow-up data from the PATH Study. This finding was further substantiated when we also considered ENDS use status not only at the baseline wave (W4) but also at the follow up wave (W5). As shown in Table 3, those who smoked cigarettes daily at W4 smoked on fewer days at W5 if they used ENDS daily at W5 compared to those who used ENDS non-daily at W5, irrespective of daily or non-daily ENDS use at W4. These findings highlight the role continued daily ENDS use may play in reducing cigarette smoking frequency. It is known that smoking cigarettes and other combusted products substantially increases the risk of all-cause mortality (National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2014). Even if those who smoke cigarettes are unable to quit smoking by using ENDS, use of ENDS may satisfy smoking cravings and reduce nicotine withdrawal (Bullen et al., 2010; Dawkins & Corcoran, 2014). However, while reduction in cigarette smoking among those who use both products may offer some harm reduction through reduction in cigarette intake, there remains concern that increases in total nicotine dependence could adversely affect the ability to quit either or both products (Martínez et al., 2020; Osibogun et al., 2020). In addition, because there is no “safe” level of cigarette smoking, only complete smoking cessation can reduce these risks. These results also suggest that longitudinal studies that examine the association between the two products should not only examine ENDS use frequency as a predictor but should also consider frequency of use at follow up among those who are unable to quit smoking to assess if there are longer term trajectories of ENDS use that are associated with greater transitions away from cigarette smoking.

Study limitations include use of self-reported data, which are subject to recall bias, especially information on frequency of past 30-day use. Even though the study provides valuable information on longitudinal dual use of cigarettes and ENDS, analysis was based on past 30-day use of the products at the time of data collection; information on frequency and intensity of use between waves was not collected in the PATH Study instrument, which could have varied between data collection time points. These findings captured transitions between 2016–17 and 2018–19 during which the landscape of ENDS devices diversified extensively and do not reflect the current tobacco product landscape. Between 2016 and 2019, brands like JUUL, with high nicotine concentrations, may have affected transitions to and away from cigarette smoking that this study did not consider because of small sample sizes for brand related data (Leavens et al., 2019; Vallone et al., 2019). Future studies on transitions in dual use should consider recent data on device types and brands of ENDS. This study considered past 30-day cigarette smoking as an outcome in W5 and did not consider intent to quit or long term successful quits over time. Additional research would be informative to examine long term smoking cessation among people who use both cigarettes and ENDS.

Strengths of this study include longitudinal analysis of a nationally representative sample which enabled generalizability of the findings. The study highlights the importance of considering frequency of ENDS use in reducing frequency of cigarette smoking which can inform smoking cessation interventions among adults who smoke cigarettes daily. Future studies can examine the stability of these transitions over longer time periods to understand how use of ENDS impacts cigarette smoking. In order to determine the public health impact of ENDS (Family Smoking Prevention and Tobacco Control Act, 2009), long-term roles of ENDS in both transitions away from and maintenance of cigarette smoking as well as use of other tobacco products must be considered.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the U.S. Department of Health and Human Services or any of its affiliated institutions or agencies.

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for Medical Education and Research, Cancer Research UK, and the Dutch Lung Foundation. He has been an expert witness/consultant for the governments of Uruguay and Australia defending their country's policies/regulations in litigation, and an expert consultant for the government of Singapore regarding policies and regulations on tobacco products. He has served as a member of the Expert Group on Articles 9/10 of the WHO Framework Convention on Tobacco Control, the WHO Expert Group on COVID-19 and Tobacco Use, and Health Canada's Scientific Advisory Board on Vaping Products. No other authors report financial disclosures.

CRediT authorship contribution statement

Eva Sharma: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Katarzyna Zebrak:** Data curation, Formal analysis, Methodology, Writing – review & editing. **Kristin Lauten:** Data curation, Formal analysis, Writing – review & editing. **Shannon Gravely:** Writing – review & editing. **Maria Cooper:** Writing – review & editing. **Lisa D. Gardner:** . **Ibrahim Zaganjor:** Writing – review & editing. **Kathryn C. Edwards:** Writing – review & editing. **Karin Kasza:** . **Daniela Marshall:** Writing – review & editing. **Heather L. Kimmel:** . **Cassandra Stanton:** Writing – review & editing. **Andrew Hyland:** Writing – review & editing. **Geoff Fong:** Conceptualization, Writing – review & editing.

Declaration of competing interest

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Data availability

Data will be made available on request.

Appendix A

List of exposures, outcomes and covariate measures, PATH Study.

Variables	Variable definitions	Notes
Tobacco use measures		
Tobacco use	Five mutually exclusive groups were created at both waves for respondents in the analytic sample: no past 30-day tobacco use past 30-day ENDS only use past 30-day cigarette only use 4) past 30-day dual cigarette and ENDS use (could use other products) 5) past 30-day other tobacco product use, including cigars, pipe, hookah, smokeless tobacco, snus pouches/loose snus (could use ENDS or cigarettes but not both)	
Daily cigarette smoking	Adults who smoked cigarettes every day in the past 30 days among adults who smoked in the past 30-days 1 = Daily cigarette smoking (now smoke cigarettes every day or smoked on 30 of the past 30 days) 2 = Non-daily cigarette smoking (now smoke cigarettes some days or smoked on 1–29 of the past 30 days)	
Daily ENDS use	Adults who used ENDS every day in the past 30 days among adults who used ENDS in the past 30-days 1 = Daily ENDS use (now use ENDS every day or used on 30 of the past 30 days) 2 = Non-daily ENDS use (now use ENDS some days or used on 1–29 of the past 30 days)	
Cigarette and ENDS use (could use other products)	Categorized into four levels based on daily and non-daily use of both products: Heavy dual use: daily cigarette smoking and daily ENDS use Predominant smoking: daily cigarette smoking and non-daily ENDS use Predominant ENDS use: daily ENDS use and non-daily cigarette smoking Light dual use: non-daily cigarette smoking and non-daily ENDS use	
Frequency of past 30-day cigarette smoking (number of days smoked in the past 30 days)	Defined as the number of days respondents reported smoking cigarettes within the past 30 days (range 1–30). Those who reported currently smoking every day were assigned a value of 30. Those who did not smoke in the past 30 days were assigned a value of 0.	
Frequency of ENDS use (number of days used in the past 30 days)	Defined as the number of days respondents reported using ENDS within the past 30 days (range 1–30). Those who reported currently using every day were assigned a value of 30. Those who did not use in the past 30 days were assigned a value of 0.	
Cigarettes smoked per day (CPD)	Defined as the mean number of cigarettes smoked per day	Values greater than 100 were deemed improbable. Those values were recoded to 100.
Daily and non-daily ENDS use at Waves 4 and 5	Daily and non-daily ENDS use at Waves 4 and 5 were categorized as follows: Wave 4 daily ENDS use and Wave 5 daily ENDS use Wave 4 daily ENDS use and Wave 5 non-daily ENDS use Wave 4 non-daily ENDS use and Wave 5 daily ENDS use Wave 4 non-daily ENDS use and Wave 5 non-daily ENDS use	Used to explore those who continued dual use at Wave 5.

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Variables	Variable definitions	Notes
OUTCOMES		
Daily cigarette smoking at Wave 5	Adults at Wave 5 who smoked cigarettes every day in the past 30 days among those who smoked in the past 30-days 1 = Daily cigarette smoking (now smokes cigarettes every day or smoked on 30 of the past 30 days) 2 = Non-daily cigarette smoking (now smokes cigarettes some days or smoked on 1–29 of the past 30 days)	
Wave 5 no-past 30-day cigarette smoking	Has not smoked cigarettes in the past 30 days at Wave 5.	
Wave 5 no past 30-day cigarette or ENDS use	Has not smoked cigarettes or used ENDS in the past 30 days at Wave 5.	
Mean change in cigarette use frequency between Waves 4 and 5	Mean change in cigarette smoking frequency was calculated by subtracting Wave 4 frequency of past 30-day smoking from Wave 5 frequency of past 30-day smoking, and taking the average of the differences. If Wave 4 or Wave 5 frequency was missing, the change variable was set to missing. An increase in frequency of cigarette smoking at Wave 5 was indicated by a positive number, a negative number indicated decrease in frequency at Wave 5, and no change between Waves 4 and 5 was zero.	
Mean change in cigarettes per day (CPD) between Waves 4 and 5 (among those who smoked cigarettes daily at Wave 5)	Mean change in CPD in the past 30 days was calculated by subtracting CPD at Wave 4 from CPD at Wave 5, and taking the average of the differences. If Wave 4 or Wave 4 CPD was missing, the change variable was set to missing. Similar to cigarette smoking frequency, a positive value for change in CPD reflected an increase in intensity from Wave 4 to 5 and a negative number reflected a decrease in CPD.	
COVARIATES		
Age	18–24, 25–39, 40–54, 55 + years	
Sex	Male, female	
Race/ethnicity	White, non-Hispanic; Black, non-Hispanic; other race, non-Hispanic; Hispanic	
Educational attainment	Less than high school/GED, high school graduate, some college/Associate's degree, Bachelor's degree or more	
Other tobacco use	Use of either cigars, smokeless/snus, hookah, or pipe	Past 30-day use of any of the other tobacco products

Appendix B

Characteristics of adults who used cigarettes and ENDS in the past 30 days at Wave 4 (n = 2,078), PATH Study.

	Past 30-Day Dual Use of Cigarettes and ENDS (Could Use Other Products) N = 2,078		Heavy Dual Use (Daily Cigarette and ENDS Use) N = 177		Predominant Smoking (Daily Cigarette and Non-Daily ENDS Use) N = 791		Predominant ENDS Use (Daily ENDS and Non-Daily Cigarette Use) N = 268		Light Dual Use (Non-Daily ENDS and Non-Daily Cigarette Use) N = 475	
	Weighted %	95 % CI	Weighted %	95 % CI	Weighted %	95 % CI	Weighted %	95 % CI	Weighted %	95 % CI
Age										
18–24	26.1	(24.2, 28.1)	13.5	(9.4, 19.1)	18.1	(15.5, 21.1)	32.6	(27.5, 38.2)	37.6	(32.3, 43.2)
25–39	40.5	(37.9, 43.2)	39.6	(32.0, 47.7)	40.5	(36.4, 44.7)	45.8	(38.7, 53.1)	42.6	(37.1, 48.2)
40–54	21.8	(19.8, 24.0)	30.3	(23.6, 38.1)	27.6	(24.0, 31.5)	15.2	(11.0, 20.6)	13.3	(9.2, 18.8)
55+	11.6	(10.1, 13.2)	16.5	(11.0, 24.2)	13.8	(11.2, 16.8)	6.4†	(3.5, 11.7)	6.5	(4.2, 10.1)
Sex										
Male	55.5	(52.8, 58.2)	50.1	(40.7, 59.4)	50.2	(45.5, 55.0)	67.9	(62.6, 72.9)	60.1	(55.1, 64.8)
Female	44.5	(41.8, 47.2)	49.9	(40.6, 59.3)	49.8	(45.0, 54.5)	32.1	(27.1, 37.4)	39.9	(35.2, 44.9)
Race/ethnicity										
White, non-Hispanic	67.2	(64.6, 69.6)	69.6	(61.9, 76.4)	76.2	(72.4, 79.7)	75.8	(69.7, 81.0)	49.0	(43.2, 54.9)
Black, non-Hispanic	11.3	(9.8, 13.0)	10.6	(6.4, 16.9)	9.6	(7.3, 12.6)	6.5	(3.8, 10.9)	15.1	(11.5, 19.6)
Other race, non-Hispanic	7.0	(5.6, 8.6)	5.5	(3.3, 9.1)	6.3	(4.3, 9.1)	6.8	(4.0, 11.2)	8.8	(5.6, 13.6)
Hispanic	14.6	(13.0, 16.3)	14.3	(9.6, 20.8)	7.8	(6.1, 10.0)	10.9	(7.1, 16.6)	27.0	(22.6, 32.0)
Educational attainment										
Less than high school/GED	23.9	(21.8, 26.2)	30.1	(22.5, 39.0)	29.1	(25.6, 32.9)	17.5	(12.6, 23.7)	15.3	(12.2, 19.0)
High school graduate	28.4	(25.9, 31.0)	30.9	(23.6, 39.3)	27.9	(24.2, 32.0)	27.8	(21.2, 35.6)	26.7	(22.4, 31.4)
Some college/Associate's degree	37.4	(35.0, 39.9)	29.4	(22.4, 37.6)	34.9	(31.0, 38.9)	44.3	(37.1, 51.8)	41.3	(36.7, 46.1)
Bachelor's degree or more	10.3	(8.7, 12.1)	9.5	(5.5, 15.9)	8.1	(6.1, 10.5)	10.4	(7.3, 14.8)	16.7	(12.5, 22.0)

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	Past 30-Day Dual Use of Cigarettes and ENDS (Could Use Other Products) N = 2,078		Heavy Dual Use (Daily Cigarette and ENDS Use) N = 177		Predominant Smoking (Daily Cigarette and Non-Daily ENDS Use) N = 791		Predominant ENDS Use (Daily ENDS and Non-Daily Cigarette Use) N = 268		Light Dual Use (Non-Daily ENDS and Non-Daily Cigarette Use) N = 475	
	Weighted %	95 % CI	Weighted %	95 % CI	Weighted %	95 % CI	Weighted %	95 % CI	Weighted %	95 % CI
Past 30-day other tobacco product use	45.6	(43.3, 47.8)	38.0	(30.2, 46.4)	43.2	(39.4, 47.1)	38.6	(32.1, 45.5)	52.5	(47.3, 57.6)

Percents are weighted using the Wave 5 single-wave weights for the Wave 4 Cohort (R05_A_S04WGT). To be included in the analysis, respondents must have participated in Waves 4 and 5.

† Estimate should be interpreted with caution because it has low statistical precision. It is based on a denominator sample size of less than 50, or the coefficient of variation of the estimate or its complement is larger than 30 %.

ENDS = electronic nicotine delivery system; GED = general educational development; CI = confidence interval.

Note: 367 Wave 4 adults who used cigarettes and ENDS in the past 30-days were missing on their daily/nondaily use status. This is largely due to discrepancies in reporting by respondents (e.g. reporting use of cigarettes or ENDS in the past 30 days but then indicating use on 0 of the past 30 days.

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