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## Patterns of Daily Cigarette and E-cigarette Use among United States Youth and Young Adults: Insights from the Truth Longitudinal Cohort between 2018 and 2019

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### ABSTRACT

**Purpose:** Temporal patterns of daily tobacco product use among ever users from the Truth Longitudinal Cohort (TLC) between 2018 and 2019 were explored.

**Methods:** The sample (N = 5274) includes individuals (15–36 years), residing in the United States, who had ever used any tobacco product at Wave 7 (February – May 2018) and provided tobacco use information at Wave 9 (September – December 2019).

**Results:** There was a nonsignificant 1.1 percentage point increase in daily tobacco use (on at least 25 of the past 30 days), from 14.6% (95% CI: 12.8, 16.6) to 15.7% (95% CI: 13.8, 17.7). Tobacco product use remained stable over time, as 65.3% (95% CI: 56.4, 73.3) of daily cigarette smokers, 57.0% (95% CI: 43.6, 69.4) of daily e-cigarette vapers, and 8.5% (95% CI: 2.0, 29.3) of daily dual users stayed with their primary tobacco product. There was also some evidence of switching, as 7.5% (95% CI: 3.7, 14.8) of daily cigarette smokers became daily e-cigarette vapers and 2.3% (95% CI: 0.7, 6.8) of daily e-cigarette vapers became daily cigarette smokers.

**Discussion:** Although most daily tobacco users were likely to continue using their primary product, some daily users transitioned to daily use of other products – suggesting that policies and public education focused on reducing overall nicotine use are essential for addressing the nicotine epidemic among young people.

### 1. Introduction

Electronic nicotine delivery system (ENDS) products were first introduced to the United States (US) tobacco marketplace around 2007 (Loewenstein & Middlekauff, 2017) and an early patent application claimed that they were a cigarette substitute that could be used to quit smoking (Office of the Surgeon General, 2021). ENDS products include e-cigarettes which are handheld battery-powered devices that work by heating e-liquids usually consisting of nicotine, propylene glycol, vegetable glycerin, and flavorings (National Academies of Sciences et al., 2018). Use of e-cigarettes increased among US adult smokers and nonsmokers from 2010 to 2014 (McMillen et al., 2015). From 2014 to 2016, the prevalence of ever use of e-cigarettes continued to increase,

while the prevalence of current e-cigarette use decreased among all US adults – suggesting that US adults had been trying, but not continuing to use e-cigarettes (Bao et al., 2018).

The pattern of e-cigarette use changed between 2014 and 2018, when the prevalence of current and daily e-cigarette use increased among US young adults, but remained stable across older age groups (Dai & Leventhal, 2019). The product that disrupted the early e-cigarette usage pattern was manufactured by JUUL labs. It had a sleek, high-tech design that looked like a computer accessory, came in multiple flavors that were known to appeal to young people, and changed the mode of nicotine delivery from free-base to nicotine salt, effectively doubling the nicotine concentration when compared to earlier e-cigarettes (Romberg et al., 2019). These high nicotine e-cigarettes have been shown to deliver

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nicotine as effectively as cigarettes (Hajek et al., 2020; Prochaska et al., 2022). By 2017, JUUL had become the most popular e-cigarette sold in the US (King et al., 2018). Although e-cigarettes have been marketed as a tool for helping smokers quit cigarettes (Caraballo et al., 2017), high nicotine e-cigarettes were not used by smokers before 2019, and earlier e-cigarettes were not effective smoking cessation aids (Chen et al., 2022; Pierce et al., 2020).

Following JUUL's rise in market predominance, other e-cigarette manufacturers moved quickly to high nicotine only products (Jackler & Ramamurthi, 2019) and their growing popularity among youth raised concerns (Cullen et al., 2018). Use of e-cigarettes by US middle and high school students increased by 900% from 2011 to 2015 (U.S. Department of Health and Human Services, 2016). Between 2017 and 2018, ENDS use among high school students increased by an additional 78%, from 11.7% to 20.8% (U.S. Department of Health and Human Services, 2016). By 2018, e-cigarettes had become the most popular product source for nicotine among US youth and young adults (Vallone et al., 2020). According to data from Monitoring the Future Study, the peak prevalence of current (past 30-day) e-cigarettes use among 10th and 12th graders was in 2019, at 19.9% and 25.5% respectively. Despite declines in e-cigarette use from 2020 to 2021, the prevalence of vaping remained one of the highest among all adolescent substances in 2022 (Miech et al., 2023). Although prior research suggests that e-cigarettes may be less harmful than cigarettes (Balfour et al., 2021; Hartmann-Boyce et al., 2022), the average nicotine strength of e-cigarette products has increased from 2.5% to 4.4% from 2017 to 2022 (Wang et al., 2023) and nicotine from e-cigarettes may affect the parts of the developing brain that control attention, mood, and impulse control (Colyer-Patel et al., 2023; England et al., 2015; Yuan et al., 2015).

The objective of this study is to describe temporal patterns of daily tobacco use among respondents who had reported ever tobacco use during the time at which e-cigarettes had become the most popular source of nicotine among US youth. We hypothesize that an increased proportion of non-daily tobacco users will progress to daily use of e-cigarettes and/or cigarettes, based upon findings from previous research (Do et al., 2022; Pierce et al., 2021, Pierce et al., 2022).

## 2. Material and methods

### 2.1. Data source

The Truth Longitudinal Cohort (TLC) utilized an address-based sampling (ABS) methodology, which involves a probability-based sampling of addresses from the United States (US) Postal Service's Delivery Sequence File, drawn from an estimated 97% of all US households, regardless of telephone status. In addition to the ABS sample, participants were recruited from existing online panels via Ipsos (i.e., Knowledge Panel). TLC participants, aged 15–24 years, were randomly selected from within eligible households. Fielding of the TLC began in 2014, with follow-up assessments occurring at least bi-annually. At Wave 7, an additional cohort of individuals, aged 25–36 years was added to the TLC, as well as a refreshment sample of 15–24-year-olds. The TLC surveys include measures of attitudes, beliefs, and behaviors regarding tobacco and other substances, including experimentation with products, frequency of use, and multiple product use.

The analytic sample included individuals aged 15–36 years, who had reported ever using any tobacco product (including e-cigarettes) at Wave 7 (collected February to May 2018) and completed a follow-up survey at Wave 9 (collected September to December 2019). Focusing on the timeframe between Wave 7 and Wave 9 allowed for the characterization of tobacco use patterns following the period during which high nicotine e-cigarettes had gained predominance in the tobacco marketplace (2016–2018).

### 2.2. Ethical considerations

Informed consent and/or assent was obtained from all study participants prior to assessments. Study procedures for human subjects research was approved by the Advarra Institutional Review Board.

### 2.3. Measures

#### 2.3.1. Daily tobacco use

Participants were asked to report on the number of days within the past 30 days they used of cigarettes (even 1 or 2 puffs), large cigars, little cigars, or cigarillos (“...smoke large cigars, little cigars, or cigarillos (like Winchester, Swisher Sweets, Phillies Blunts, Dutch Masters, Black and Mild, or White Owl) (even 1 or 2 puffs)?”), e-cigarettes (“...use each of the following products: e-cigarettes (like blu, NJOY, Vuse, or Mark Ten)”, e-hookah/e-cigars/vape pens/hookah pens/vape pipes), hookah, smokeless (snus, chewing tobacco/dip/snuff), and other tobacco products. For each of these product-specific items, we categorized participants as: daily users (i.e., used at least 25 days of the past 30 days), nondaily users (i.e., used less than 25 days of the past 30 days), or noncurrent users (i.e., not used in the past 30 days). From these product-specific items, we created a daily tobacco product use variable that includes thirteen mutually exclusive categories, describing daily, non-daily, and noncurrent use of cigarettes, e-cigarettes, cigarettes and e-cigarettes, smokeless tobacco (inclusive of chewing tobacco and snus), little cigar, cigarillo, and cigar (LCC), hookah/pipe use, and polytobacco use. Although we acknowledge that other studies require use on all 30 days in the past month to be classified as daily use, a threshold of at least 25 of the past 30 days was chosen due to the low prevalence of daily users among this study sample. This threshold has been applied to data included in other studies (Pierce et al., 2021; Pulvers et al., 2015; Sánchez-Romero et al., 2021).

#### 2.3.2. Demographic variables

Covariates included gender (female, male), age (15–17, 18–20, 21–24, 25–28, and 29–36), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic or Latino, and another race/ethnicity), education (less than high school/completed some high school, high school graduate, some college/associates degree, college graduate or higher), and self-perceived financial situation (don't meet basic expenses, just meet basic expenses, meets needs with a little left, or lives comfortably).

#### 2.3.3. Analytic strategy

Descriptive statistics (e.g., frequencies and weighted percentages) were calculated for all demographic characteristics and tobacco use behaviors - inclusive of cigarette, e-cigarette, dual use of cigarettes and e-cigarettes, smokeless tobacco, little cigars, cigarillos, and cigars, hookah, pipe, and polytobacco use. Survey responses are weighted to United States census quotas, according to age, race, and gender, so that it is nationally representative and account for the complex sampling design of the survey and non-response. Survey weights were applied to the data to obtain statistically valid estimates for longitudinal analyses focused on characterizing changes in tobacco product use among ever tobacco users from baseline (Wave 7) to follow-up (Wave 9). Specifically, we estimated the weighted % of reported noncurrent, nondaily, and daily use of cigarettes and e-cigarettes at each survey wave and determined patterns of use from noncurrent, nondaily, and daily use across different tobacco products. Variance estimates and 95% confidence intervals were calculated using Stata 17.0 (StataCorp LLC, College Station, Texas).

## 3. Results

Table 1 displays demographic characteristics and tobacco use behaviors of ever tobacco users at Wave 7 who had also completed the survey at Wave 9 (N = 5274). At Wave 7, 14.6% (95% CI: 12.8, 16.6)

**Table 1**  
Descriptive Statistics of Tobacco Product Use and Sociodemographic Characteristics among a United States Youth and Young Adult Sample from the Truth Longitudinal Cohort (2018–2019, N = 5274).

	N	Weighted % (95% CI)
<b>Tobacco Use Behavior at Baseline (Wave 7)</b>		
Daily tobacco use	602	14.6 (12.8 – 16.6)
Nondaily tobacco use	1400	22.6 (20.7 – 24.6)
Noncurrent tobacco use	3269	62.6 (60.2 – 65.0)
Missing	3	0.2 (0.1 – 0.7)
<b>Tobacco Use Behavior at Follow-Up (Wave 9)</b>		
Daily tobacco use	698	15.7 (13.8 – 17.7)
Nondaily tobacco use	1266	21.1 (19.3 – 23.0)
Noncurrent tobacco use	3270	62.5 (60.1–64.8)
Missing	40	0.8 (0.5–1.3)
<b>Gender</b>		
Female	2991	49.5 (47.0 – 52.0)
Male	2283	50.5 (48.0 – 53.0)
<b>Age (in years)</b>		
15–17	289	7.1 (6.0 – 8.2)
18–20	1117	11.9 (11.0 – 13.0)
21–24	2480	22.4 (21.0 – 23.9)
25–28	803	21.9 (19.8 – 24.2)
29–36	585	36.7 (34.0 – 39.4)
<b>Race/Ethnicity</b>		
Non-Hispanic, White	3348	56.1 (53.6 – 58.6)
Non-Hispanic, Black	491	12.4 (10.8 – 14.2)
Hispanic or Latino	861	23.3 (21.1 – 25.5)
Non-Hispanic, Another Race/Ethnicity	573	8.2 (7.0 – 9.7)
Missing	1	0.0 (0.0 – 0.0)
<b>Parental educational attainment</b>		
Less than high school/completed some high school	235	7.3 (5.9 – 8.9)
High school graduate	705	20.1 (18.0 – 22.4)
Some college/associate degree	1253	22.9 (20.9 – 25.0)
College graduate or more	3019	47.9 (45.5 – 50.4)
Missing	62	1.8 (1.2 – 2.8)
<b>Self-perceived financial situation</b>		
Don't meet basic expenses	344	5.7 (4.7 – 7.0)
Just meet basic expenses	1058	20.1 (18.2 – 22.2)
Meet needs with a little left	2063	39.8 (37.4 – 42.3)
Live comfortably	1787	33.9 (31.6 – 36.3)
Missing	22	0.5 (0.2 – 1.1)

Note: Tobacco use includes cigarette, e-cigarette, smokeless (chewing tobacco, snus), hookah, and little cigars, cigarillos, and cigar (LCC) use. Daily use is defined as using on at least 25 days of the past 30 days, nondaily use is defined as using within the past 30 days, but on less than 25 days, and noncurrent use is defined as no use within the past 30 days.

were daily tobacco users, 22.6% (95% CI: 20.7, 24.6) were nondaily tobacco users, and 62.6% (95% CI: 60.2, 65.0) were noncurrent tobacco users. Daily tobacco product use increased to 15.7% (95% CI: 13.8, 17.7), nondaily tobacco product use decreased to 21.1% (95% CI: 19.3, 23.0), and noncurrent tobacco product use increased to 63.2% (95% CI: 60.1, 64.8) by Wave 9. These changes were not statistically significant.

Supplementary Table 1S provides information on patterns of noncurrent, nondaily, and daily tobacco use from Wave 7 to Wave 9. Among those who were daily users at Wave 7, there was considerable stability over time: 65.3% (95% CI: 56.4, 73.3) of daily cigarette smokers remained daily cigarette smokers, 57.0% (95% CI: 43.6, 69.4) of daily e-cigarette vapers remained daily e-cigarette vapers, but only 8.5% (95% CI: 2.0, 29.3) of daily dual users stayed as daily dual users. There was also evidence of switching, as 7.5% (95% CI: 3.7, 14.8) of daily cigarette smokers became daily e-cigarette vapers and 2.3% (95% CI: 0.7, 6.8) of daily e-cigarette vapers became daily cigarette smokers. Some daily cigarette smokers converted to dual users (2.6%, 95% CI: 0.6, 10.1), as did some daily e-cigarette vapers (1.9%, 95% CI: 0.7, 5.1).

Among non-daily users, there was evidence of progression using the same product type. Specifically, 8.7% (95% CI: 5.2, 14.0) of non-daily cigarette smokers progressed to daily smoking, 9.6% (95% CI: 6.3, 14.1) of non-daily e-cigarette vapers progressed to daily e-cigarette vaping. There was also evidence of tobacco users changing to different

products: 5.2% (95% CI: 2.1, 12.3) of non-daily cigarette smokers progressed to daily e-cigarette vaping, but only 1.2% (95% CI: 0.5, 2.5) of non-daily e-cigarette vapers progressed to daily cigarette smoking. Among non-daily dual users, 10.0% (95% CI: 3.5, 23.6) progressed to daily cigarette smoking, 5.5% (95% CI: 2.9, 10.5) progressed to daily e-cigarette vaping, and 5.2% (95% CI: 2.9, 10.5) progressed to daily dual use.

Table 2 displays new daily tobacco product use at Wave 9 among ever users of any tobacco product at Wave 7, separated by age. Results show that the proportion of ever users who progressed to daily use varied by age, as well as by product. Among those 15–17 years old at Wave 7, 4.0% (95% CI: 2.1, 7.3) became new daily cigarette smokers and 6.9% (95% CI: 3.7, 12.5) became new daily e-cigarette vapers, with some overlap so that there was a total of 8.8% (95% CI: 5.1, 14.8) new daily users of any tobacco product. Similar proportions of those who were 18–20 years old at Wave 7 became new daily users of any tobacco product, with the exception that fewer of them became daily cigarette smokers (15–17 years = 2.9%, 95% CI: 2.0, 4.3; 18–20 years = 8.1%, 95% CI: 6.0, 10.8, p < 0.01). For older age groups (21–24 years, 25–28 years, and 29–36 years) the proportion of ever tobacco users who became new daily users was less than half the proportion who were under 21 years at Wave 7.

#### 4. Discussion

Between February 2018 and December 2019, there was a 1.1 percentage point increase in the prevalence of daily tobacco use in our study population, from 14.6% (95% CI: 12.8, 16.6) to 15.7% (95% CI: 13.8, 17.7). Nondaily tobacco use decreased by 1.5 percentage points, from 22.6% (95% CI: 20.7, 24.6) to 21.1% (95% CI: 19.3, 23.0) and noncurrent tobacco use increased by 0.6 percentage points from 62.6% (95% CI: 60.2, 65.0) to 63.2% (95% CI: 60.1, 64.8). These changes were not statistically significant. During this observation period, 8.7% (95% CI: 5.2, 14.0) of nondaily cigarette smokers became daily cigarette smokers and 9.6% (95% CI: 6.3, 14.1) of nondaily e-cigarette vapers became daily e-cigarette vapers. Nondaily users of other tobacco products also transitioned to daily e-cigarette use: 1.2% (95% CI: 0.2, 5.4) of nondaily smokeless tobacco users and 1.0% (95% CI: 0.3, 3.3) of

**Table 2**  
New Daily Tobacco Product Use<sup>a</sup> at Wave 9, Among Ever Users of Any Tobacco Product at Wave 7, from a United States Youth and Young Adult Sample from the Truth Longitudinal Cohort, Separated by Age Group (2018–2019, N = 5274).

Age at Wave 7	Daily Cigarette Use at Wave 9 N, Weighted % (95% CI)	Daily E-cigarette Use at Wave 9 N, Weighted % (95% CI)	Daily Use of Tobacco Product at Wave 9 (Excluding Cigarettes and E-cigarettes) N, Weighted % (95% CI)	Daily Use of Any Tobacco Product at Wave 9 N, Weighted % (95% CI)
15–17 years	14, 4.0 (2.1, 7.3)	19, 6.9 (3.7, 12.5)	Not Available	25, 8.8 (5.1, 14.8)
18–20 years	32, 2.9 (2.0, 4.3)	72, 8.1 (6.0, 10.8)	6, 0.8 (0.3, 1.7)	96, 10.9 (8.5, 14.0)
21–24 years	42, 2.4 (1.5, 4.1)	69, 3.1 (2.2, 4.4)	15, 1.1 (0.6, 2.3)	94, 5.4 (3.9, 7.4)
25–28 years	14, 3.2 (1.5, 6.8)	27, 5.1 (2.7, 9.6)	4, 0.2 (0.1, 0.7)	31, 5.3 (3.0, 9.3)
29–36 years	15, 2.6 (1.3, 5.2)	8, 1.7 (0.7, 4.1)	6, 1.0 (0.3, 3.3)	24, 4.2 (2.4, 7.2)

Note. Tobacco use includes cigarette, e-cigarette, smokeless (chewing tobacco, snus), hookah, and little cigars, cigarillos, and cigar (LCC) use. <sup>a</sup>New daily tobacco product users includes any participant who had reported ever use of any tobacco product, no daily use of any tobacco product at Wave 7, and daily tobacco product use at Wave 9. Not available indicates that estimates could not be calculated, due to small sample size (n less than 4).

nondaily LCC/hookah/pipe users became daily e-cigarette vapers.

Results also demonstrate that a greater proportion of tobacco users under 21 years of age progressed to daily e-cigarette use, relative to those over the age of 21 years. This is a similar pattern reported by Pierce et al. (2022), using data from the Population Assessment of Tobacco and Health (PATH) study data (2017–2019) – 75.4% of new daily tobacco users aged 14–17 vaped daily, 64.5% of new daily tobacco users aged 18–21 vaped daily, and 39.0% of new daily tobacco users aged 22–25 years vaped daily (Pierce et al., 2022). Results from these studies may be attributed to the widespread adoption of nicotine salt technology in e-cigarettes, following the initial market success of JUUL. Nicotine intake levels from JUUL pods have been reported to be between half to three-quarters that of a combustible cigarette in industry-conducted studies of JUUL-naïve users, but comparable to or greater than combustible cigarettes in independent studies of experienced e-cigarette users (Goniewicz et al., 2019; Omaiye et al., 2019). By 2018, JUUL had more than 70% of the e-cigarette market share (Herzog, 2019); the surge was accompanied by increased daily e-cigarette use and a significant increase in the 2-year incidence of new daily tobacco use, among those aged 14 to 17 years from 4.8% in 2014 to 6.3% in 2018 (Pierce et al., 2022). The rise in e-cigarette use stalled later in 2019, as perceptions of the harms of vaping increased during and immediately after the E-cigarette, or Vaping Product, Use Associated Lung Injury (EVALI) outbreak (East et al., 2022; Kreslake et al., 2021).

More research is needed to determine how this and other events affecting the availability of e-cigarettes in the tobacco marketplace after 2019 [e.g., COVID-19 restrictions (Kreslake et al., 2021), the US Food and Drug Administration's guidance on unauthorized flavored e-cigarettes in 2020 (Office of the Commissioner, 2020), and the rise of disposable e-cigarette use (Park-Lee et al., 2021)] influence tobacco use patterns over time. Despite some decreases in current e-cigarette use among young people from 2020 to 2021 (Gentzke et al., 2022; Miech et al., 2023; Park-Lee et al., 2021), e-cigarettes remain the most used tobacco product among young people, followed by cigarettes in 2022 (Miech et al., 2023; Park-Lee et al., 2022) and the third most popular substance used by 12th graders after marijuana and alcohol (Miech et al., 2023). Although e-cigarettes using nicotine salt technology have only been available on the tobacco marketplace for less than a decade, results from our study suggest that these products have had an influence on the daily use of e-cigarettes and tobacco product use overall.

Relative to previously conducted studies (Coleman et al., 2019; Weaver et al., 2015), this study also reports lower proportions of dual users continuing to use cigarettes or cigarettes and e-cigarettes, and a higher proportion transitioning to daily e-cigarette use. For example, of daily dual users of cigarettes and e-cigarettes at Wave 7, 16.5% (95% CI: 3.6, 51.6) became daily cigarette smokers, 8.5% (95% CI: 2.0, 29.3) remained daily dual users, and 12.8% (95% CI: 3.1, 40.1) became daily e-cigarette vapers. Given that a large proportion of the sample includes single tobacco product users transitioning to daily e-cigarette use, these trends may reflect a growing population of youth and young adults who are in the process of discontinuing cigarette use, or former smokers who are in the process of relapsing in their use of tobacco and nicotine products (Owusu et al., 2019; Soule et al., 2019). Further study of the trajectories of dual users of tobacco products is needed, as dual use may provide an opportunity to reduce the burden of tobacco use, if it represents a transitory state in which smokers are able to switch to e-cigarettes or quit using tobacco entirely (Abi Nehme et al., 2022; Coleman et al., 2019; Johnson et al., 2019; Owusu et al., 2019; Zhuang et al., 2016) or pose significant public health risks if it prolongs and sustains nicotine addiction (Owusu et al., 2019).

## 5. Limitations

Study results should be considered in light of certain limitations. First, information on the type or brand of e-cigarette used by participants is limited and not available for all waves of data. At the time of

data collection, pod-based e-cigarettes held 85% of the e-cigarette market share. Of that share, JUUL made up more than half (Huang et al., 2019). Although we hypothesize that most participants initiating e-cigarette use during this time were using pod-based e-cigarettes, which generally utilize nicotine-salt technology and have high nicotine concentrations, it is possible that they were also using other e-cigarette products with varied levels of nicotine. Second, although most young people prefer flavored e-cigarettes (Leventhal et al., 2019) and it is likely that participants were using flavored e-cigarettes (Romberg et al., 2019), we did not control for the use of flavors in our analyses. We were also unable to account for other factors, such as puffing behavior, which might influence nicotine intake. Finally, due to sample size limitations, daily use was defined as using any tobacco product at least 25 of the past 30 days. Future research will want to conduct sensitivity analyses to determine whether patterns of tobacco product use are similar when a narrower definition (e.g., use on 30 days of the past 30 days) is applied to analyses.

Thus, future research is needed to determine what influence e-cigarette characteristics such as device type, nicotine concentration, and flavors, have on long-term trajectories of tobacco product use. Finally, this study focused on describing the trajectories of tobacco product use among ever tobacco users and did not include information on quitting behaviors, or whether e-cigarettes have been successful in getting daily cigarette smokers to switch to e-cigarettes. We recognize that this is a critical question that the US Food and Drug Administration (FDA) is requiring the e-cigarette industry to demonstrate, especially as a recently published study has raised concerns about the potential long-term effects of e-cigarette use, including EVALI, cytotoxicity, and neutrophilic inflammation from the inhalation of e-cigarette chemicals (Park et al., 2022).

## 6. Conclusions

This study provides evidence that US youth and young adults are experimenting with tobacco products. There were a considerable proportion of tobacco users becoming daily e-cigarette vapers and a reduced proportion who were switching to become daily cigarette smokers from 2017 to 2019. It is likely that this reflects the change in nicotine dose that comes from e-cigarette products, suggesting that higher doses may be meeting the needs of many who may be on the path to addiction. However, further research is needed to see whether these changes result in a future cessation benefit.

## CRedit authorship contribution statement

**Elizabeth C. Hair:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision. **Elizabeth K. Do:** Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Project administration. **Shiyang Michael Liu:** Methodology, Data curation, Formal analysis, Writing – review & editing. **Shreya Tulsiani:** Writing – review & editing, Project administration. **Donna M. Vallone:** Writing – review & editing. **John P. Pierce:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Funding acquisition.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

The data that has been used is confidential.

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## Appendix A. Supplementary data

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