



## Original article

Multiple Tobacco Product Use Among Youth E-Cigarette Users:  
National Youth Tobacco Survey, 2020Nicole A. Tashakkori, M.P.H. \*, Eunice Park-Lee, Ph.D., Esther J. Roh, Ph.D., M.S., and  
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## A B S T R A C T

**Purpose:** Limited information exists on multiple tobacco product use, particularly among youth. This study assessed the prevalence of current youth use of e-cigarettes with other tobacco products and their associated characteristics using 2020 National Youth Tobacco Survey data.

**Methods:** Prevalence estimates were calculated for current e-cigarette users, by multiple tobacco product use status and product combination. Demographic characteristics, e-cigarette use behaviors, age at first combustible tobacco use, and tobacco dependence symptoms were compared between current users of both e-cigarettes and combustible tobacco (dual users) and current exclusive e-cigarette users.

**Results:** In 2020, 61.1% of all current e-cigarette users reported exclusive e-cigarette use, and 38.9% used e-cigarettes with other tobacco products. Among those who used e-cigarettes with other tobacco products, 85.0% used combustible tobacco, with cigarettes being the most commonly used other tobacco product. Compared with current exclusive e-cigarette users, higher proportions of dual users reported the following: frequent e-cigarette use; obtaining e-cigarettes from gas stations, persons other than a family member/friend, vape shops, or the internet; and having any tobacco dependence symptoms. Among dual users, 31.2% reported first combustible product use after e-cigarette initiation, and 34.3% reported first combustible product use prior to e-cigarette initiation.

**Discussion:** Approximately four in 10 youth current e-cigarette users reported using multiple tobacco products, with a majority using combustible tobacco. Frequent e-cigarette use and tobacco dependence symptoms were more prevalent among dual users of e-cigarettes and combustible tobacco.

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IMPLICATIONS AND  
CONTRIBUTION

This study provides nationally representative estimates of multiple tobacco product use, overall and by product combination, among current middle and high school e-cigarette users in 2020. The detailed product combination breakdowns and comparisons will help inform targeted prevention measures to reduce youth tobacco use.

**Conflicts of interest:** The authors have no conflicts of interest to declare.

**Disclaimer:** The findings and conclusions in this study are those of the authors and do not necessarily represent the official position of the United States Food and Drug Administration (FDA).

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Since 2014, e-cigarettes have remained the most commonly used tobacco product among youth [1]. In 2022, an estimated 2.6 million middle and high school students reported current e-cigarette use [2]. Nearly all tobacco product use begins and is established during the adolescent years [1,3]. Given the high nicotine concentrations in e-cigarettes commonly used by youth [4,5] and the vulnerability of the developing adolescent brain to

nicotine exposure, youth e-cigarette users may develop cognitive deficits, reduced impulse control, and nicotine dependence [6–8]. Nicotine dependence among youth is particularly of concern as it may lead to experimentation with other tobacco products to satisfy cravings and possibly to multiple tobacco product use [9–11].

Patterns of youth multiple ( $\geq 2$ ) tobacco product use have evolved over the past decade. In 2012, analyses of data from the National Youth Tobacco Survey (NYTS) found that almost two-thirds of youth tobacco users (62.4%) used multiple tobacco products [11]. Data from the 2013–2014 Population Assessment of Tobacco and Health (PATH) Study noted that among youth multiple product users, most (71.4%) used cigarettes in combination with other tobacco products [12]. The 2017–2018 NYTS data indicated a shift; 40.8% of youth tobacco users used two or more products, with most using e-cigarettes in combination with combustible tobacco products [13]. In 2019, while the majority of youth tobacco users reported exclusive e-cigarette use, 33.9% reported use of multiple products; six of the seven most common product combinations involved both e-cigarettes and combustible tobacco products (e.g., cigarettes, cigars, hookahs) [14].

Previous studies indicate that exclusive and multiple tobacco product use patterns vary by demographic characteristics including sex, race/ethnicity, and various other domains [9,15,16]. Current understanding of multiple tobacco product use is largely limited to these domains, with current data showing that characteristics, such as high school attendance [13], non-Hispanic White ethnicity [16], or male gender [15,16], being associated with multiple tobacco product use. When compared with exclusive e-cigarette users, youth e-cigarette users who use other tobacco products are more likely to continue dual use with cigarettes or switch to using other tobacco products [17]. However, less is known about youth e-cigarette use behaviors associated with multiple product use, e.g., frequency of use, device type, flavor use, access source, age at initiation, and dependence symptoms. More information about these behaviors inform regulatory efforts and evidence-based tobacco control strategies.

While youth multiple tobacco product use has declined in the recent years, combustible tobacco continued to be the most commonly used products in combination with e-cigarettes (referred to herein as “dual use”) and youth e-cigarette use continues to be of concern [14,18]. Moreover, as youth multiple tobacco product use patterns have changed with the evolving tobacco product landscape, it is important to continue monitoring these patterns and associated characteristics. This cross-sectional analysis of 2020 NYTS data expanded upon existing literature regarding multiple tobacco product use by providing a comprehensive breakdown of product combinations used by youth e-cigarette users and a comparison of demographic characteristics, e-cigarette use behaviors, age at first combustible tobacco use, and tobacco dependence symptoms between dual users and exclusive e-cigarette users. Data from the 2021 NYTS were not included due to sample size limitations and because comparisons between 2021 and prior survey years cannot be made due to the COVID-related disparate data collection methods utilized in 2021 [19].

## Methods

### Data source

The NYTS is a nationally representative, cross-sectional, school-based, self-administered survey of middle (grades 6–8)

and high school (grades 9–12) students in the United States attending public and private schools. Parental consent and student assent are required to participate in the survey. The study protocol was approved by the institutional review board of the Centers for Disease Control and Prevention. The 2020 data collection occurred between January 16, 2020, and March 16, 2020, ending earlier than planned due to widespread school closures related to the COVID-19 pandemic. The overall response rate, defined as a product of the school-level participation rate (49.9%) and student-level participation rate (87.4%), was lower (43.6%) compared with prior years; however, the truncated data collection period did not affect the original study design or the national representativeness of the weighted estimates. Detailed information on the 2020 NYTS methodology, including methodological investigations on the nationally representativeness of estimates, is available elsewhere [20].

### Measures

**Current use of e-cigarettes.** Current use was defined as use of a tobacco product on  $\geq 1$  day during the past 30 days. We categorized current e-cigarette users into two tobacco user groups: 1) “exclusive users,” defined as respondents who reported currently using e-cigarettes but no other tobacco products (cigarettes, cigars, smokeless tobacco [SLT] [chewing tobacco/snuff/dip, snus, and dissolvable tobacco], hookahs, pipe tobacco, bidis, or heated tobacco products [HTPs]); and 2) “current multiple product users,” defined as respondents who reported currently using e-cigarettes and any other tobacco products. Multiple product users were further categorized based on combustible and noncombustible tobacco product use. Current users of e-cigarette and combustible tobacco (dual users) were defined as those who reported currently using e-cigarettes and any combustible tobacco products (cigarettes, cigars, hookahs, pipe tobacco, or bidis), irrespective of noncombustible tobacco product use. Current users of e-cigarettes and noncombustible tobacco were defined as those who reported currently using e-cigarettes and any noncombustible tobacco products (SLT, HTPs) and no combustible tobacco product. Additional subgroups of current multiple product users are described in Table 1. Subgroups were chosen based on prevalence of use.

**Demographic characteristics.** We characterized respondents based on self-reported school level (middle school and high school), sex (male/female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic other races), and sexual identity (heterosexual; lesbian, gay, or bisexual; not sure).

**Frequency of e-cigarette use.** Respondents who reported ever use of e-cigarettes were asked, “During the past 30 days, on how many days did you use e-cigarettes?” Response options ranged between zero and 30 days. We categorized these responses into one to five days, six to 19 days, and 20 or more days. We defined frequent use as use on  $\geq 20$  days during the past 30 days and daily use as use on all 30 days.

**Device type.** Current e-cigarette users were asked, “Which of the following best describes the type of e-cigarette you have used in the past 30 days? If you have used more than one type, please think about the one you use most often.” Response options were: “a disposable e-cigarette that uses pre-filled pods or cartridges (e.g., JUUL),” “a disposable e-cigarette,” “an e-cigarette with a

**Table 1**

Multiple product use status and product combinations among middle and high school current e-cigarette users: National Youth Tobacco Survey, 2020

	Unweighted sample size	Weighted population number	%	95% CI
Among current e-cigarette users	1,769	3,580,000	100.0	
Exclusive use	1,087	2,190,000	61.1	(56.7, 65.3)
Multiple Product use <sup>b</sup>	682	1,390,000	38.9	(34.7, 43.3)
Among current e-cigarette multiple product users	682	1,390,000	100.0	
<i>E-cigarettes + Combustible<sup>c</sup> (dual users)</i>	573	1,180,000	85.0	(80.6, 88.5)
E-cigarettes + combustible only	366	780,000	56.0	(49.9, 62.0)
E-cigarettes + cigarettes	117	230,000	17.1	(13.6, 21.2)
E-cigarettes + cigars	86	170,000	12.3	(9.7, 15.5)
E-cigarettes + cigarettes + cigars	44	110,000	8.5	(5.0, 14.0)
E-cigarettes + hookahs	48	90,000	7.0	(4.1, 11.6)
E-cigarettes + cigars + hookah	22	a	a	a
E-cigarettes + other combustible only	49	110,000	8.2	(5.5, 12.1)
E-cigarettes + combustible + noncombustible	189	370,000	26.8	(22.9, 31.1)
E-cigarettes + cigarettes + SLT	40	70,000	5.7	(4.1, 8.0)
E-cigarettes + cigarettes + cigars + SLT	20	40,000	3.0	(1.7, 5.1)
E-cigarettes + other combustible and noncombustible combinations <sup>d</sup>	129	250,000	18.1	(14.9, 21.9)
E-cigarettes + combustible + unknown noncombustible use	18	30,000	2.2	(1.3, 3.5)
<i>E-cigarettes + noncombustible only</i>	105	200,000	14.6	(11.1, 18.9)
E-cigarettes + SLT	72	140,000	10.3	(7.3, 14.4)
E-cigarettes + HTPs	30	50,000	4.0	(2.6, 6.2)
E-cigarettes + other noncombustible only	3	a	a	a
<i>E-cigarettes + all other combinations<sup>e</sup></i>	4	a	a	a

CI = confidence interval; HTPs = heated tobacco products; SLT = smokeless tobacco.

<sup>a</sup> Data are statistically unreliable and not shown due to an unweighted denominator <50 or a relative standard error > 30%.<sup>b</sup> Current e-cigarette and multiple product use was defined as use of e-cigarettes and one or more other tobacco products (cigarettes, cigars, SLT [chewing tobacco/snuff/dip, snus, and dissolvable tobacco], hookahs, pipe tobacco, bidis, or heated tobacco products) on ≥ 1 day during the past 30 days.<sup>c</sup> Combustible tobacco products include cigarettes, cigars, hookah, pipe tobacco, and bidis. This category includes current e-cigarette users who use any combustible tobacco products irrespective of their noncombustible tobacco product use.<sup>d</sup> All other 75 distinct product combinations were combined into one category because estimates of each combination were statistically unreliable.<sup>e</sup> This category includes current e-cigarette users who did not provide valid information about their current use of one or more combustible and/or noncombustible tobacco products.

tank that you refill with liquids,” “a mod system (an e-cigarette that can be customized by the user with their own combination of batteries or other parts),” and “I don’t know the type.” Due to small sample sizes, respondents who selected “an e-cigarette with a tank that you refill with liquids” and “a mod system” were combined into “tank/mod system.”

**Flavor use.** Current e-cigarette users were asked, “Were any of the e-cigarettes that you used in the past 30 days flavored to taste like menthol, mint, clove or spice, alcohol (wine, cognac), candy, fruit, chocolate, or any other flavor?” Response options were: “yes,” “no,” and “don’t know.” We analyzed e-cigarette use as flavored if “yes,” unflavored if “no,” and don’t know.

**Access sources.** Current e-cigarette users were asked, “During the past 30 days, where did you get or buy the e-cigarettes that you have used? (Select one or more).” Response options were: “a gas station or convenience store,” “a grocery store,” “a drugstore,” “a mall or shopping center kiosk/stand,” “on the internet,” “a vape shop or other store that only sells e-cigarettes,” “from a family member,” “from a friend,” “from some other person that is not a family member or a friend,” and “some other place not listed here.” We used the same categories in our analysis of access source.

**Ages at first use of e-cigarettes and combustible products.** Age at first use of each tobacco product was assessed among ever users of the product by the question, “How old were you when you first [used an e-cigarette, even once or twice; smoked a cigarette,

even one or two puffs; smoked a cigar, cigarillo, or little cigar, even one or two puffs; smoked tobacco in a hookah or waterpipe, even one or two puffs]?” Response options ranged from eight years or younger to 19 years or older. We categorized responses to the question on age at first use of e-cigarettes into “<13 years” and “≥13 years.” Age 13 was used as the cutoff because it was the median age of e-cigarette initiation in the 2020 NYTS. Age at first combustible product use was based on respondents’ earliest report of first using cigarettes, cigars, or hookahs and was compared with age at first e-cigarette use to categorize into “before e-cigarette initiation,” “same age as e-cigarette initiation,” and “after e-cigarette initiation.” No data were available on when respondents first used pipe tobacco or bidis in the 2020 NYTS.

**Tobacco dependence symptoms.** Tobacco dependence symptoms were assessed among current tobacco users using two questions: “During the past 30 days, have you had a strong craving or felt like you really needed to use a tobacco product of any kind?” and “How soon after you wake up do you want to use a tobacco product?” We categorized current e-cigarette users as having any tobacco dependence symptom if they reported both having had a strong craving for a tobacco product in the past 30 days or wanting to use a tobacco product within 30 minutes of waking.

### Statistical analyses

We conducted data analyses using SAS—callable SUDAAN (SUDAAN version 11.0.3, Research Triangle Institute) to account

for the complex sampling design. Data were weighted and adjusted for nonresponse and varying sampling probabilities. Prevalence estimates and 95% confidence intervals (CIs) were calculated for current e-cigarette users, by multiple tobacco product use status and specific product combinations. Additional weighted estimates for demographic characteristics, e-cigarette use behaviors, age at first combustible product use, and tobacco dependence symptoms were calculated among exclusive e-cigarette users and dual users. Two-sided t-tests were conducted to test for differences between the two groups, and  $p$  values  $<0.05$  were considered statistically significant. Estimates were considered statistically unstable and were suppressed if an unweighted denominator was  $<50$  or a relative standard error was  $>30\%$ .

## Results

### *Multiple product use among current e-cigarette users*

In 2020, an estimated 13.1% (3.6 million) of middle and high school students reported current e-cigarette use [18]. Among all current e-cigarette users, the prevalence of exclusive e-cigarette use was 61.1% (95% CI: 56.7–65.3), and 38.9% (95% CI: 34.7–43.3) reported use of e-cigarettes and other tobacco products (Table 1). Among current multiple product users who reported e-cigarette use, most used combustible tobacco products in combination with e-cigarettes (85.0%, 95% CI: 80.6–88.5), including 56.0% (95% CI: 49.9–62.0) using combustible only products and 26.8% (95% CI: 22.9–31.1) using both combustible and noncombustible products (Supplemental Figure A). Among dual users, cigarettes (17.1%, 95% CI: 13.6–21.2) were the most commonly used combustible tobacco product, followed by cigars (12.3%, 95% CI: 9.7–15.5), both cigarettes and cigars (8.5%, 95% CI: 5.0–14.0), and hookahs (7.0%, 95% CI: 4.1–11.6). Of current e-cigarette users who also used both combustible and noncombustible products, 5.7% (95% CI: 4.1–8.0) used a combination of e-cigarettes, cigarettes, and SLT, and 3.0% (95% CI: 1.7–5.1) used a combination of e-cigarettes, cigarettes, cigars, and SLT. Among those who report e-cigarette and noncombustible tobacco use only, an estimated 10.3% (95% CI: 7.3–14.4) used e-cigarettes and SLT and 4.0% (95% CI: 2.6–6.2) used e-cigarettes and HTPs.

### *Exclusive e-cigarette users versus users of e-cigarettes and combustible tobacco (“dual users”)*

The majority of both exclusive e-cigarette users and current dual users were high school students and non-Hispanic White students (Table 2). Compared with exclusive e-cigarette users, a higher percentage of dual users were non-Hispanic Black students (4.7% vs. 8.3%,  $p = .04$ , respectively), identified as lesbian, gay, or bisexual (13.2% vs. 21.2%,  $p = .002$ ), and reported frequent e-cigarette use (32.1% vs. 43.7%,  $p < .001$ ). While the most commonly used e-cigarette device type was pre-filled pods or cartridges across groups, compared with exclusive users, a higher percentage of dual users reported using tank/mod systems (17.6% vs. 25.3%,  $p = .004$ ). There were no differences in flavored product use between exclusive users and dual users.

Compared with exclusive users, a lower percentage of dual users reported getting their e-cigarettes from friends (63.1% vs. 47.8%,  $p < .001$ ). However, higher proportions of dual users than exclusive e-cigarette users reported getting their e-cigarettes from gas stations/convenience stores (26.0% vs. 18.2%,  $p = .016$ ),

vape shops (20.4% vs. 13.8%,  $p = .003$ ), some other person not a family member or friend (22.7% vs. 14.1%,  $p < .001$ ) or on the internet (10.0% vs. 4.0%,  $p < .001$ ). Furthermore, compared with exclusive users, a higher percentage of dual users initiated e-cigarette use at  $<13$  years (14.5% vs. 37.6%,  $p < .001$ ) and reported having any tobacco dependence symptoms (31.3% vs. 55.7%,  $p < .001$ ). Among dual users, 34.3% (95% CI: 29.1–39.9) started using combustible tobacco before e-cigarette initiation, 34.5% (95% CI: 30.1–39.1) started using e-cigarettes and combustible products at the same age, and 31.2% (95% CI: 26.6–36.3) used their first combustible product after using e-cigarettes.

## Discussion

This study provides nationally representative estimates of multiple tobacco product use, overall and by product combination, among current middle and high school e-cigarette users. Consistent with what has been reported in recent research, while the majority of current youth e-cigarette users reported exclusive use of e-cigarettes [6,21], about four in 10 reported multiple tobacco product use. In addition, despite the declines in youth multiple tobacco product use, combustible tobacco continues to be the most commonly used product class in combination with e-cigarettes. Consistent with findings from previous research, this study found that in 2020, approximately 85% of e-cigarette multiple tobacco product users reported using combustible products, with cigarettes being the most commonly used combustible tobacco product. Prevention of youth combustible tobacco use is critical, as almost 90% of daily established adult smokers initiated cigarette use prior to age 18 [22,23].

Study results showed that among e-cigarette and noncombustible-only users, a higher proportion of youth e-cigarette multiple product users reported using SLT than HTPs. Literature examining youth e-cigarette and SLT use is limited. Previous NYTS analyses found that youth SLT use, with or without e-cigarettes, has remained relatively stable over time [24]. However, youth who initiated tobacco use with SLT had increased odds of multiple tobacco product use compared to those who initiated with e-cigarettes [24,25].

Multiple tobacco product users have consistently shown increased tobacco dependence compared with single or exclusive tobacco product users and nonusers [11,15,26]. For example, a study suggested that high nicotine dependence levels were almost four times more likely among multiple product users and almost twice as likely among dual users, relative to single product users [15]. Furthermore, the risk of addiction is also higher among multiple product users when compared with both single and dual product users [15]. Consistent with past research, the current study found that higher percentages of dual users reported having one or more dependence symptoms and more frequent e-cigarette use compared with exclusive e-cigarette users. High frequency of use among multiple tobacco product users leads to increased levels of nicotine dependence [27]. This increased dependence among youth multiple product users may indicate an increased risk of continuing tobacco product use into adulthood [1,3,23].

Over one-third of current e-cigarette and combustible users reported initiating e-cigarette use before age 13, and over 60% reported using their first combustible product at the same age or after they began using e-cigarettes. As previously noted, ever e-cigarette use among youth may be associated with new and established cigarette smoking [17,28,29]. A previous study

**Table 2**

Characteristics of middle and high school current e-cigarette users, by dual-use and exclusive e-cigarette use: National Youth Tobacco Survey, 2020

	Current dual users (n = 573) Weighted % (95% CI)	Current exclusive e-cigarette users (n = 1,087) Weighted % (95% CI)	p-value <sup>a</sup>
<b>Demographic characteristics</b>			
<i>School type</i>			
Middle school	20.0 (13.7, 28.1)	13.0 (8.8, 18.7)	.004
High school	80.0 (71.9, 86.3)	87.0 (81.3, 91.2)	.004
<i>Sex</i>			
Female	46.2 (40.5, 52.0)	51.4 (47.6, 55.2)	.152
Male	53.8 (48.0, 59.5)	48.6 (44.8, 52.4)	.152
<i>Race/ethnicity</i>			
Non-Hispanic White	54.1 (45.4, 62.5)	65.5 (58.8, 71.5)	.006
Non-Hispanic Black	8.3 (5.6, 12.2)	4.7 (3.3, 6.7)	.040
Hispanic	32.4 (23.6, 42.6)	25.9 (20.3, 32.4)	.111
Non-Hispanic other	5.2 (3.3, 8.0)	3.9 (2.3, 6.5)	.357
<i>Sexual identity</i>			
Heterosexual	70.9 (65.3, 75.9)	83.8 (80.6, 86.6)	<.001
Lesbian, gay, and bisexual	21.2 (17.1, 25.9)	13.2 (10.7, 16.3)	.002
Not sure	7.9 (5.4, 11.6)	2.9 (1.8, 4.7)	.002
<b>E-cigarette use behaviors</b>			
<i>Frequency of e-cigarette use</i>			
1–5 days	34.1 (28.3, 40.4)	50.2 (46.0, 54.3)	<.001
6–19 days	22.2 (18.6, 26.4)	17.7 (15.0, 20.8)	.051
20+ days	43.7 (37.0, 50.6)	32.1 (28.9, 35.5)	<.001
<i>Daily e-cigarette use<sup>c</sup></i>	26.7 (21.4, 32.7)	17.4 (14.4, 21.0)	.001
<i>E-cigarette device type</i>			
Disposable	20.3 (14.8, 27.2)	27.3 (20.9, 34.7)	.014
Pre-filled pods or cartridges	46.5 (40.2, 52.9)	48.4 (42.4, 54.4)	.576
Tank/mod system	25.3 (20.0, 31.6)	17.6 (13.7, 22.3)	.004
Don't know the type	7.8 (5.7, 10.7)	6.8 (5.0, 9.1)	.480
<i>Flavored e-cigarette use</i>			
Flavored	80.6 (76.0, 84.5)	83.4 (80.8, 85.6)	.238
Unflavored	14.3 (10.7, 18.8)	12.9 (10.6, 15.6)	.538
Don't know	5.2 (3.2, 8.3)	3.8 (2.7, 5.3)	.334
<i>Access source of e-cigarettes</i>			
From a friend	47.8 (41.6, 54.1)	63.1 (59.0, 67.0)	<.001
From a family member	15.2 (11.6, 19.5)	9.0 (6.7, 12.0)	.016
From some other person that is not a family member or a friend	22.7 (18.1, 28.1)	14.1 (11.9, 16.6)	<.001
Gas station or convenience store	26.0 (20.5, 32.3)	18.2 (15.0, 21.9)	.016
Vape shop or other store that only sells e-cigarettes	20.4 (16.3, 25.3)	13.8 (10.7, 17.6)	.003
On the Internet	10.0 (7.3, 13.6)	4.0 (2.8, 5.5)	<.001
Drug store	7.1 (4.6, 10.7)	b	NA
Mall or shopping center kiosk/stand	b	b	NA
Grocery store	b	b	NA
Some other place not listed here	7.0 (4.9, 10.1)	2.7 (1.6, 4.5)	.006
<i>Age at first use of e-cigarettes</i>			
<13 years	37.6 (31.5, 44.1)	14.5 (11.9, 17.5)	<.001
≥13 years	62.4 (55.9, 68.5)	85.5 (82.5, 88.1)	<.001
<i>Age at first use of combustible products (cigarettes, cigars, hookah)</i>			
Before e-cigarette initiation	34.3 (29.1, 39.9)	NA	NA
Same age as e-cigarette initiation	34.5 (30.1, 39.1)	NA	NA
After e-cigarette initiation	31.2 (26.6, 36.3)	NA	NA
<b>Tobacco dependence symptoms</b>			
<i>Any dependence symptom<sup>d</sup></i>	55.7 (50.7, 60.7)	31.3 (28.4, 34.3)	<.001
Past 30-day craving	50.4 (45.4, 55.4)	27.3 (24.2, 30.6)	<.001
Within 30 minutes of waking	30.9 (24.6, 38.0)	15.2 (12.9, 17.8)	<.001

CI = confidence interval; NA = not applicable.

<sup>a</sup> T-tests were used to test for differences between the two groups.<sup>b</sup> Data are statistically unreliable and not shown due to an unweighted denominator <50 or a relative standard error > 30%.<sup>c</sup> Defined as reported use on all 30 days during the past 30 days.<sup>d</sup> Defined as reported having one or more dependence symptoms.

suggested that, compared with exclusive e-cigarette users, e-cigarette users who use other tobacco products were more likely to continue using e-cigarettes and combustible tobacco or switch to other tobacco products [17]. Notably, e-cigarette use among youth may be a contributing factor to the progression to combustible tobacco product use [17,28–30]. Previous literature found that most youth and young adult dual users remain dual

product users when followed up in ≤ 1 year [30–32]. However, among studies with follow-up periods of longer than one year, youth and young adult multiple tobacco product users were more likely to have transitioned to exclusive combustible product use [31,32]. Considering both the published literature and the increased dependence and frequency of use among dual users reported in this study, these findings demonstrate the need for

preventing e-cigarette initiation by nonusers of tobacco and preventing current e-cigarette users from transitioning to multiple tobacco product use, specifically combustible tobacco use, as multiple tobacco product users were less likely to quit tobacco product use compared to exclusive e-cigarette users [31]. Use of any tobacco products, including e-cigarettes, is unsafe [1], and while the long-term health effects of e-cigarette use are unknown, early indications of health effects have been demonstrated [33].

Several demographic differences were observed among exclusive e-cigarette users and dual users. Compared with exclusive users, dual users were more likely to be non-Hispanic Black students or identified as lesbian, gay, or bisexual. This is consistent with recent NYTS analyses reporting that non-Hispanic Black e-cigarette users were more likely to be dual users of e-cigarettes and cigarettes or other tobacco products than their non-Hispanic White peers [34]. Limited previous studies have shown the prevalence of multiple tobacco product use is higher among young adults identifying as sexual minorities than those identifying as heterosexual [35], and female sexual minority youth had almost twice the odds of multiple tobacco product use compared with heterosexual youth [36]. The increased likelihood of dual product use of e-cigarettes and combustible products, particularly among non-Hispanic Black and sexual minority students, raises concerns about increasing tobacco-related health disparities among these vulnerable populations.

This study, consistent with previous research [37,38], found that friends were the most commonly reported source for obtaining e-cigarettes for both exclusive e-cigarette users and dual users. However, when the two groups were compared, exclusive users obtained their e-cigarettes predominantly from friends, while dual users appeared to access products from various sources. In addition to friends (47.8%), dual users reported obtaining products from other than family and friends (22.7%), gas stations or convenience stores (26.0%), and vape shops (20.4%). In 2021, retail stores (65.4%) were the most commonly reported source for youth to see ads or promotions for e-cigarettes, cigarettes, and other tobacco products [19]. Furthermore, as social media use is associated with increased e-cigarette use among United States youth [39], exposure to tobacco product marketing at stores that youth frequently visit in person and/or through social media could prompt initiation and use but reinforce continued use of tobacco products.

This study is subject to several limitations. Due to school closures related to the COVID-19 pandemic, the 2020 NYTS data collection period was truncated resulting in a lower overall response rate compared with prior years. However, the truncated data collection period did not affect the original study design or the national representativeness of the weighted estimates [20]. Second, NYTS is cross-sectional in design. A temporal relationship between domains and tobacco product use patterns cannot be determined because both are examined at the same time. Moreover, the longitudinal relationship between e-cigarette use and subsequent use of other tobacco products remains unclear. All data collected were self-reported by participants and therefore may be subject to recall and response bias. These findings are not generalizable to youth who are not enrolled in public or private schools or who are home-schooled. Lastly, based on the wording in the 2020 NYTS question regarding flavored e-cigarette use, those who consider tobacco flavor a type of flavored e-cigarette could theoretically specify their e-cigarettes used as “any other flavor.”

The present study provided nationally representative estimates of current multiple tobacco product use, overall and by product combination, among middle and high school e-cigarette users. Of the e-cigarette multiple product users, 85% reported using combustible tobacco products. Compared with exclusive e-cigarette users, higher proportions of these dual users were high school students, non-Hispanic Black students, and students identifying as lesbian, gay, or bisexual. The dual users reported frequent and daily e-cigarette use, younger age at e-cigarette initiation, any tobacco dependence symptoms, and accessing e-cigarettes from various sources. Given the shifting and diverse patterns of youth multiple tobacco product use over the past decade [11–13], frequent monitoring of youth tobacco use, and associated characteristics is warranted to understand any changes and support ongoing efforts to reduce tobacco use and initiation [15].

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## Supplementary Data

Supplementary data related to this article can be found at 10.1016/j.jadohealth.2023.05.025.

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