## Chapter 2 Patterns of E-Cigarette Use Among U.S. Youth and Young Adults

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## Introduction

This chapter documents patterns and trends in awareness of electronic cigarettes (e-cigarettes), their use, and perceptions about these devices among youth and young adults in the United States. Both the awareness of e-cigarettes and levels of their use have increased rapidly throughout the U.S. population. Understanding young people's patterns of e-cigarette use is essential to determining the scope of potential benefits or harms that these products may have from a public health perspective. This chapter summarizes the patterns of use of e-cigarettes, identifies subgroups at higher risk for using them, highlights the ways in which e-cigarettes are used with other tobacco products, and identifies correlates of e-cigarette use, including knowledge, attitudes, beliefs, and sociodemographic characteristics. In most cases, the term "e-cigarette(s)" is used, but when needed to accord with usage in the cited literature, the acronym "ENDS" (electronic nicotine delivery systems) is employed.

## Sources of Data

Data summarized in this chapter come from nationally representative datasets that were federally funded and peer-reviewed literature of subnational and international surveillance studies of e-cigarette use that were mostly cross-sectional in design. Appendix 2.1. and Table A2.1-1 in that appendix<sup>1</sup> describe all the years of data available for these data sources, but only selected years are used for this report. For youth, this report relies on data from the National Youth Tobacco Survey (NYTS) and the Monitoring the Future Study (MTF), as measures of e-cigarette use were available for at least two or more time points. For this reason, the report also relies on data from the National Adult Tobacco Survey (NATS) for young adults. More recently, the Youth Risk Behavior Surveillance System and other surveys from the National Center for Health Statistics have added measures of e-cigarette use to their surveys, but only one data point was available at the time this report was prepared. Only five longitudinal studies were available on this topic at the time this report was prepared (Leventhal et al. 2015; Primack et al. 2015; Barrington-Trimis et al. 2016; Unger et al. 2016; Wills et al. 2016). Because e-cigarettes only became prevalent in the tobacco product marketplace in recent years, minimal data are available on their use before 2011. Given the paucity of surveillance information on e-cigarettes and the low prevalence of their use in the early years of their availability in the United States, peer-reviewed studies with smaller subnational samples are used in this chapter to complement national surveillance data. Surveillance of e-cigarette use presents a unique set of challenges, given the emerging and dynamic market specific to these products (see Chapter 4 for more on the latter topic). Appendix 2.1 and Tables A2.2-1 and A2.2-2 in Appendix 2.2 summarize the key terms and measures used in this chapter.

## **Other Literature**

This chapter also summarizes findings from peerreviewed literature on e-cigarettes that were identified through a systematic review of studies of these products from the United States and abroad. A literature search was conducted in April 2015 (Glasser et al. 2015) using the National Library of Medicine's PubMed database and the following keywords: "e-cigarette\*" OR "electronic cigarette" OR "electronic cigarettes" OR "electronic nicotine delivery" OR "vape" OR "vaping." Articles were excluded from this review for any of five reasons: (1) the article was not available in English; (2) the article was not relevant to e-cigarettes; (3) the study included nonhuman subjects; (4) the study did not include original data; or (5) the study did not include findings specific to adolescents or young adults. More details about this review's methodology are available in Glasser and colleagues' (2015) report. The search was subsequently updated in November 2015, January 2016, and March 2016 during continued development of the report. For consistency, the same search strategy and databases were employed at all times. Studies on patterns of e-cigarette use behaviors for both youth and young adults are reviewed in the text and tables that follow. All other studies not explicitly described in the text are summarized in Appendix 2.3 and Tables A2.3-1 through A2.3-3.

<sup>&</sup>lt;sup>1</sup>All appendixes and appendix tables that are cross-referenced in this chapter are available only online at http://www.surgeongeneral.gov/ library/reports/

## **Key Findings**

## Youth

## **Current Prevalence**

## Ever Use

According to the 2015 National Youth Tobacco Survey (NYTS), an estimated 27.1% of U.S. adolescents, representing approximately 7,260,500 persons, had ever tried e-cigarettes (Centers for Disease Control and Prevention [CDC], unpublished data [NYTS 2015]). This included 13.5% of middle school students and 37.7% of high school students (Tables 2.1a and 2.1b). Among middle school students, use was comparable between boys and girls, but it was higher among Hispanics compared with other racial/ ethnic groups (Table 2.1a). For high school students, use was also comparable between boys and girls, but higher among both White and Hispanic youth compared with Black youth (Table 2.1b). According to data from the 2015 Youth Risk Behavior Survey (YRBS), a larger percentage of high school students (44.9%) had ever used e-cigarettes (Kann et al. 2016), while the Monitoring the Future (MTF) survey does not collect data on ever use of e-cigarettes (Johnston et al. 2016).

## Past-30-Day Use

According to the 2015 NYTS, an estimated 620,000 middle school students and 2,390,000 high school students had used e-cigarettes at least once in the past 30 days (CDC 2016). This was an increase from the 2014 NYTS, which reported 450,000 middle school students and 2,010,000 high school students had used e-cigarettes in the past 30 days (CDC 2015c). Levels of past-30-day use were 5.3% for middle school students and 16% for high school students in 2015 (Tables 2.2a and 2.2b), compared with 3.9% for middle school students and 13.4% for high school students in 2014. Sociodemographic differences in past-30-day use for middle and high school students had the same patterns as those for ever use (Tables 2.2a and 2.2b). In 2015, according to the YRBS, 24.1% of high school students had used e-cigarettes at least once in the past 30 days (Kann et al. 2016). The 2015 MTF shows past-30-day prevalence of e-cigarette use among adolescents was 9.5% among 8th graders, 14% among 10th graders, and 16% among 12th graders (Johnston et al. 2016). Notably, data from NYTS, YRBS, and MTF show that in 2014 exclusive past-30-day use of e-cigarettes exceeded exclusive past-30-day use of conventional cigarettes for the first time since these types of data were collected (University of Michigan 2014; CDC 2015c).

## Frequency of Use

Among middle school students, according to the 2015 NYTS, 5.3% were current users of e-cigarettes, and 0.6% used e-cigarettes frequently (defined as using an e-cigarette 20 or more days in the past 30 days preceding the survey) (Table 2.1a). Among high school students, these estimates were 15.5% and 2.5%, respectively (Table 2.1b). Due to smaller sample sizes, confidence intervals were too wide to determine sociodemographic differences in these measures. These estimates are consistent with a report by CDC (2015b).

A recent analysis of 2014 MTF data, specific to high school seniors, showed the frequency of e-cigarette use (defined as the number of days in the past 30 days a student used an e-cigarette) increases with ever cigarette smoking (Warner et al. 2016). Among high school seniors who used at least 1 e-cigarette in the past 30 days, the frequency of e-cigarette use was almost twice as high (10.2 days)among those who regularly smoke conventional cigarettes, compared to those who had never smoked a conventional cigarette (5.8 days). However, the frequency of e-cigarette use did not vary substantially among current cigarette smokers. Among high school seniors who used at least 1 e-cigarette in the past 30 days, the frequency of e-cigarette use averaged 8-10 days for "heavy cigarette smokers" (those who smoked more than a half pack of cigarettes per day), "light cigarette smokers" (those who smoked 1–5 cigarettes per day), and "very light cigarette smokers" (those who smoked fewer than 1 cigarette per day) (Warner et al. 2016).

## Susceptibility to Use

Among those who had never used an e-cigarette, 32.1% of middle school students and 38.4% of high school students were susceptible to using e-cigarettes in the future. That is, these students did not have a firm resolve not to use e-cigarettes in the future. This is according to the 2015 NYTS (Tables 2.1a and 2.1b). No differences in susceptibility to use e-cigarettes were observed by gender or race/ ethnicity for either middle school or high school students.

## **Trends in Prevalence**

## Ever Use

Overall, according to the NYTS, ever use of e-cigarettes among students in grades 6-12 increased from 3.3% in 2011, to 6.8% in 2012, to 8.1% in 2013, to 19.8% in 2014, and then to 27% in 2015 (Figure 2.1). As

				Frequent use <sup>c</sup> : Among current Frequent use <sup>c</sup> :			°.	Susceptibility use <sup>d</sup> : Among no	to ever	Susceptibility to use <sup>d</sup> : Among all		
	Ever use <sup>a</sup>		Current use	b	users		Among all stud	ents	users		students	
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	13.5 (11.8–15.5)	0.9	5.3 (4.6-6.2)	0.4	11.7 (8.6–15.8)	1.8	0.6 (0.4-0.9)	0.1	32.1 (29.7–34.7)	1.3	41.4 (38.3–44.5)	1.5
Gender												
Female	12.2 (10.5 - 14.1)	0.9	4.8 (4.0-5.6)	0.4	11.0 (6.9–17.0)	2.5	0.5 (0.3–0.8)	0.1	33.1 (30.2–36.2)	1.5	41.4 (38.0–44.8)	1.7
Male	14.9 (12.9–17.2)	1.1	5.9 (4.7-7.2)	0.6	11.8 (8.3–16.5)	2.0	0.7(0.5-1.0)	0.1	31.3 (28.2–34.6)	1.6	41.6 (37.9–45.4)	1.9
Race/ethnicity												
White	12.2 (10.1–14.5)	1.1	4.4 (3.6–5.5)	0.5	10.8 (6.5–17.5)	2.7	0.5 (0.3–0.8)	0.1	29.7 (26.1-33.6)	1.9	38.0 (33.7-42.5)	2.2
Black or African American	11.7 (9.5–14.3)	1.2	4.1 (3.1–5.3)	0.6	14.0 (5.9–29.6)	5.7		_	34.7 (30.7–39.0)	2.1	42.5 (39.0–46.2)	1.8
Hispanic or Latino	18.6 (15.9–21.5)	1.4	8.3 (6.8–10.0)	0.8	12.1 (7.5–18.9)	2.8	1.0 (0.6–1.6)	0.2	38.0 (35.2–40.8)	1.4	49.8 (46.9–52.7)	1.5
Other <sup>e</sup>	11.9 (8.2–17.1)	2.2	4.6 (2.7-7.7)	1.2	—			_	30.4 (24.7–36.8)	3.1	39.5 (33.2-46.2)	3.3

# Table 2.1aPercentage of middle school students who have used e-cigarettes, by gender and race/ethnicity; National Youth Tobacco Survey (NYTS)2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

Notes: CI = confidence interval; SE = standard error. An em dash (---) indicates that data are statistically unstable because of a relative standard error >40%.

<sup>a</sup>Includes those who reported using an e-cigarette, even once or twice.

<sup>b</sup>Includes those who reported using e-cigarettes on 1 or more days in the past 30 days.

<sup>c</sup>Includes those who responded "≥20 days" to the following question: "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?" See CDC (2015b).

<sup>d</sup>Includes those who failed to respond "definitely not" to any of the following questions: (a) "Do you think that you will try an electronic cigarette or e-cigarette soon?";

(b) "If one of your best friends were to offer you an electronic cigarette or e-cigarette, would you use it?"; or (c) "Have you ever been curious about using an electronic cigarette or e-cigarette, even once or twice?"

eIncludes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native.

	Ever use <sup>a</sup>		Current use	b	Frequent use Among curre users	°: nt	Frequent use Among all stud	erts	Susceptibility use <sup>d</sup> : Among no users	to ever	Susceptibility use <sup>d</sup> : Among a students	to all
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	37.7 (35.3-40.2)	1.2	16.0 (14.1-18.0)	1.0	15.5 (12.9–18.4)	1.4	2.5 (1.9-3.2)	0.3	38.4 (36.5-40.4)	1.0	61.1 (59.0-63.2)	1.0
Gender												
Female	34.6 (31.9–37.3)	1.4	12.8 (11.0-15.0)	1.0	10.1 (7.2–14.0)	1.7	1.3 (0.9–1.8)	0.2	39.8 (37.4-42.2)	1.2	60.3 (58.1-62.5)	1.1
Male	40.7 (37.7-43.7)	1.5	19.0 (16.5–21.7)	1.3	19.1 (15.6–23.1)	1.9	3.6 (2.7-4.8)	0.5	36.9 (34.3–39.5)	1.3	61.8 (59.2-64.4)	1.3
Race/ethnicity												
White	38.0 (35.1-41.0)	1.5	17.2 (14.7–19.9)	1.3	16.8 (13.4–20.8)	1.9	2.9 (2.1-3.9)	0.4	36.3 (33.4–39.4)	1.5	60.1 (57.4-62.7)	1.3
Black or African American	28.5 (25.5–31.8)	1.6	8.9 (7.4–10.8)	0.8	8.5 (3.9–17.4)	3.2	0.8 (0.3–1.7)	0.3	37.2 (32.2–42.5)	2.6	54.5 (51.0–57.9)	1.7
Hispanic or Latino	43.0 (38.9–47.2)	2.1	16.4 (14.1–19.0)	1.2	12.8 (9.3–17.3)	2.0	2.1 (1.4–3.1)	0.4	44.6 (41.2–48.0)	1.7	67.8 (64.3–71.1)	1.7
Other <sup>e</sup>	37.4 (24.8–52.1)	7.0	18.9 (10.3–32.2)	5.5	18.2 (11.2–28.2)	4.3	3.4 (2.1–5.7)	0.9	41.2 (35.4–47.3)	3.0	62.6 (54.0-70.5)	4.2

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

*Note:* **CI** = confidence interval; **SE** = standard error.

<sup>a</sup>Includes those who reported using an e-cigarette, even once or twice.

<sup>b</sup>Includes those who reported using e-cigarettes on 1 or more days in the past 30 days.

<sup>c</sup>Includes those who responded "≥20 days" to the following question: "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?" See CDC (2015b).

<sup>d</sup>Includes those who failed to respond "definitely not" to any of the following questions: (a) "Do you think that you will try an electronic cigarette or e-cigarette soon?"; (b) "If one of your best friends were to offer you an electronic cigarette or e-cigarette, would you use it?"; or (c) "Have you ever been curious about using an electronic cigarette or e-cigarette, even once or twice?"

eIncludes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native.

	2011		2012		2013		2014		2015	
Characteristic	% (95% CI)	SE	% (95% CI)	SE						
Overall	0.6 (0.4–0.9)	0.1	1.1 (0.9–1.5)	0.1	1.1 (0.8–1.5)	0.2	3.9 (3.0-5.0)	0.5	5.3 (4.6-6.2)	0.4
Gender										
Female	0.4 (0.2–0.7)	0.1	0.8(0.5-1.1)	0.1	0.9(0.6-1.4)	0.2	3.3 (2.5-4.3)	0.5	4.8 (4.0-5.6)	0.4
Male	0.7 (0.4–1.3)	0.2	1.5 (1.1–2.1)	0.3	1.4(0.9-1.9)	0.2	4.5 (3.4–5.9)	0.6	5.9 (4.7-7.2)	0.6
Race/ethnicity										
White	0.6 (0.3–1.0)	0.2	0.9 (0.6–1.3)	0.2	0.9(0.6-1.4)	0.2	3.1 (2.2–4.2)	0.5	4.4 (3.6–5.5)	0.5
Black or African American	_	—	1.1 (0.6–2.2)	0.4	1.4 (0.7–2.5)	0.4	3.8 (2.5–5.6)	0.7	4.1 (3.1–5.3)	0.6
Hispanic or Latino	0.6 (0.4–1.1)	0.2	2.0 (1.4–2.9)	0.4	1.8 (1.1–2.7)	0.4	6.2 (4.8–7.9)	0.8	8.3 (6.8–10.0)	0.8
Other <sup>b</sup>							3.2 (1.6-6.3)	1.1	4.6 (2.7-7.7)	1.2

Table 2.2aPercentage of middle school students who used e-cigarettes in the past 30 days<sup>a</sup>, by gender and race/ethnicity; National Youth Tobacco<br/>Survey (NYTS) 2011–2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011-2015).

*Notes:* CI = confidence interval; SE = standard error. An em dash (—) indicates that data are statistically unstable because of a relative standard error >40%. Wording of questions used to measure e-cigarette use varied from 2011 to 2015.

<sup>a</sup>Includes those who reported using e-cigarettes on 1 or more of the past 30 days. This is also considered "current use" in this survey.

<sup>b</sup>Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native.

	2011		2012		2013		2014		2015	
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	1.5 (1.2–2.0)	0.2	2.8 (2.3-3.5)	0.3	4.5 (3.8–5.3)	0.4	13.4 (11.2–16.1)	1.2	16.0 (14.1–18.0)	1.0
Gender										
Female	0.7 (0.5 - 1.0)	0.1	1.9 (1.5–2.4)	0.2	3.5 (2.8-4.3)	0.4	11.9 (9.7–14.5)	1.2	12.8 (11.0–15.0)	1.0
Male	2.3 (1.7-3.2)	0.4	3.7 (2.9-4.8)	0.5	5.5 (4.5-6.8)	0.6	15.0 (12.4–18.2)	1.4	19.0 (16.5–21.7)	1.3
Race/ethnicity										
White	1.8 (1.3–2.4)	0.3	3.4 (2.7-4.2)	0.4	4.8 (3.8-6.1)	0.6	15.3 (12.4–18.8)	1.6	17.2 (14.7–19.9)	1.3
Black or African American	_	—	1.1 (0.7–1.9)	0.3	2.7 (1.9-3.9)	0.5	5.6 (3.7-8.5)	1.2	8.9 (7.4–10.8)	0.8
Hispanic or Latino	1.3 (0.8–2.1)	0.3	2.7 (1.9–3.8)	0.5	5.3 (4.2-6.6)	0.6	15.3 (11.8–19.5)	1.9	16.4 (14.1–19.0)	1.2
Other <sup>b</sup>	—				4.0 (2.3-6.9)	1.1	9.4 (6.8–12.9)	1.5	18.9 (10.3–32.2)	5.5

Table 2.2bPercentage of high school students who used e-cigarettes in the past 30 days<sup>a</sup>, by gender and race/ethnicity; National Youth Tobacco Survey<br/>(NYTS) 2011–2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011-2015).

*Notes:* CI = confidence interval; SE = standard error. An em dash (—) indicates that data are statistically unstable because of a relative standard error >40%. Wording of questions used to measure e-cigarette use varied from 2011 to 2015.

<sup>a</sup> Includes those who reported using e-cigarettes on 1 or more of the past 30 days. This is also considered "current use" in this survey.

<sup>b</sup> Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native.



Figure 2.1 Trends in ever e-cigarette use<sup>a</sup> among U.S. middle and high school students; National Youth Tobacco Survey (NYTS) 2011–2015

*Source:* Centers for Disease Control and Prevention 2013a, 2014b; unpublished data (data: NYTS 2015). *Note:* In 2014, modifications were made to the e-cigarette measure to enhance its accuracy, which may limit the comparability of this estimate to those collected in previous years. The dotted lines from 2013 to 2015 represent these differences. <sup>a</sup>Includes those who responded "1 or more" to the following question: *During the last 30 days, on how many days did you use electronic cigarettes or e-cigarettes?* 

discussed in Appendix 2.2 (see NYTS Measures—Special Issues), measures of e-cigarette use were changed for the 2014 NYTS, as signaled by the dotted line in the figure. Research conducted using the New Jersey Youth Tobacco Survey suggests that the NYTS measures used in 2011–2013 may potentially underestimate use, compared with the 2014 measure (Delnevo et al. 2016). For the 2011–2015 period, use of e-cigarettes was higher in each year among high school students than among middle school students (Tables 2.3a and 2.3b).

**Middle school students.** Trends in ever use of e-cigarettes among U.S. middle school students are presented in Table 2.3a and Figure 2.1, using data from the 2011–2015 NYTS. The prevalence of ever use increased from 1.4% in 2011 to 2.7% in 2012, to 3.0% in 2013, to 10.1% in 2014, and then to 13.5% in 2015. The jump in prevalence between 2013 and 2014 may be an artifact of a change in how the use item was asked (see Appendix 2.2. Key Measures of Use). Nonetheless, prevalence of use would be expected to be minimal prior to 2011, suggesting that a considerable increase in use was still observed during this relatively short 4-year period. In 2015, among middle school students, an estimated 1,595,481 had ever tried e-cigarettes (CDC, unpublished data [NYTS 2015]). From 2011 to 2013,

the prevalence of ever use did not differ significantly by gender or race/ethnicity. There remained no significant difference in ever use by gender in the 2014 or 2015 NYTS, but by 2014 and still in 2015, a greater percentage of Hispanic middle school students (18.6%) had tried e-cigarettes than White (12.2%) or Black (11.7%) students or students of other races/ethnicities (11.9%) (Table 2.3a).

High school students. Trends in ever use of e-cigarettes among U.S. high school students are presented in Tables 2.3b and Figure 2.1, using data from the 2011-2015 NYTS. The prevalence of ever use increased from 4.7% in 2011 to 10% in 2012, to 11.9% in 2013, to 27.3% in 2014, and then to 37.7% in 2015. In that year, an estimated 5,624,876 high school students had ever used e-cigarettes (CDC, unpublished data [NYTS 2015]). In 2011–2013, male high school students had a higher rate of ever use each year compared with female students, but in 2014 the genders did not differ significantly in their rates. From 2011 to 2015, White and Hispanic high school students were more likely each year to be ever users than were Black students: In 2015, these figures were 38% and 43%, respectively, for White and Hispanic students compared with 28.5% for Black students.

	2011		2012		2013		2014		2015	
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	1.4 (1.0-2.0)	0.2	2.7 (2.2-3.2)	0.2	3.0 (2.5–3.5)	0.2	10.1 (8.5–11.9)	0.8	13.5 (11.8–15.5)	0.9
Gender										
Female	1.2 (0.8–1.6)	0.2	2.4 (1.9-3.0)	0.3	2.8 (2.3-3.5)	0.3	9.9 (7.8-12.6)	1.2	12.2 (10.5–14.1)	0.9
Male	1.7 (1.1–2.7)	0.4	3.0 (2.4–3.6)	0.3	3.1 (2.5–3.9)	0.3	10.3 (8.6–12.3)	0.9	14.9 (12.9–17.2)	1.1
Race/ethnicity										
White	1.5 (0.9–2.3)	0.3	2.6 (2.1-3.3)	0.3	3.0 (2.4–3.7)	0.3	8.9 (7.2–11.1)	1.0	12.2 (10.1–14.5)	1.1
Black or African American	1.2 (0.7–2.0)	0.3	2.3 (1.3-4.2)	0.7	2.7 (1.9–3.7)	0.5	9.7 (7.9–11.9)	1.0	11.7 (9.5–14.3)	1.2
Hispanic or Latino	1.6 (1.1-2.3)	0.3	3.3 (2.3-4.6)	0.6	3.9 (2.9–5.2)	0.6	14.6 (12.2–17.4)	1.3	18.6 (15.9–21.5)	1.4
Other <sup>b</sup>			1.0(0.5-2.2)	0.4			6.5 (3.9–10.9)	1.7	11.9 (8.2–17.1)	2.2

Table 2.3aPercentage of middle school students who have ever used e-cigarettes<sup>a</sup>, by gender and race/ethnicity; National Youth Tobacco Survey<br/>(NYTS) 2011–2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011–2015).

*Notes:* CI = confidence interval; SE = standard error. An em dash (—) indicates that data are statistically unstable because of a relative standard error >40%. Wording of questions used to measure e-cigarette use varied from 2011 to 2015.

<sup>a</sup>Includes those who reported ever trying e-cigarettes.

<sup>b</sup>Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native.

	2011		2012		2013		2014		2015	
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	4.7 (3.8–5.7)	0.5	10.0 (8.6–11.6)	0.7	11.9 (10.5–13.5)	0.8	27.3 (24.4–30.5)	1.5	37.7 (35.3–40.2)	1.2
Gender										
Female	3.5 (2.7-4.4)	0.4	8.0 (6.7–9.5)	0.7	9.9 (8.3–11.7)	0.8	24.5 (21.4–27.9)	1.6	34.6 (31.9–37.3)	1.4
Male	5.9 (4.7-7.3)	0.7	12.0 (10.2–14.1)	1.0	13.8 (12.1–15.8)	0.9	30.1 (27.2–33.3)	1.5	40.7 (37.7-43.7)	1.5
Race/ethnicity										
White	5.8 (4.6-7.4)	0.7	12.3 (10.5–14.4)	1.0	14.7 (12.8–16.9)	1.0	29.7 (26.2–33.4)	1.8	38.0 (35.1-41.0)	1.5
Black or African American	1.5 (0.9–2.4)	0.4	4.0 (3.1–5.1)	0.5	4.9 (3.6–6.6)	0.7	17.6 (14.1–21.8)	1.9	28.5 (25.5–31.8)	1.6
Hispanic or Latino	3.7 (2.5–5.5)	0.7	8.5 (6.6–10.8)	1.0	10.4 (8.6–12.5)	1.0	29.9 (25.4–34.9)	2.4	43.0 (38.9–47.2)	2.1
Other <sup>b</sup>	2.8 (1.7-4.6)	0.7	6.0 (3.3-10.8)	1.8	8.3 (5.3–12.8)	1.8	18.7 (14–24.5)	2.6	37.4 (24.8–52.1)	7.0

Table 2.3bPercentage of high school students who have ever used e-cigarettes<sup>a</sup>, by gender and race/ethnicity; National Youth Tobacco Survey (NYTS)2011–2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011-2015).

*Notes:* CI = confidence interval; SE = standard error. Wording of questions used to measure e-cigarette use varied from 2011 to 2015.

<sup>a</sup>Includes those who reported ever trying e-cigarettes.

<sup>b</sup>Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native.

#### Past-30-Day Use

According to the NYTS, past-30-day use of e-cigarettes among students in grades 6-12 in the United States increased from 1.1% in 2011 to 2.1% in 2012, to 3.1% in 2013, to 9.3% in 2014, and then 11.3% in 2015 (CDC 2013b; Ambrose et al. 2014; Lippert 2015; CDC, unpublished data) (Figure 2.2). In 2015, approximately 3,038,000 middle and high school students were past-30-day users of e-cigarettes (CDC, unpublished data [NYTS 2015]). Across all years, past-30-day use of e-cigarettes was higher among high school students than middle school students (Figure 2.2; Tables 2.2a and 2.2b). In the MTF, estimates were stable from 2014 to 2015; among 8th, 10th, and 12th graders, past-30-day use went from 8.7% to 9.5%, 16.2% to 14%, and 17.1% to 16.2%, respectively (University of Michigan, Institute for Social Research, unpublished data). Differences in trends in past-30-day use between the NYTS and MTF may be due to differences in age groups (e.g., the NYTS includes all grades in middle school and all grades in high schools) and the way in which these measures were asked on the instruments (see Table A2.2-1 in Appendix 2.2).

Middle school students. Trends in past-30-day use of e-cigarettes among middle school students in the United States are presented in Table 2.2a and Figure 2.2, again using data from the 2011–2015 NYTS. The prevalence of such use in this population increased from 0.6% in 2011 to 1.1% in 2012 and 2013, to 3.9% in 2014, and then to 5.3% in 2015 (Table 2.2a) (CDC 2016). Between 2011 and 2015, there were no significant differences in prevalence by gender; unstable estimates (see notes to the table) precluded an examination of differences in past-30-day e-cigarette use by race/ethnicity for 2011-2013. In 2014, the prevalence of past-30-day use was higher among Hispanics (6.2%) than Whites (3.1%), a trend that was also seen in 2015 with 8.3% of Hispanics and 4.4% of Whites reporting past-30-day use. From 2011 to 2015, increases were seen among females (0.4% to 4.8%), males (0.7% to 4.8%)5.9%), Whites (0.6% to 4.4%), Hispanics (0.6% to 8.3%), and Blacks (1.1% in 2012 to 4.1%) (Table 2.2a) (CDC 2013b; CDC 2015c; CDC 2016).

**High school students.** Trends in past-30-day use of e-cigarettes among high school students are also presented in Table 2.2b and Figure 2.2, again using data from the 2011–2015 NYTS. The prevalence of such use in this population increased from 1.5% in 2011 to 2.8% in 2012,





*Source:* Centers for Disease Control and Prevention 2013a, 2014b; unpublished data (data: NYTS 2015). *Note:* In 2014, modifications were made to the e-cigarette measure to enhance its accuracy, which may limit the comparability of this estimate to those collected in previous years. The dotted lines from 2013 to 2015 represent these differences. <sup>a</sup>Includes those who responded "1 or more" for the following question: "*During the last 30 days, on how many days did you use electronic cigarettes or e-cigarettes?*" to 4.5% in 2013, to 13.4% in 2014, and then to 16% in 2015. From 2011 to 2013 and in 2015, males were significantly more likely each year to be past-30-day users than were females, but this difference was not significant in 2014 (Table 2.2b). From 2012 to 2015, Black high school students were less likely each year to be past-30-day users than were White or Hispanic high school students (Table 2.2b). During 2011–2015, large increases in past-30-day use were seen among females (0.7% to 12.8%), males (2.3% to 19%), Whites (1.8% to 17.2%), and Hispanics (1.3% to 16.4%) (Table 2.2b) (CDC 2013b, 2015c, 2016).

## **Young Adults**

#### **Current Prevalence**

According to the 2013–2014 National Adult Tobacco Survey (NATS), among young U.S. adults aged 18-24 years, the prevalence of ever use and current use of e-cigarettes was 35.8% and 13.6%, respectively (Table 2.4a). These percentages were significantly higher than for the same measures among adults aged 25 years or over (16.4% and 5.7%, respectively) (Table 2.4b). Among young adults, ever and current use were both higher among males than females and for Whites than in other racial/ethnic groups (Table 2.4a). By educational attainment, among young adults, both ever and current use were lowest among those with a college degree (Table 2.4a). Among all young adults, 2% reported using e-cigarettes "every day"; while among current users in this age group, 15% reported this frequency (Table 2.4a). Use of e-cigarettes "every day" among older adults (≥25 years of age) was 1.3% overall and 22% among current users (Table 2.4b). Among young adults, sociodemographic differences in frequent use followed the same pattern as those for ever and current use (Table 2.4a).

#### **Trends in Prevalence**

According to the Styles (also known as HealthStyles or Summer Styles) survey, the prevalence of ever use of e-cigarettes among young adults aged 18–24 years was 6.9% in 2011, 4.1% in 2012, 7.8% in 2013, and 14.3% in 2014, a year that saw the addition of other products to this measure, including e-hookahs and e-pipes or e-cigars (Figure 2.3). Although the prevalence of ever use of e-cigarettes among young adults remained consistent from 2010 to 2013, it doubled from 2013 to 2014, pre-sumably reflecting in part the addition of new products to the definition of e-cigarettes. In 2010, young adults (18–24 years) were more likely than older adults (25–44 and 45–64 years of age) to be ever users of e-cigarettes

(King et al. 2015). In 2014, ever use of e-cigarettes or similar products was statistically equivalent between young adults (18–24 years old) at 14.3%, adults 25–44 years old at 15%, and adults 45–64 years old at 11.9% (p >0.05) (CDC, unpublished data [Styles 2014]).

# E-Cigarette Use and Use of Other Tobacco Products

Evidence from both national and regional studies suggests that e-cigarette use is strongly associated with other tobacco use, especially the use of combustible products (including conventional cigarettes, cigar products, and hookahs). However, many youth and young adults use e-cigarettes exclusively, too. Estimates from crosssectional surveys such as the NYTS, MTF, and NATS are presented below for youth and young adults, followed by longitudinal studies that examine whether e-cigarette use precedes the use of other tobacco products (Leventhal et al. 2015; Primack et al. 2015; Barrington-Trimis et al. 2016; Unger et al. 2016; Wills et al. 2016).

#### **Cross-Sectional Studies**

#### Youth

Current prevalence. Using data from the 2015 MTF survey. Figure 2.4 and Table 2.5 show past-30-day use of e-cigarettes and conventional cigarettes, including both exclusive and combined use of these products, among 8th-, 10th-, and 12th-grade students. In the 2015 MTF survey, 10.4% of 12th graders used e-cigarettes only, 5.3% used conventional cigarettes only, and 5.8% used both e-cigarettes and conventional cigarettes at least once in the past 30 days (Table 2.5) (MTF 2015a,b). For all grade levels, exclusive use of e-cigarettes was more prevalent (6.8%, 10.4%, and 10.4% of 8th, 10th, and 12th graders, respectively) than exclusive use of conventional cigarettes alone (1.4%, 2.2%, 5.3%, respectively). In the 8th and 10th grades, the combined or dual use of e-cigarettes and conventional cigarettes was also more prevalent than the use of conventional cigarettes alone (2.4% vs. 1.4%, and 3.5% vs. 2.2% for 8th and 10th graders, respectively); while in the 12th grade, the prevalence in the two categories was nearly identical (5.8% vs. 5.3%). As grade level increases, the ratio of any e-cigarette use to any conventional cigarette use decreases. Among 12th graders, dual use of these products was higher among boys than girls and among Whites than Blacks. In all grade levels, dual use was much higher among students who planned to attend fewer than 4 years of college compared to those who planned to attend 4 years of college. No other sociodemographic

	Ever use <sup>a</sup>		Current use <sup>b</sup>		Frequent use <sup>c</sup> : Am current users	ong	Frequent use <sup>c</sup> : Among all young adults		
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	
Overall	35.8 (34.1–37.6)	0.9	13.6 (12.5–14.8)	0.6	15.0 (12.1–18.5)	1.6	2.0 (1.6–2.6)	0.2	
Gender									
Female	28.4 (26.1–30.8)	1.2	9.8 (8.3-11.5)	0.8	10.0 (6.5–15.1)	2.2	1.0 (0.6–1.5)	0.2	
Male	42.9 (40.4–45.3)	1.2	17.1 (15.4–19.0)	0.9	17.8 (13.9–22.5)	2.2	3.0 (2.3-4.0)	0.4	
Race/ethnicity									
White	39.7 (37.4–41.9)	1.2	16.1 (14.5–17.8)	0.9	15.3 (11.7-19.7)	2.0	2.5 (1.9-3.2)	0.4	
Black or African American	23.1 (19.0–27.8)	2.3	5.4 (3.7–7.9)	1.1	_		—		
Hispanic or Latino	36.6 (32.6–40.7)	2.1	13.4 (10.9–16.4)	1.4	12.0 (6.8-20.2)	3.3	1.6 (0.9–2.8)	0.5	
Other <sup>d</sup>	30.8 (25.8–36.3)	2.7	10.8 (8.1-14.2)	1.6	21.5 (11.6-36.4)	6.3	2.3 (1.2-4.4)	0.8	
Education									
< High school	44.8 (38.9–50.9)	3.1	15.2 (11.5–19.7)	2.1	9.8 (4.8–18.8)	3.4	1.5 (0.7–3.0)	0.5	
High school	39.4 (36.7–42.2)	1.4	14.9 (13.1–17.0)	1.0	17.6 (13.0-23.4)	2.6	2.6 (1.9-3.6)	0.4	
Some college <sup>e</sup>	34.3 (31.6–37.0)	1.4	14.7 (12.8–16.8)	1.0	14.8 (10.2–21.0)	2.7	2.2 (1.5-3.2)	0.4	
College degree <sup>f</sup>	16.9 (14.2–20.0)	1.5	4.5 (3.1–6.4)	0.8	—	—	—	_	

# Table 2.4a Percentage of young adults (18–24 years of age) who have used e-cigarettes, by gender, race/ethnicity, and education; National Adult Tobacco Survey (NATS) 2013–2014

Source: Centers for Disease Control and Prevention, unpublished data (data: NATS 2013–2014).

*Notes:* CI = confidence interval; SE = standard error. An em dash (—) indicates that data are statistically unstable because of a relative standard error >40%. <sup>a</sup>Includes those who reported they had heard of e-cigarettes and tried e-cigarettes.

<sup>b</sup>Includes those who reported they had heard of, tried, and used e-cigarettes every day, some days, or rarely at the time of the interview.

<sup>c</sup>Includes those who reported they had heard of e-cigarettes, tried e-cigarettes, and reported using e-cigarettes every day at the time of the interview.

<sup>d</sup>Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, non-Hispanic American Indian/Alaska Native, and multiracial.

eIncludes some college, no degree; associate's degree, academic program; associate's degree, unspecified; certificate; diploma; or associate's degree.

<sup>f</sup>Includes bachelor's degree, master's/professional school degree, or doctoral degree.

	Ever use <sup>a</sup>		Current use <sup>b</sup>		Frequent use <sup>c</sup> : Am current users	ong	Frequent use <sup>c</sup> : Among all adult	ts
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	16.4 (15.9–16.8)	0.2	5.7 (5.5-6.0)	0.1	22.0 (20.1–24.0)	1.0	1.3 (1.1–1.4)	0.1
Gender								
Female	14.7 (14.2–15.3)	0.3	5.0 (4.7–5.4)	0.2	20.6 (18.1–23.3)	1.3	1.0 (0.9–1.2)	0.1
Male	18.3 (17.6–18.9)	0.3	6.6 (6.1–7.0)	0.2	23.0 (20.2–25.9)	1.5	1.5 (1.3–1.7)	0.1
Race/ethnicity								
White	16.2 (15.8–16.7)	0.2	6.0 (5.7–6.4)	0.2	23.9 (21.7–26.3)	1.2	1.4 (1.3–1.6)	0.1
Black or African American	15.1 (13.9–16.5)	0.7	3.8 (3.2–4.5)	0.3	15.2 (10.2–22.2)	3.0	0.6 (0.4–0.9)	0.1
Hispanic or Latino	15.6 (14.3–17.0)	0.7	4.9 (4.1–5.8)	0.4	15.8 (10.4–23.4)	3.3	0.8 (0.5–1.2)	0.2
Other <sup>d</sup>	21.0 (19.2-22.9)	0.9	8.0 (6.7–9.4)	0.7	19.4 (14.0–26.2)	3.1	1.5 (1.1–2.1)	0.3
Education								
<high school<="" td=""><td>18.2 (16.8–19.7)</td><td>0.8</td><td>5.2 (4.4-6.1)</td><td>0.4</td><td>20.8 (15.2–27.7)</td><td>3.2</td><td>1.1 (0.8–1.5)</td><td>0.2</td></high>	18.2 (16.8–19.7)	0.8	5.2 (4.4-6.1)	0.4	20.8 (15.2–27.7)	3.2	1.1 (0.8–1.5)	0.2
High school	20.6 (19.7-21.6)	0.5	7.6 (7.0–8.3)	0.3	19.2 (16.1–22.7)	1.7	1.5 (1.2–1.8)	0.1
Some college <sup>e</sup>	19.7 (18.9–20.5)	0.4	7.4 (6.8–7.9)	0.3	24.5 (21.4–27.8)	1.6	1.8 (1.6–2.1)	0.1
College degree <sup>f</sup>	8.7 (8.2–9.1)	0.2	2.8 (2.5-3.1)	0.1	22.0 (18.1-26.4)	2.1	0.6 (0.5-0.8)	0.1

Table 2.4b Percentage of adults (≥25 years of age) who have used e-cigarettes, by gender, race/ethnicity, and education; National Adult Tobacco Survey (NATS) 2013–2014

Source: Centers for Disease Control and Prevention, unpublished data (data: NATS 2013-2014).

*Note:* **CI** = confidence interval; **SE** = standard error.

<sup>a</sup>Includes those who reported they had heard of and tried e-cigarettes.

<sup>b</sup>Includes those who reported they had heard, tried, and used e-cigarettes every day, some days, or rarely at the time of the interview.

<sup>c</sup>Includes those who reported they had heard of, tried, and reported using e-cigarettes every day at the time of the interview.

<sup>d</sup>Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, non-Hispanic American Indian/Alaska Native, and multiracial.

eIncludes some college, no degree; associate's degree, academic program; associate's degree, unspecified; certificate; diploma; or associate's degree.

<sup>f</sup>Includes bachelor's degree, master's/professional school degree, or doctoral degree.



Figure 2.3 Trends in ever e-cigarette use<sup>a</sup> among U.S. adults by age group; Styles 2010–2014

*Source:* King et al. (2015) (data: HealthStyles 2010–2013); Centers for Disease Control and Prevention, unpublished data (data: HealthStyles 2014).

*Note:* In 2014, modifications were made to the e-cigarette measure to enhance its accuracy, which may limit the comparability of this estimate to those collected in previous years. The dotted lines from 2013 to 2014 represent these differences. <sup>a</sup>Includes those who responded "electronic cigarettes or e-cigarettes" to the following question, "*Have you ever tried any of the following products, even just one time? Electronic cigarettes or e-cigarettes, such as Ruyan or NJOY?*"





*Source:* University of Michigan, Institute for Social Research, unpublished data (data: MTF 2015). *Note:* Questions on e-cigarette use were asked on four of six questionnaire forms. Data presented here are based on those four forms only.

		8th g	rade			10th grade				12th grade			
	Neither: % (95% CI)	E-cigarettes only: % (95% CI)	Cigarettes only: % (95% CI)	Both: % (95% CI)	Neither: % (95% CI)	E-cigarettes only: % (95% CI)	Cigarettes only: % (95% CI)	Both: % (95% CI)	Neither: % (95% CI)	E-cigarettes only: % (95% CI)	Cigarettes only: % (95% CI)	Both: % (95% CI)	
Overall	89.4	6.8	1.4	2.4	83.9	10.4	2.2	3.5	78.5	10.4	5.3	5.8	
	(88.4–90.5)	(5.8–7.8)	(0.9–1.8)	(1.9–2.9)	(81.9–85.9)	(9.0–11.8)	(1.7–2.7)	(2.8–4.3)	(76.7–80.3)	(9.1–11.8)	(4.6–6.0)	(5.0–6.6)	
Gender													
Female	90.2	6.2	1.4	2.2	85.6	8.6	2.4	3.4	84.4	7.1	4.7	3.8	
	(88.7–91.7)	(4.9–7.5)	(0.7-2.0)	(1.6-2.9)	(83.6–87.6)	(7.2–10.1)	(1.6–3.1)	(2.5–4.3)	(82.8–86.0)	(6.2–8.0)	(3.6–5.7)	(3.1–4.6)	
Male	88.9	7.2	1.4	2.5	82.2	12.2	2.0	3.6	72.9	14.1	5.6	7.5	
	(87.3–90.4)	(6.0–8.5)	(0.7-2.0)	(1.7–3.3)	(79.6–84.7)	(10.2–14.2)	(1.3–2.7)	(2.6–4.7)	(70.2–75.6)	(11.8–16.3)	(4.6–6.6)	(6.1–8.9)	
Race/ ethnicity													
White	90.1	6.2	1.2	2.6	82.1	11.2	2.3	4.4	75.2	12.0	5.8	7.1	
	(88.6–91.6)	(4.9–7.4)	(0.6–1.8)	(1.7-3.4)	(79.5–84.7)	(9.2–13.2)	(1.6–2.9)	(3.4–5.4)	(72.7–77.7)	(10.4–13.6)	(4.7–6.9)	(5.9–8.3)	
African	91.2	5.3	2.1	1.5	89.9	6.6	1.8	1.7	87.7	5.2	5.1	2.0	
American	(88.2–94.1)	(2.7–7.8)	(0.6–3.7)	(0.0-2.9)	(85.7–94.1)	(3.6–9.5)	(0.4–3.1)	(0.4-3.1)	(85.1–90.3)	(3.8–6.6)	(3.3–6.8)	(1.1–3.0)	
Hispanic	88.7	8.2	0.9	2.2	84.6	10.5	2.4	2.5	80.9	10.3	4.4	4.5	
	(85.8–91.5)	(6.1–10.4)	(0.2–1.6)	(1.2–3.2)	(81.5–87.6)	(7.6–13.4)	(0.9-4.0)	(0.8–4.2)	(78.0–83.7)	(8.0–12.5)	(3.2–5.5)	(3.1–6.0)	
College plans													
None or	76.8	10.1	4.9	8.3	66.3	15.4	7.0	11.3	65.1	13.0	10.2	11.7	
<4 years	(71.0–82.5)	(6.1 $-14.0$ )	(1.7–8.1)	(4.8–11.8)	(61.1–71.5)	(11.3–19.4)	(3.8–10.2)	(7.6–15.1)	(61.2–68.9)	(9.7–16.3)	(8.2–12.3)	(9.5–13.9)	
Complete	90.5	6.5	1.1	2.0	85.7	9.8	1.7	2.8	81.6	9.9	4.1	4.5	
4 years	(89.4–91.5)	(5.5–7.4)	(0.7-1.5)	(1.5-2.5)	(83.6–87.7)	(8.3–11.4)	(1.3–2.2)	(2.1–3.5)	(79.9–83.2)	(8.6–11.1)	(3.4–4.8)	(3.8–5.2)	

Table 2.5Percentage of students in grades 8, 10, and 12 who used e-cigarettes, cigarettes, or both products in the past 30 days, by sociodemographic characteristics;<br/>Monitoring the Future (MTF) 2015

		8th g	irade			10th	grade		12th grade				
	Neither: % (95% CI)	E-cigarettes only: % (95% CI)	Cigarettes only: % (95% CI)	Both: % (95% CI)	Neither: % (95% CI)	E-cigarettes only: % (95% CI)	Cigarettes only: % (95% CI)	Both: % (95% CI)	Neither: % (95% CI)	E-cigarettes only: % (95% CI)	Cigarettes only: % (95% CI)	Both: % (95% CI)	
Parental education <sup>a</sup>													
1–2 (Low)	88.1	5.9	1.8	4.3	77.2	12.6	4.8	5.4	77.3	10.1	7.9	4.7	
	(83.9–92.2)	(3.3–8.4)	(0.3–3.2)	(2.1–6.6)	(72.0–82.4)	(9.0–16.2)	(1.5–8.0)	(3.1–7.8)	(73.4–81.2)	(7.3–13.0)	(5.4–10.4)	(3.1–6.3)	
2.5–3	86.2	9.4	1.8	2.6	81.7	10.6	2.5	5.2	75.2	11.1	7.2	6.5	
	(83.3–89.1)	(6.7–12.1)	(0.6–3.1)	(1.2–3.9)	(78.3–85.2)	(8.1–13.0)	(1.3–3.7)	(3.2–7.1)	(72.4–78.1)	(9.0–13.3)	(5.5–8.8)	(5.0–7.9)	
3.5–4	89.6	7.3	1.3	0.8	83.5	10.0	2.8	3.7	78.7	9.9	4.6	6.8	
	(87.5–91.8)	(5.5–9.2)	(0.3–2.3)	(1.7-2.7)	(80.3–86.7)	(7.7–12.3)	(1.7–3.9)	(2.5–5.0)	(75.9–81.5)	(7.9–11.8)	(3.6–5.6)	(5.3–8.4)	
4.5–5	91.0	6.2	1.3	1.5	86.1	9.7	1.4	2.9	78.6	11.2	4.4	5.8	
	(89.1–92.8)	(4.5–7.9)	(0.4-2.1)	(0.6-2.5)	(83.5–88.8)	(7.5–11.8)	(0.7-2.0)	(1.7-4.1)	(75.7–81.5)	(9.1–13.2)	(3.3–5.5)	(4.4–7.2)	
5.5–6	91.9	5.2	1.0	1.9	87.6	9.2	1.0	2.2	82.7	10.4	3.2	3.7	
(High)	(89.4–94.5)	(3.3–7.0)	(0.0–2.1)	(0.4 $-3.4$ )	(83.6–91.6)	(6.3–12.2)	(0.2–1.8)	(0.7–3.7)	(79.7–85.7)	(8.1–12.7)	(2.1–4.3)	(2.2–5.2)	

Source: University of Michigan, Institute for Social Research, unpublished data (data: MTF 2015).

*Notes*: Questions on e-cigarette use were asked on four of six questionnaire forms. Data presented here are based on those four forms only.

<sup>a</sup>Parental education is an average score of mother's education and father's education.

differences were observed among dual users (Table 2.5). For 10th and 12th graders, exclusive use of e-cigarettes was higher among boys than girls.

Tables 2.6a and 2.6b present data from the 2015 NYTS for middle and high school students. These data represent the percentages of tobacco users who were either lifetime or past-30-day users of e-cigarettes, by tobacco-use category (e.g., cigarettes only, other combustibles only). In these data, a correlation among the increasing levels of tobacco use, increasing complexity of poly-tobacco use, and e-cigarette use is apparent, with ever use and past-30-day use of e-cigarettes emerging as least prevalent among never tobacco users and most prevalent among the highest category of poly-tobacco users (conventional cigarettes plus other combustibles and noncombustibles) for both age groups. As an example, past-30-day e-cigarette use was rare (2.8%) among middle school students who did not use other tobacco products in that time period. However, using the standard of past-30-day-use for each category, the level of such use grew from 44.9% among those who had used cigarettes only; to 61.3% among those who had used cigarettes and other combustibles only; to 74.6% among those who had used cigarettes, other combustibles, and other noncombustibles only (Table 2.6a). These data are consistent with results from the 2013-2014 PATH study (n = 13,651 youth, 12-17 years old), which showed that 52.6% of past-30-day tobacco users also used e-cigarettes (Kasza et al. 2016).

According to the 2015 NYTS, among high school students, past-30-day use of e-cigarettes was also rare (3.4%) among never users of other tobacco products (Table 2.6b). In contrast, 18.4% of ever smokers of cigarettes only; 36.3% of ever smokers of cigarettes and other combustible products only; and 55% of ever users of cigarettes, other combustibles, and other noncombustible products only had used e-cigarettes in the past 30 days. Although the survey found that just 7.3% of high school students were past-30-day exclusive users of e-cigarettes, many types of tobacco product users in the past 30 days were found to have used e-cigarettes in that period: 41.1% of cigaretteonly smokers; 58.8% of cigarette smokers and smokers of other combustible tobacco products only; and 77% of cigarette, other combustible, and noncombustible product users only. Similarly, 27.4% of high school students who had not used tobacco products in the past 30 days had ever tried e-cigarettes, as had 80.8% of past-30-day cigaretteonly smokers and 95.5% of those who had used cigarettes, other combustible, and other noncombustible tobacco products only (Table 2.6b).

Figure 2.5 presents data from the 2015 NYTS on the prevalence of past-30-day use of various tobacco products among middle and high school students. Although the overall level of tobacco use was lower in middle school,

the patterns of poly-tobacco use were similar between the two groups, albeit with a larger proportion of poly-tobacco use in high school. An estimated 6.6% of high school students and 1.8% of middle school students were dual users of combustible tobacco products and e-cigarettes in 2015. Combined use of combustible tobacco, noncombustible tobacco, and e-cigarettes in the past 30 days was rare, with this pattern found for just 0.7% of middle school and 2.6% of high school students in 2015 (Figure 2.5). Longitudinal data are needed to follow individuals over time, ideally for several years, to more precisely examine both the trajectories into and out of cigarette and e-cigarette use and to determine if dual use is a steady state or a pathway-to-persistent-use-of-combustible-tobacco state (Cobb et al. 2015). The small number of such studies that currently exist are discussed below.

**Trends in prevalence.** Tables 2.7a and 2.7b and Figures 2.6 and 2.7 present patterns of ever e-cigarette and poly-tobacco use over time, using the NYTS data from 2011 to 2015. Among both middle school and high school students, the exclusive use of combustible products declined over time, while both the exclusive use of e-cigarettes and the dual use of e-cigarettes with combustible products increased, especially from 2013 to 2015.

Middle school students. In 2011, an estimated 21% of middle school students had ever used some form of tobacco in their lifetimes, compared to just 1.4% of middle school students who had ever used e-cigarettes (Table 2.7a). By 2015, 13.5% of middle school students had ever tried a tobacco product, while 3.5% had tried e-cigarettes. In that year, 4.5% of middle school students were ever users of e-cigarettes only; 6.2% were ever users of e-cigarettes and combustible products only; and 2.2% were ever users of combustible products, noncombustible products, and e-cigarettes. This means that 70% of middle school students who had ever used e-cigarettes had also experimented with a combustible tobacco product, although which came first is unknown. In 2015, for past-30-day use, exclusive e-cigarette use was 2.6% and exclusive combustible tobacco use was 1.2%. Also in 2015, the prevalence of past-30-day dual use of e-cigarettes and any other combustible or noncombustible product was similar to those estimates, at 2.7% (1.8% for e-cigarettes plus combustibles only, 0.2% for noncombustibles and e-cigarettes only, and 0.7% for e-cigarettes plus combustibles and noncombustibles only). In 2015, ever use of cigarettes in combination with combustibles (6.2%) was equal to or higher than ever use of e-cigarettes only (4.5%) or combustibles only (4.4%) (Table 2.7a).

*High school students*. In 2011, an estimated 47.2% of high school students had ever used other tobacco products in their lifetimes, compared to 4.7% who had ever used e-cigarettes (Table 2.7b). By 2015, 50.4% of high

		Lifetime e-cigaret	te use <sup>a</sup>	Past-30-day e-cigarette us	y se <sup>b</sup>
	N <sup>c</sup>	% (95% CI)	SE	% (95% CI)	SE
Ever other tobacco use <sup>d</sup> (n = 1,757)	8,162				
Never	6,942	5.3 (4.5-6.2)	0.4	1.6 (1.3-2.0)	0.2
Cigarettes only	343	54.3 (46.7-61.7)	3.8	20.8 (15.7-27.0)	2.8
Other combustibles only	261	59.0 (51.5-66.1)	3.7	24.8 (19.0-31.7)	3.2
Noncombustibles only	89	30.7 (23.2–39.3)	4.1		_
Cigarettes + other combustibles only	300	70.6 (62.9–77.3)	3.6	35.0 (27.5–43.3)	4.0
Cigarettes + noncombustibles only	67	69.5 (54.5-81.3)	6.9	21.7 (12.7-34.6)	5.5
Other combustibles + noncombustibles only	27	80.3 (56.1-92.9)	9.2	39.4 (20.3-62.3)	11.2
Cigarettes + other combustibles + noncombustibles only	133	84.1 (73.3–91.1)	4.4	45.0 (34.7–55.7)	5.3
Past-30-day other tobacco use <sup><math>e</math></sup> (n = 417)	8,145				
No	7,728	10.5 (9.1–12.0)	0.7	2.8 (2.3-3.4)	0.3
Cigarettes only	70	80.6 (68.3-89.0)	5.2	44.9 (32.0–58.6)	6.8
Other combustibles only	153	82.8 (74.0-89.1)	3.8	69.2 (59.1-77.8)	4.7
Noncombustibles only	50	49.0 (34.9-63.3)	7.3	23.1 (12.7-38.2)	6.4
Cigarettes + other combustibles only	63	77.3 (58.8–89.0)	7.6	61.3 (43.9–76.2)	8.4
Cigarettes + noncombustibles only	18	87.2 (65.2–96.1)	7.2	67.8 (40.0-87.0)	12.6
Other combustibles + noncombustibles only	20	87.5 (63.2–96.6)	7.7	64.8 (42.2-82.3)	10.6
Cigarettes + other combustibles + noncombustibles only	43	85.8 (67.5–94.6)	6.5	74.6 (43.4–91.8)	12.7

# Table 2.6aLifetime and past-30-day e-cigarette use among U.S. middle school students, by other tobacco productuse; National Youth Tobacco Survey (NYTS) 2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

*Notes:* **CI** = confidence interval; **SE** = standard error. *Cigarettes Only* includes those who reported trying cigarettes but not any other tobacco product. *Other combustibles* includes cigars, pipes, and hookah or bidis. *Noncombustibles* includes smokeless tobacco, dissolvables, or snus. *Other Combustibles Only* includes those who reported trying other combustibles but not cigarettes nor noncombustibles. *Noncombustibles Only* includes those who reported trying cigarettes and other combustibles only includes those who reported trying cigarettes and other combustibles but not noncombustibles. *Cigarettes and Other Combustibles Only* includes those who reported trying cigarettes and other combustibles but not noncombustibles. *Cigarettes and Noncombustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Other Combustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Cigarettes Combustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Cigarettes Combustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Cigarettes Combustibles Only* includes those who reported trying other combustibles and noncombustibles but not cigarettes. *Cigarettes, Other Combustibles, and Noncombustibles* includes those who reported trying a product from each group.

<sup>a</sup>Includes those who responded "yes" to the following question, "Have you ever used an electronic cigarette or e-cigarette, even once or twice?"

<sup>b</sup>Includes those who responded "1 or more days" to the following question, "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?"

<sup>c</sup>Includes all respondents categorized into each group. It does not exclude those missing for e-cigarette status.

<sup>d</sup>Includes those who reported trying at least one of the following products (e-*cigarettes not included in the definitions*): *Cigarettes Only; Other Combustibles Only; Noncombustibles Only; Cigarettes and Other Combustibles Only; Cigarettes and Noncombustibles Only; Other Combustibles and Noncombustibles Only;* and *Cigarettes, Other Combustibles, and Noncombustibles.* 

<sup>e</sup>Includes those who reported using at least one of the following products on 1 of the past 30 days (*e-cigarettes were not included in the definitions*): Cigarettes Only; Other Combustibles Only; Noncombustibles Only; Cigarettes and Other Combustibles Only; Cigarettes and Noncombustibles Only; and Cigarettes, Other Combustibles, and Noncombustibles.

		Lifetime e-cigaret	te use <sup>a</sup>	Past-30-day e-cigarette us	y se <sup>b</sup>
	N <sup>c</sup>	% (95% CI)	SE	% (95% CI)	SE
Ever other tobacco use <sup>d</sup> (n = 5,094)	9,422				
Never	5,326	13.1 (11.7–14.8)	0.8	3.4 (2.5-4.4)	0.5
Cigarettes only	675	54.7 (48.5-60.6)	3.0	18.4 (13.7–24.4)	2.7
Other combustibles only	947	60.0 (54.4-65.3)	2.7	21.7 (18.0-25.9)	2.0
Noncombustibles only	137	39.8 (30.8-49.6)	4.7	20.2 (12.5-31.0)	4.6
Cigarettes + other combustibles only	1,307	79.6 (74.7-83.8)	2.3	36.3 (31.5-41.3)	2.5
Cigarettes + noncombustibles only	131	61.5 (48.7-72.9)	6.2	25.5 (18.5-34.0)	3.9
Other combustibles + noncombustibles only	171	69.5(57.1-79.6)	5.7	35.3 (26.1-45.8)	5.0
Cigarettes + other combustibles + noncombustibles only	728	89.2 (82.6–93.5)	2.7	55.0 (47.5–62.4)	3.8
Past-30-day other tobacco use <sup><math>e</math></sup> (n = 2,389)	9,416				
No	7,542	27.4 (25.2–29.7)	1.1	7.3 (6.1–8.8)	0.7
Cigarettes only	288	80.8 (74.2-86.0)	2.9	41.1 (32.2-50.6)	4.7
Other combustibles only	701	77.2 (71.2-82.3)	2.8	50.4 (45.0-55.8)	2.7
Noncombustibles only	192	69.6 (54.6-81.4)	6.8	31.2 (23.0-40.9)	4.5
Cigarettes + other combustibles only	353	87.1 (77.5–93.0)	3.8	58.8 (49.1-67.8)	4.7
Cigarettes + noncombustibles only	62	76.9 (59.8-88.2)	7.2	50.8 (27.9-73.5)	12.3
Other combustibles + noncombustibles only	108	88.7 (78.8–94.3)	3.8	74.1 (61.3-83.9)	5.7
Cigarettes + other combustibles + noncombustibles only	170	95.9 (87.2–98.8)	2.4	77.0 (66.6–84.8)	4.6

# Table 2.6bLifetime and past-30-day e-cigarette use among U.S. high school students, by other tobacco product use;National Youth Tobacco Survey (NYTS) 2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

*Notes:* **CI** = confidence interval; **SE** = standard error. *Cigarettes Only* includes those who reported trying cigarettes but not any other tobacco product. *Other combustibles* includes cigars, pipes, and hookah or bidis. *Noncombustibles* includes smokeless tobacco, dissolvables, or snus. *Other Combustibles Only* includes those who reported trying other combustibles but not cigarettes nor noncombustibles. *Noncombustibles Only* includes those who reported trying cigarettes and *Other Combustibles Only* includes those who reported trying cigarettes and other combustibles but not noncombustibles. *Cigarettes and Other Combustibles Only* includes those who reported trying cigarettes and other combustibles but not noncombustibles. *Cigarettes and Noncombustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Other Combustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Cigarettes Combustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Cigarettes Combustibles Only* includes those who reported trying cigarettes and noncombustibles but not other combustibles. *Cigarettes Combustibles Only* includes those who reported trying other combustibles and noncombustibles but not cigarettes. *Cigarettes, Other Combustibles, and Noncombustibles* includes those who reported trying a product from each group.

<sup>a</sup>Includes those who responded "yes" to the following question, "Have you ever used an electronic cigarette or e-cigarette, even once or twice?"

<sup>b</sup>Includes those who responded "1 or more days" to the following question, "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?"

<sup>c</sup>Includes all respondents categorized into each group. It does not exclude those missing for e-cigarette status.

<sup>d</sup>Includes those who reported trying at least one of the following products (e-*cigarettes not included in the definitions*): *Cigarettes Only; Other Combustibles Only; Noncombustibles Only; Cigarettes and Other Combustibles Only; Cigarettes and Noncombustibles Only; Other Combustibles and Noncombustibles Only;* and *Cigarettes, Other Combustibles, and Noncombustibles.* 

<sup>e</sup>Includes those who reported using at least one of the following products on 1 of the past 30 days (*e-cigarettes were not included in the definitions*): Cigarettes Only; Other Combustibles Only; Noncombustibles Only; Cigarettes and Other Combustibles Only; Cigarettes and Noncombustibles Only; and Cigarettes, Other Combustibles, and Noncombustibles.





Source: Centers for Disease Control and Prevention 2015b; unpublished data (data: NYTS 2015).

<sup>a</sup>Includes exclusive use of e-cigarettes. It does not include use of any other product.

<sup>b</sup>Includes exclusive use of smokeless tobacco, snus, and/or dissolvable tobacco. It does not include use of combustible products or e-cigarettes.

<sup>c</sup>Includes the use of cigarettes, cigars, pipes, bidis, kreteks, and/or hookahs. It includes participants who reported use of combustible and noncombustible products but not e-cigarettes.

	2011		2012		2013		2014		2015	
Characteristic	% (95% CI)	SE								
Any lifetime <sup>a</sup> tobacco use	21.0 (19.2-22.9)	0.9	17.9 (15.9–20.0)	1.0	17.6 (15.6–19.9)	1.1	19.1 (16.7-21.8)	1.3	19.4 (17.0-22.0)	1.2
Any lifetime e-cigarette use <sup>b</sup>	1.4 (1.0-2.0)	0.2	2.7 (2.2-3.2)	0.2	3.0 (2.5-3.5)	0.2	10.1 (8.5–11.9)	0.8	13.5 (11.8–15.5)	0.9
Ever tobacco use <sup>c</sup>										
E-cigarettes only	0.3 (0.2–0.6)	0.1	0.4 (0.3-0.5)	0.1	0.5 (0.3-0.9)	0.1	2.9 (2.3-3.5)	0.3	4.5 (3.9–5.2)	0.3
Combustibles and e-cigarettes only	0.4 (0.3–0.6)	0.1	1.1 (0.9–1.4)	0.1	1.5 (1.1–1.9)	0.2	4.5 (3.9–5.3)	0.4	6.2 (5.4–7.2)	0.5
Noncombustibles and e-cigarettes only	ND	ND				_	0.3 (0.1–0.6)	0.1	0.4(0.2-0.7)	0.1
Combustibles, noncombustibles, and e-cigarettes	0.5 (0.3–0.9)	0.1	1.1 (0.8–1.4)	0.1	0.8 (0.6–1.2)	0.1	2.2 (1.45–3.2)	0.4	2.2 (1.7–2.9)	0.3
Combustibles only	13.9 (12.5–15.4)	0.7	10.7 (9.5–12.1)	0.7	11.6 (10.1–13.3)	0.8	6.9 (5.6-8.4)	0.7	4.4 (3.7–5.2)	0.4
Noncombustibles only	1.5 (1.1–1.9)	0.2	1.2(0.9-1.6)	0.2	0.8 (0.6–1.1)	0.1	0.8 (0.5–1.2)	0.2	1.0(0.7-1.4)	0.2
Combustibles and noncombustibles only	4.3 (3.5–5.1)	0.4	3.4 (2.8–4.0)	0.3	2.4 (1.8–3.2)	0.3	1.5 (1.1–2.1)	0.2	0.7 (0.4–1.1)	0.2
Any past-30-day tobacco use $d$	7.5 (6.4-8.8)	0.6	6.7 (5.8–7.7)	0.5	6.5 (5.43–7.8)	0.6	7.7 (6.7-8.9)	0.6	7.4 (6.3-8.7)	0.6
Any past-30-day e-cigarette use <sup>e</sup>	0.6 (0.4–0.9)	0.1	1.1 (0.9 - 1.5)	0.1	1.1 (0.8–1.5)	0.2	3.9 (3.0-5.0)	0.5	5.3 (4.6-6.2)	0.4
Past-30-day tobacco use										
E-cigarettes only <sup>f</sup>	0.2 (0.1-0.4)	0.1	0.3 (0.2–0.4)	0.1	0.4 (0.2 - 0.8)	0.1	1.9(1.4-2.5)	0.3	2.6 (2.2–3.2)	0.3
Combustibles and e-cigarettes only	0.1 (0.1-0.3)	0.0	0.5(0.3-0.7)	0.1	0.4 (0.3–0.6)	0.1	1.3(1.0-1.7)	0.2	1.8 (1.4–2.2)	0.2
Noncombustibles and e-cigarettes only		—		_		_	0.1 (0.1-0.2)	0.0	0.2 (0.1 - 0.3)	0.0
Combustibles, noncombustibles, and e-cigarettes	0.2 (0.1–0.3)	0.1	0.4 (0.2–0.5)	0.1	0.2 (0.1–0.4)	0.1	0.6 (0.4–0.8)	0.1	0.7 (0.4–1.1)	0.1
Combustibles only	4.5 (3.7–5.5)	0.4	3.7 (3.2-4.3)	0.3	4.0 (3.3-4.9)	0.4	2.7 (2.1-3.3)	0.3	1.2 (0.9–1.6)	0.2
Noncombustibles only	0.9 (0.6–1.3)	0.2	0.7 (0.5–1.0)	0.1	0.6 (0.3-0.9)	0.2	0.7 (0.4–1.2)	0.2	0.6 (0.3–1.2)	0.2
Combustibles and noncombustibles only	1.6 (1.3–2.0)	0.2	1.2 (0.9–1.5)	0.2	0.8 (0.5–1.1)	0.1	0.5 (0.4–0.8)	0.1	0.3 (0.1–0.6)	0.1

Table 2.7a Percentage of middle school students who have ever used tobacco, by type of product; National Youth Tobacco Survey (NYTS) 2011-2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011–2015).

*Notes:* **CI** = confidence interval; **ND** = no data for this cell; **SE** = standard error. An em dash (—) indicates that data are statistically unstable because of a relative standard error >40%. Wording of questions used to measure e-cigarette use varied from 2011 to 2015. Cigarettes were not included in this analysis. *Combustibles* includes cigars, pipes, hookahs, or bidis. *Noncombustibles* includes smokeless tobacco, dissolvables, or snus. *Combustibles and E-Cigarettes Only* includes those who reported trying e-cigarettes and combustibles but not noncombustibles. *Noncombustibles and E-Cigarettes Only* includes those who reported trying e-cigarettes and noncombustibles.

## Table 2.7a Continued

*Combustibles, Noncombustibles, and E-Cigarettes* includes those who reported trying e-cigarettes, noncombustibles, and combustibles. *Combustibles Only* includes those who reported trying combustibles but not noncombustibles or e-cigarettes. *Noncombustibles Only* includes those who reported trying noncombustibles but not combustibles or e-cigarettes. *Combustibles and Noncombustibles Only* includes those who reported trying noncombustibles but not combustibles or e-cigarettes.

<sup>a</sup>Includes those who reported having tried at least one tobacco product in their lives (e-cigarettes, combustibles, and noncombustibles).

<sup>b</sup>Includes those who reported having tried e-cigarettes in their lives.

<sup>c</sup>Includes those who reported having tried at least one tobacco product in their lives.

<sup>d</sup>Includes those who reported using at least one other tobacco product on at least 1 of the past 30 days.

<sup>e</sup>Includes those who reported using e-cigarettes on at least 1 of the past 30 days.

<sup>f</sup>Includes those who reported using e-cigarettes only on at least 1 of the past 30 days.

	2011		2012		2013		2014		2015	
Characteristic	% (95% CI)	SE								
Any lifetime <sup>a</sup> tobacco use	47.2 (44.0-50.4)	1.6	45.7 (43.0-48.5)	1.4	46.0 (43.3-48.7)	1.4	47.1 (44.5–49.8)	1.3	50.4 (47.9-52.9)	1.3
Any lifetime e-cigarette use <sup>b</sup>	4.7 (3.8–5.7)	0.5	10.0 (8.6-11.6)	0.7	11.9 (10.5–13.5)	0.8	27.3 (24.4-30.5)	1.5	37.7 (35.3-40.2)	1.2
Ever tobacco use <sup>c</sup>										
E-cigarettes only	0.1 (0.1-0.2)	0.0	0.2 (0.2–0.4)	0.0	0.3 (0.2–0.6)	0.1	3.7 (2.9-4.8)	0.5	7.4 (6.6-8.4)	0.5
Combustibles and e-cigarettes only	1.6 (1.3–2.0)	0.2	4.2 (3.5–5.0)	0.4	6.0 (5.2–6.9)	0.4	14.5 (13.2–16.0)	0.7	20.0 (18.6–21.6)	0.8
Noncombustibles and e-cigarettes only	—		—	_	—		0.3 (0.1–0.4)	0.1	0.6 (0.4–0.8)	0.1
Combustibles, noncombustibles, and e-cigarettes	2.8 (2.2–3.6)	0.4	5.2 (4.3-6.2)	0.5	5.2 (4.2–6.3)	0.5	8.3 (7.0–9.7)	0.7	9.1 (7.6–10.9)	0.8
Combustibles only	29.1 (27.3-30.9)	0.9	25.1 (23.1-27.1)	1.0	25.2 (22.7-27.8)	1.3	15.8 (14.3–17.5)	0.8	10.2 (8.8–11.8)	0.8
Noncombustibles only	1.8 (1.3–2.4)	0.3	1.3 (1.0–1.8)	0.2	1.5(1.1-1.9)	0.2	1.2(0.9-1.7)	0.2	0.9(0.7-1.2)	0.1
Combustibles and noncombustibles only	11.8 (9.8–13.9)	1.1	9.7 (8.6–10.9)	0.6	7.8 (6.6–9.3)	0.7	3.3 (2.6–4.2)	0.4	2.2 (1.6–3.0)	0.4
Any past-30-day tobacco use <sup>d</sup>	24.0 (22.0-26.5)	1.2	23 (21.5–25.2)	0.9	22.9 (21.1-24.9)	0.9	24.6 (22.6–26.7)	1.0	25.3 (23.1-27.6)	1.1
Any past-30-day e-cigarette use <sup>e</sup>	1.5 (1.2–2.0)	0.2	2.8 (2.3-3.5)	0.3	4.5 (3.8–5.3)	0.4	13.4 (11.2–16.1)	1.2	16.0 (14.1–18.0)	1.0
Past-30-day tobacco use										
E-cigarettes only <sup>f</sup>	0.1 (0.1-0.2)	0.0	0.3 (0.2–0.4)	0.1	0.7 (0.5 - 0.9)	0.1	4.4 (3.4–5.7)	0.6	5.9 (4.9–7.0)	0.5
Combustibles and e-cigarettes only	0.7 (0.5–0.9)	0.1	1.4 (1.1–1.8)	0.2	2.6 (2.1–3.2)	0.3	5.8 (4.9-6.8)	0.5	6.6 (5.7–7.7)	0.5
Noncombustibles and e-cigarettes only	ND	ND	—	—	—	—	0.6 (0.4–0.8)	0.1	0.7 (0.5–0.9)	0.1
Combustibles, noncombustibles, and e-cigarettes	0.6 (0.4–0.9)	0.1	1.1 (0.8–1.4)	0.1	1.1 (0.8–1.4)	0.1	2.5 (2.0–3.2)	0.3	2.6 (2.1–3.3)	0.3
Combustibles only	15.6 (14.5–16.8)	0.6	14.4 (13.2–15.6)	0.6	13.5 (12.4–14.8)	0.6	8.1 (7.2–9.2)	0.5	6.8 (5.9–7.8)	0.5
Noncombustibles only	2.3 (1.7-3.0)	0.3	1.9 (1.4–2.4)	0.2	1.6 (1.2–2.2)	0.3	1.5 (1.1-2.0)	0.2	1.5 (1.0-2.2)	0.3
Combustibles and noncombustibles only	4.9 (4.0-6.1)	0.5	4.3 (3.7–5.2)	0.4	3.4 (2.7-4.3)	0.4	1.6 (1.2–2.2)	0.2	1.1 (0.7–1.8)	0.2

Table 2.7b Percentage of high school students who have ever used tobacco, by type of product; National Youth Tobacco Survey (NYTS) 2011-2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011-2015).

## Table 2.7b Continued

*Notes:* **CI** = confidence interval; **ND** = no data for this cell; **SE** = standard error. An em dash (—) indicates that data are statistically unstable because of a relative standard error >40%. Wording of questions used to measure e-cigarette use varied from 2011 to 2015. Cigarettes were not included in this analysis. *Combustibles* includes cigars, pipes, hookahs, or bidis. *Noncombustibles* includes smokeless tobacco, dissolvables, or snus. *Combustibles and E-Cigarettes Only* includes those who reported trying e-cigarettes and combustibles. *Noncombustibles and E-Cigarettes Only* includes those who reported trying e-cigarettes and noncombustibles. *Combustibles, and E-Cigarettes* includes those who reported trying e-cigarettes, noncombustibles, and combustibles. *Combustibles Only* includes those who reported trying combustibles but not noncombustibles or e-cigarettes. *Noncombustibles Only* includes those who reported trying noncombustibles but not combustibles or e-cigarettes. *Combustibles and Noncombustibles Only* includes those who reported trying noncombustibles but not e-cigarettes.

<sup>a</sup>Includes those who reported having tried at least one tobacco product in their lives (e-cigarettes, combustibles, and noncombustibles).

<sup>b</sup>Includes those who reported having tried e-cigarettes in their lives.

<sup>c</sup>Includes those who reported having tried at least one tobacco product in their lives.

<sup>d</sup>Includes those who reported using at least one other tobacco product on at least 1 of the past 30 days.

eIncludes those who reported using e-cigarettes on at least 1 of the past 30 days.

<sup>f</sup>Includes those who reported using e-cigarettes only on at least 1 of the past 30 days.



Figure 2.6 Percentage of U.S. middle school students who have ever used tobacco<sup>a</sup>, by type of product; National Youth Tobacco Survey (NYTS) 2011–2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011-2015).

*Notes:* For more information see Table 2.10a. In 2014, modifications were made to the e-cigarette measure to enhance its accuracy, which may limit the comparability of this estimate to those collected in previous years. The dotted lines from 2013 to 2015 represent these differences.

<sup>a</sup>Includes those who reported having tried at least one other tobacco product in their lives.

<sup>b</sup>Includes exclusive use of only e-cigarettes. It does not include use of any other product. Ever e-cigarette use includes those who responded "electronic cigarettes or e-cigarettes, such as Ruyan or NJOY" to the following question: "*Which of the following tobacco products have you ever tried, even just one time?*"

<sup>c</sup>Includes exclusive use of only cigarettes, cigars, pipes, bidis, kreteks, and/or hookahs. It does not include use of noncombustible products or e-cigarettes. They were defined using the following questions: Conventional cigarettes: "*Have you ever tried cigarette smoking, even one or two puffs?*" and "*During the past 30 days, on how many days did you smoke cigarettes?*"; cigars: "*Have you ever tried smoking cigars, cigarillos, or little cigars, such as Black and Milds, Swisher Sweets, Dutch Masters, White Owl, or Phillies Blunts, even one or two puffs?*" and "*During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?*"; pipes: "*Have you ever tried smoking tobacco in a pipe, even one or two puffs?*" and "*During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?*"; pipes: "*Have you ever tried smoking tobacco in a pipe, even one or two puffs?*" and "*During the past 30 days, on how many days did you smoke tobacco in a pipe?*"; and hookahs, kreteks, and bidis: "*Which of the following tobacco products have you ever tried, even just one time? (CHOOSE ALL THAT APPLY)*" and "*During the past 30 days, which of the following products have you used on at least 1 day? (CHOOSE ALL THAT APPLY)*."

<sup>d</sup>Includes exclusive use of only smokeless tobacco, snus, and/or dissolvable tobacco. It does not include use of combustible products or e-cigarettes. They were defined using the following questions: Smokeless tobacco: *"Have you ever used chewing tobacco, snuff, or dip, such as Red Man, Levi Garrett, Beechnut, Skoal, Skoal Bandits, or Copenhagen, even just a small amount?"* and *"During the past 30 days, on how many days did you use chewing tobacco, snuff, or dip?";* and dissolvables and snus: *"Which of the following tobacco products have you ever tried, even just one time? (CHOOSE ALL THAT APPLY)"* and *"During the past 30 days, which of the following products have you used on at least 1 day? (CHOOSE ALL THAT APPLY)."* 





*Source:* Centers for Disease Control and Prevention, unpublished data (data: NYTS 2011–2015).

*Notes:* For more information see Table 2.10b. In 2014, modifications were made to the e-cigarette measure to enhance its accuracy, which may limit the comparability of this estimate to those collected in previous years. The dotted lines from 2013 to 2015 represent these differences.

<sup>a</sup>Includes those who reported having tried at least one other tobacco product in their lives.

<sup>b</sup>Includes exclusive use of only e-cigarettes. It does not include use of any other product. Ever e-cigarette use includes those who selected "electronic cigarettes or e-cigarettes, such as Ruyan or NJOY" for the following question: "*Which of the following tobacco products have you ever tried, even just one time?*"

<sup>c</sup>Includes exclusive use of only cigarettes, cigars, pipes, bidis, kreteks, and/or hookahs. It does not include use of noncombustible products or e-cigarettes. They were defined using the following questions: Conventional cigarettes: *"Have you ever tried cigarette smoking, even one or two puffs?"* and *"During the past 30 days, on how many days did you smoke cigarettes?"*; cigars: *"Have you ever tried smoking cigars, cigarillos, or little cigars, such as Black and Milds, Swisher Sweets, Dutch Masters, White Owl, or Phillies Blunts, even one or two puffs?"* and *"During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?"*; pipes: *"Have you ever tried smoking tobacco in a pipe, even one or two puffs?"* and *"During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?"*; pipes: *"Have you ever tried smoking tobacco in a pipe, even one or two puffs?"* and *"During the past 30 days, on how many days did you smoke tobacco in a pipe?"*; and hookahs, kreteks, and bidis: *"Which of the following tobacco products have you ever tried, even just one time? (CHOOSE ALL THAT APPLY)"* and *"During the past 30 days, which of the following products have you used on at least 1 day? (CHOOSE ALL THAT APPLY)."* 

<sup>d</sup>Includes exclusive use of only smokeless tobacco, snus, and/or dissolvable tobacco. It does not include use of combustible products or e-cigarettes. They were defined using the following questions: Smokeless tobacco: *"Have you ever used chewing tobacco, snuff, or dip, such as Red Man, Levi Garrett, Beechnut, Skoal, Skoal Bandits, or Copenhagen, even just a small amount?"* and *"During the past 30 days, on how many days did you use chewing tobacco, snuff, or dip?"*; and dissolvables and snus: *"Which of the following tobacco products have you ever tried, even just one time? (CHOOSE ALL THAT APPLY)"* and *"During the past 30 days, which of the following products have you used on at least 1 day? (CHOOSE ALL THAT APPLY)."*  school students had ever tried a tobacco product, and 37.7% had ever used an e-cigarette. In 2015, 7.4% of high school students had ever used e-cigarettes exclusively; 20% were ever dual users of e-cigarettes and combustible products; 0.6% were ever dual users of noncombustible products and e-cigarettes only; and 9.1% were ever poly users of combustibles, noncombustibles, and e-cigarettes. However, the order of the use (i.e., which product came first) remains unknown. In 2015, 5.9% of high school students were exclusive past-30-day users of e-cigarettes; 6.6% were past-30-day dual users of e-cigarettes and combustible tobacco products; 0.7% were past-30-day dual users of e-cigarettes and noncombustible tobacco products only; and 2.6% were past-30-day poly users of e-cigarettes, combustible, and noncombustible tobacco products. Exclusive use of combustible products (6.8%) remained as prevalent as past-30-day dual use of e-cigarettes and combustible products (6.6%) among high school students (Table 2.7b).

### Young Adults<sup>2</sup>

**Current prevalence.** Using data from the 2013–2014 NATS, current exclusive and combined use of e-cigarettes and cigarettes are presented in Figure 2.8 and Table 2.8a for young adults (18–24 years old), and in Figure 2.8 and

Table 2.8b for adults 25 years of age and older. For both age groups, exclusive use of regular cigarettes was the most prevalent pattern of behavior (9.6%, young adults; 13%, adults), followed by dual use of cigarettes and e-cigarettes (7.5%, young adults; 4.2%, adults), and exclusive use of e-cigarettes (6.1%, young adults; 1.6%, adults). Among young adults, combined use of the two products and exclusive use of e-cigarettes were both higher among males than females; combined use was higher among Whites than in Hispanics or Blacks; and both combined use of the two products and exclusive use of e-cigarettes were lowest among those with a college degree.

## **Longitudinal Studies**

Understanding the role that e-cigarettes play in the initiation of tobacco product use, especially conventional cigarettes and other combustible tobacco products, such as cigars and hookahs, is extremely important for informing public health policy, planning, and practice. It is unclear what impact e-cigarette use will have on the overall toll of tobacco use on public health (Cobb et al. 2015). Some researchers and policymakers are concerned about the order in which the initiation of tobacco products takes place, positing that the use of e-cigarettes





*Source:* Centers for Disease Control and Prevention, unpublished data (data: NATS 2013–2014). <sup>a</sup>Current e-cigarette use was defined as those who reported they had heard of e-cigarettes and had tried e-cigarettes, and reported using e-cigarettes every day, some days, or rarely at the time of the interview.

<sup>&</sup>lt;sup>2</sup>As opposed to the situation in youth, cigarettes are the most commonly used tobacco product among young adults. Therefore, this chapter does not assess co-use of e-cigarettes and other tobacco products among young adults.

	Neitherd		E-cigarettes on	ly <sup>e</sup>	Cigarettes only	yf	Both <sup>c</sup>	
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	76.8 (75.3–78.3)	0.8	6.1 (5.3–7.0)	0.4	9.6 (8.6–10.7)	0.5	7.5 (6.6-8.4)	0.5
Gender								
Female	81.8 (79.7-83.7)	1.0	4.0 (3.1–5.2)	0.5	8.4 (7.1–9.9)	0.7	5.8 (4.7-7.2)	0.6
Male	72.3 (70.1–74.4)	1.1	8.1 (6.9–9.4)	0.6	10.6 (9.2-12.2)	0.8	9.0 (7.7–10.4)	0.7
Race/ethnicity								
White	72.8 (70.7–74.8)	1.1	6.3 (5.3–7.5)	0.6	11.2 (9.8–12.8)	0.8	9.7 (8.4–11.2)	0.7
Black or African American	84.8 (80.8-88.2)	1.9	2.9 (1.7-4.9)	0.8	9.8 (7.0–13.5)	1.6	2.5 (1.4-4.4)	0.7
Hispanic or Latino	80.5 (77.0-83.6)	1.7	7.5 (5.7–9.7)	1.0	6.1 (4.3-8.5)	1.1	5.9 (4.2-8.3)	1.1
Other <sup>g</sup>	79.8 (75.5–83.5)	2.1	5.7 (3.8-8.6)	1.2	9.4 (6.9–12.5)	1.4	5.1 (3.4-7.6)	1.0
Education								
<high school<="" td=""><td>67.4 (61.7–72.6)</td><td>2.8</td><td>5.8 (3.7–9.1)</td><td>1.3</td><td>17.3 (13.4–22.1)</td><td>2.2</td><td>9.4 (6.6–13.3)</td><td>1.7</td></high>	67.4 (61.7–72.6)	2.8	5.8 (3.7–9.1)	1.3	17.3 (13.4–22.1)	2.2	9.4 (6.6–13.3)	1.7
High school	74.4 (71.9–76.7)	1.2	6.5 (5.3–7.8)	0.6	10.7 (9.2-12.5)	0.8	8.5 (7.0–10.1)	0.8
Some college <sup>h</sup>	78.2 (75.8-80.4)	1.2	7.3 (5.9–9.0)	0.8	7.2 (5.9-8.7)	0.7	7.3 (6.1-8.8)	0.7
College degree <sup>i</sup>	92.5 (90.2–94.4)	1.1	2.3 (1.4–3.9)	0.6	3.1 (2.0-4.7)	0.7	2.1 (1.2-3.5)	0.6

Table 2.8aPercentage of young adults (18–24 years of age) who currently use e-cigarettes<sup>a</sup>, cigarettes<sup>b</sup>, or both<sup>c</sup> products, by gender, race/ethnicity,<br/>and education: National Adult Tobacco Survey (NATS) 2013–2014

Source: Centers for Disease Control and Prevention, unpublished data (data: NATS 2013-2014).

*Note:* **CI** = confidence interval; **SE** = standard error.

aIncludes those who reported they had heard of, tried, and used e-cigarettes every day, some days, or rarely at the time of the interview.

<sup>b</sup>Includes those who smoked at least 100 cigarettes and reported using cigarettes every day or some days at the time of the interview.

<sup>c</sup>Includes those who reported currently using both e-cigarettes and conventional cigarettes.

<sup>d</sup>Includes those who reported currently using neither conventional cigarettes nor e-cigarettes.

eIncludes those who reported currently using e-cigarettes but not conventional cigarettes.

<sup>f</sup>Includes those who reported currently using conventional cigarettes but not electronic e-cigarettes.

gIncludes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, non-Hispanic American Indian/Alaska Native, and multiracial.

<sup>h</sup>Includes some college, no degree; associate's degree, academic program; associate's degree, unspecified; certificate; diploma; or associate's degree.

<sup>1</sup>Includes bachelor's degree, master's/professional school degree, or doctoral degree.

	Neither <sup>d</sup>		E-cigarettes on	ly <sup>e</sup>	Cigarettes only	<sub>/</sub> f	Both <sup>c</sup>	
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	81.3 (80.8–81.7)	0.2	1.6 (1.5–1.7)	0.1	13.0 (12.6–13.4)	0.2	4.2 (3.9–4.4)	0.1
Gender								
Female	83.4 (82.8-84.0)	0.3	1.3 (1.1–1.4)	0.1	11.5 (11.0–12.0)	0.3	3.8 (3.5-4.1)	0.2
Male	78.8 (78.1–79.5)	0.4	2.0 (1.7-2.2)	0.1	14.6 (14.0–15.3)	0.3	4.6 (4.2–5.0)	0.2
Race/ethnicity								
White	82.1 (81.6-82.6)	0.3	1.6 (1.5–1.8)	0.1	11.9 (11.5–12.3)	0.2	4.4 (4.1-4.7)	0.1
Black or African American	76.2 (74.6–77.7)	0.8	0.9 (0.7–1.3)	0.2	20.0 (18.6-21.5)	0.7	2.9 (2.4–3.5)	0.3
Hispanic or Latino	83.2 (81.6-84.6)	0.8	1.5 (1.1-2.0)	0.2	12.0 (10.7-13.3)	0.7	3.4 (2.7-4.2)	0.4
Other <sup>g</sup>	77.5 (75.6–79.4)	1.0	2.5 (1.9-3.3)	0.4	14.5 (13.0–16.1)	0.8	5.5 (4.4-6.7)	0.6
Education								
<high school<="" td=""><td>71.3 (69.5–73.1)</td><td>0.9</td><td>1.0 (0.7–1.4)</td><td>0.2</td><td>23.5 (21.8-25.2)</td><td>0.9</td><td>4.2 (3.5–5.1)</td><td>0.4</td></high>	71.3 (69.5–73.1)	0.9	1.0 (0.7–1.4)	0.2	23.5 (21.8-25.2)	0.9	4.2 (3.5–5.1)	0.4
High school	75.4 (74.4–76.4)	0.5	1.8 (1.5-2.2)	0.2	16.9 (16.1–17.8)	0.4	5.9 (5.3-6.5)	0.3
Some college <sup>h</sup>	79.2 (78.4-80.0)	0.4	2.0 (1.8-2.3)	0.1	13.4 (12.7–14.1)	0.3	5.3 (4.9–5.8)	0.2
College degree <sup>i</sup>	92.5 (92.1-93.0)	0.2	1.2 (1.0–1.4)	0.1	4.7 (4.3–5.0)	0.2	1.6 (1.4–1.8)	0.1

Table 2.8b Percentage of adults (≥25 years of age) who currently use e-cigarettes<sup>a</sup>, cigarettes<sup>b</sup>, or both<sup>c</sup> products, by gender, race/ethnicity, and education: National Adult Tobacco Survey (NATS) 2013–2014

Source: Centers for Disease Control and Prevention, unpublished data (data: NATS 2013-2014).

*Note:* **CI** = confidence interval; **SE** = standard error.

<sup>a</sup>Includes those who reported they had heard of, tried, and used e-cigarettes every day, some days, or rarely at the time of the interview.

<sup>b</sup>Includes those who smoked at least 100 cigarettes and reported using cigarettes every day or some days at the time of the interview.

<sup>c</sup>Includes those who reported currently using both e-cigarettes and conventional cigarettes.

<sup>d</sup>Includes those who reported currently using neither conventional cigarettes nor e-cigarettes.

eIncludes those who reported currently using e-cigarettes but not conventional cigarettes.

<sup>f</sup>Includes those who reported currently using conventional cigarettes but not e-cigarettes.

gIncludes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, non-Hispanic American Indian/Alaska Native, and multiracial.

<sup>h</sup>Includes some college, no degree; associate's degree: academic program; associate's degree, unspecified; certificate; diploma; or associate's degree.

<sup>i</sup>Includes bachelor's degree, master's/professional school degree, or doctoral degree.

could increase the likelihood that adolescents and young adults who have never used any tobacco products, but initiate e-cigarettes, will become lifetime users of conventional cigarettes or other tobacco products in sufficiently large numbers, resulting in a net harm to public health (USDHHS 2012). Other researchers suggest that the order of product initiation for tobacco products is unimportant and that experimentation with a variety of substances may be a marker of a common vulnerability to tobacco, alcohol, marijuana, and other substance-use behaviors (Vanyukov et al. 2012). Regardless, both of these perspectives on the effect of e-cigarette use on youth and young adults require longitudinal data to understand how current behaviors may affect health outcomes.

Five longitudinal studies to date suggest that e-cigarette use among youth (Leventhal et al. 2015; Barrington-Trimis et al. 2016; Wills et al. 2016) and youth and young adults (Primack et al. 2015; Unger et al. 2016) might lead to initiation of the use of combustible tobacco products in the future. The first study to appear was by Leventhal and colleagues (2015). In this study, a cohort of 9th graders in Los Angeles, California, was followed up at both 6 and 12 months, into 10th grade. Those who at baseline had never used combustible tobacco, but were ever users of an e-cigarette, were more likely to use combustible tobacco products at both follow-up points (odds ratio [OR] = 4.27, 95% confidence interval [CI], 3.19–5.71). Product-specific analyses showed that e-cigarette use in 9th grade was associated with the use of cigars (OR = 4.85, 95% CI, 3.38-6.96), hookahs (OR = 3.25, 95% CI, 2.29-4.62), and cigarettes (OR = 2.65, 95% CI, 1.73-4.05) in 10th grade. It was also associated with the number of different combustible products used in 10th grade (OR = 4.26, 95% CI, 3.16-5.74) (all ORs presented here were averaged across the two time points). In these analyses, Leventhal and colleagues (2015) adjusted for demographic characteristics (age, gender, race/ethnicity, highest parental education), social factors (peer smoking, parental smoking), and intrapersonal factors (depression, impulsivity, delinguent behaviors) linked with cigarette smoking in previous research.

Primack and colleagues (2015), in a national cohort study, followed youth and young adults, 16–26 years of age, for 1 year. At baseline, only 16 participants (2.3%) had ever used e-cigarettes. In adjusted models that included only those who did not use conventional cigarettes at baseline and adjusted for gender, age, race/ethnicity, maternal educational level, sensation seeking, parental cigarette smoking, and peer cigarette smoking, baseline e-cigarette use was independently associated with progression to cigarette smoking (OR = 8.3, 95% CI, 1.2–58.6) and susceptibility to cigarette smoking (OR = 8.5, 95% CI, 1.3–57.2). Susceptibility was defined as a lack of a firm commitment

not to smoke using established measures of this construct (Evans et al. 1995; Pierce et al. 1996).

Wills and colleagues (2016) followed a cohort of 2,338 students in grades 9 and 10 in Hawaii for 1 year. At baseline, 31% of the sample had ever used an e-cigarette, and 15% had ever used a conventional cigarette. One year later, these increased to 38% and 21%, respectively. Of those who had not used either of these products at baseline, 10% initiated exclusive e-cigarette use 1 year later; 2% initiated exclusive conventional cigarette use; and 4% initiated use of both products. Students who had never smoked a conventional cigarette at baseline but had used an e-cigarette at baseline were three times more likely to smoke conventional cigarettes 1 year later (adjusted OR = 2.87, p < 0.001). By comparison, among those who smoked conventional cigarettes at baseline, use of e-cigarettes at that same point in time was not related to any reduction in the use of conventional cigarettes 1 year later (p >0.05). Moreover, students were more likely to transition from never use to dual use of both products 1 year later if they were older, Caucasian or Native Hawaiian (compared with Asian-American), more rebellious, and perceived e-cigarettes as healthier (adjusted OR = 2.05, 2.15, 3.10, 3.32, 2.59, respectively, all p <0.001).

Barrington-Trimis and colleagues (2016) followed a cohort of 11th and 12th grade students in California for more than 1 year (median 15.6 months). In this cohort, at baseline, 146 were ever e-cigarette users and 152 were never e-cigarette users; none had ever smoked a cigarette. Among never e-cigarette users at baseline, 16 participants (10.5%) reported using cigarettes at follow-up; among ever e-cigarette users at baseline, 59 participants (40.4%) reported the same (OR = 6.17; 95% CI, 3.30-11.60). After adjusting for cigar, pipe, or hookah use at baseline, the relationship attenuated only somewhat (OR = 5.48; 95% CI, 2.69–11.20). When stratified by susceptibility to cigarette smoking at baseline (defined, like Primack and colleagues [2015], as the lack of a firm commitment not to smoke using established measures of this construct [Evans et al. 1995; Pierce et al. 1996]), the relationship was actually stronger among those who were not susceptible (OR = 9.69; 95% CI, 4.02-23.40) compared to those who were susceptible (OR = 2.12; 95% CI, 0.79–5.74). The latter relationship was not statistically significant. In additional analyses that were restricted to those who reported no use of any combustible tobacco product at baseline, e-cigarette users were more likely to initiate use of any combustible tobacco product at follow-up (OR = 4.98; 95% CI, 2.37-10.4), including the use of cigarettes (OR = 4.29; 95% CI; 1.84-10.0), hookahs (OR = 2.86;95% CI, 1.21–6.78), cigars (OR = 4.39; 95% CI, 1.72–11.2), and pipes (OR = 8.21; 95% CI, 1.20–56.2). The models used by Barrington-Trimis and colleagues (2016) adjusted for a variety of demographic characteristics (grade, gender, race/ethnicity, highest parental education) and social factors (peer and parental smoking). Additionally, gender, race/ethnicity (Hispanic White, non-Hispanic White, other), grade (11th or 12th), and ever use of hookahs were tested as potential effect modifiers of these associations, but no evidence was found for the same.

Unger and colleagues (2016) followed a cohort of 1,332 Hispanic young adults in California who provided survey data in 2014 and 2015. At baseline, these participants were an average of 22.7 years old. E-cigarette use at baseline was significantly associated with cigarette smoking (OR = 3.32; 95% CI, 1.55-7.10, among non-cigarette smokers at baseline) and marijuana use (OR = 1.97; 95% CI, 1.01–3.86, among non-marijuana users at baseline) at follow-up. Among those who did not smoke cigarettes at baseline (n = 1,056), 42 reported past month e-cigarette use in 2014; 26% of those who smoked e-cigarettes at baseline became cigarette smokers in 2015, compared to 7% of those who did not smoke e-cigarettes. Further, among those who did not smoke marijuana at baseline (n = 1,028), 68 reported past month e-cigarette use in 2014; 24% of those who smoked e-cigarettes at baseline became marijuana smokers in 2015, compared to 12% of those who did not smoke e-cigarettes. Moreover, in this study, e-cigarette use at baseline was not associated with cessation of cigarette smoking (OR = 1.31; 95% CI, 0.73-2.36) or marijuana use (OR = 1.05; 95% CI. 0.54–2.01) at follow-up. Among those who did smoke cigarettes at baseline (n = 276), 76% reported past month e-cigarette use in 2014; and 63% of those who smoked e-cigarettes at baseline were still smoking cigarettes at follow-up, compared to 58% of those who did not smoke e-cigarettes. Covariates in these regression models included age, gender, past month use of alcohol, and past month use of other tobacco products (hookah, cigars, little cigars, smokeless tobacco).

Despite the several strengths of these studies, including their longitudinal nature, they had weaknesses as well. Rigotti (2015) notes, for example, that the study by Leventhal and colleagues (2015) could not distinguish between those who merely began experimenting with a combustible product and those who became regular smokers at follow-up. The same could be said for the studies by Barrington-Trimis and colleagues (2016), Primack and colleagues (2015), and Wills and colleagues (2016). Similarly, the single exposure measure of the independent variable (i.e., any e-cigarette use) in these studies did not allow the authors to assess whether there was a dose–response relationship between the extent of prior e-cigarette use and subsequent use of combustible tobacco products. In addition, the studies by Primack and colleagues (2015) and Wills and colleagues (2016) did not assess prior use at baseline of other tobacco products, marijuana, or alcohol. Though it is not highlighted prominently in their article, Leventhal and colleagues (2015) showed a bidirectional relationship between e-cigarette use and other combustible tobacco product use in their study: Use of other combustible tobacco products at baseline was significantly associated with the onset of e-cigarette use in two follow-ups. This hypothesis was not tested by Barrington-Trimis and colleagues (2016), Wills and colleagues (2016), or Primack and colleagues (2015). However, at the 1-year follow-up, Wills and colleagues (2016) did consider other demographics, personality, and psychosocial predictors of exclusive e-cigarette use and dual use of conventional cigarettes and e-cigarettes.

Concerns about the samples for the two studies can be raised as well. The samples in the studies by Barrington-Trimis and colleagues (2016) and Leventhal and colleagues (2015) were limited to youth in California; the study by Primack and colleagues (2015) suffered from a small sample size, with only 16 e-cigarette users at baseline (Leventhal et al. 2015; Primack et al. 2015); and the study by Wills and colleagues (2016) was limited to 9th- and 10th-grade students in Hawaii. Additional studies are still needed in the future to further elucidate any causal relationship in either direction between the use of e-cigarettes and other types of tobacco products, such as combustibles.

# E-Cigarette Use and Other Substance Use

Few studies have investigated the co-occurrence of e-cigarette use and other risk behaviors in adolescents and young adults. The available evidence suggests that e-cigarette use is associated not only with the use of other tobacco products, but also with alcohol and other substance use, such as marijuana. This is consistent with the common liability model for substance use and other risky behaviors (Vanyukov et al. 2012). Because nearly all currently available studies on this topic focus on regional, international, and at-risk samples, the conclusions from most studies cannot be generalized to the U.S. population as a whole, however.

In the only nationally representative study examining the associations between e-cigarettes, alcohol, and other drug use in young adults 18–24 years of age, the odds of alcohol use were nine times as high and the odds of everyday/some-day marijuana use were three-and-a-half times as high among past-30-day e-cigarette users as they were for those who had not used these products in that period (Cohn et al. 2015). Elsewhere, in a nonprobability sample of college students 17–25 years of age, 66% of current e-cigarette users and 67% of current dual users were heavy drinkers, defined as consuming at least once, five or more drinks (men) or four or more drinks (women) in a single sitting during the course of 1 month (Littlefield et al. 2015). In another study, this one of college students in New York, past-30-day use of e-cigarettes was positively associated with current binge drinking and tobacco product use, and it was less common among those 20–23 years of age (versus those 18 years of age), females, non-Hispanic non-Whites (compared with non-Hispanic Whites), and those reporting better-than-average school performance (Saddleson et al. 2015).

Data from a longitudinal cohort study of children with alcoholic parents found that adolescents (both middle and late adolescence) who used cigarettes, marijuana, or alcohol were significantly more likely to have ever used e-cigarettes. Among those who had used marijuana, e-cigarette use was associated with greater use of marijuana during the previous 30 days (Lessard et al. 2014). In a cross-sectional pilot study of seventh-grade students in Southern California, ever use of e-cigarettes was 11%, compared to 6.8% for cigarettes, 38.1% for alcohol, and 39% for cigarettes or alcohol. In this study, 80% of ever users of e-cigarettes had used alcohol, and 42.2% had used conventional cigarettes (Pentz et al. 2015).

In a 2013 sample of students (n = 2,002) in two states in the southeastern United States, 53.4% of e-cigarette users also used marijuana (Berg et al. 2015). Elsewhere, in a sample of young adults (18–23 years of age) at colleges and universities that was taken in 2013 in upstate New York (n = 1,437), 54.2% of past-30-day marijuana users, 23.9% of past-30-day alcohol users, and 40.3% of past-30-day binge drinkers had ever used e-cigarettes (Saddleson et al. 2015). In Switzerland, among a sample of eighth graders, nearly 60% of regular e-cigarette users "had been drunk" at least once in the past 30 days (defined as an affirmative response to the question, "have you been drunk in the previous 30 days"), and 44.8% had used marijuana at least once during that period (Suris et al. 2015).

There are several limitations to these observational studies. For example, when considering the associations derived from these observational studies, the order of initiation of the products of interest cannot be inferred. In addition, some biases cannot be ruled out because of the nature of the samples, and patterns of associations may reflect an underlying common liability to use substances and take part in other risky behaviors. Some studies adjusted for risk taking, sensation seeking, and impulsivity, while others did not.

## **E-Cigarettes and Marijuana**

Because of their design, e-cigarettes may facilitate drug use among youth and young adults, as these products can be used as a delivery system for cannabinoids and other illicit drugs (Giroud et al. 2015; Morean et al. 2015; Schauer et al. 2016). The aerosolization of cannabis is a relatively new technology used to deliver inhaled tetrahydrocannabinol (THC) and other cannabinoids while reducing the toxic byproducts of smoked cannabis, which are primarily caused by combustion (Abrams et al. 2007).

Laboratory studies of prototype aerosolizers have demonstrated that they can provide a relatively effective mode of delivering THC, with plasma THC concentrations similar to those obtained from smoking a standard marijuana cigarette (Abrams et al. 2007; Giroud et al. 2015). In addition, thermal metered-dose cannabis inhalers have been developed for medical applications; their technology is similar to that of e-cigarettes (Eisenberg et al. 2014). While the first generation of cannabis aerosolizers was developed to aerosolize dry cannabis, the widespread availability of e-cigarettes and rapid advances in their technology have led to the development of liquid/oil forms of cannabis/THC that can be used with e-cigarettes in a fashion similar to that employed when they are filled with nicotine (Giroud et al. 2015). Articles explaining how to acquire and use THC-containing liquid using e-cigarette technology are accessible on the Internet and are strongly suggestive of relatively widespread awareness and use (Gray 2013).

The actual prevalence of users of marijuana aerosolizers and their experiences remain unclear and understudied (Van Dam and Earleywine 2010; Malouff et al. 2014). In one of the few published studies on this issue specific to youth, Morean and colleagues (2015) found that, among high school students in Connecticut, vaporizing cannabis was common among ever e-cigarette users (18%), ever cannabis users (18.4%), and ever dual users (26.5%). This finding suggests a need for more specific surveillance measures that take into account the use of drugs other than nicotine in e-cigarettes.

## **Use of Flavored E-Cigarettes**

The liquid that is vaporized in an e-cigarette is available to consumers in a wide variety of flavors, including tobacco, mint/menthol, and fruit flavors. Although characterizing "flavors" are prohibited in cigarettes (with the exception of menthol and tobacco) by the *Family Smoking Prevention and Tobacco Control Act of 2009*, this practice is not currently prohibited in other tobacco products, like e-cigarettes. Retail sales data suggest that the consumption of flavored e-cigarettes and tobacco products, such as flavored cigars, has increased in recent years (Delnevo et al. 2015; Giovenco et al. 2015), and recent studies show that youth and young adults may find these flavored products more appealing than their unflavored counterparts (Table 2.9) (Ambrose et al. 2015; Krishnan-Sarin et al. 2015; McDonald and Ling 2015).

Data on the use of flavored e-cigarettes among youth and young adults is presented in Table 2.9. In the 2015 NYTS, participants were asked about any current use of e-cigarettes that were "flavored to taste like menthol (mint), alcohol (wine, cognac), candy, fruit, chocolate, or other sweets" (CDC 2015a, 1066). Among middle and high school students who were past-30-day users of e-cigarettes, 1.26 million, or 44.6%, had used a flavored e-cigarette in that timeframe (CDC, unpublished data [NYTS 2015]); this included 42.6% of middle school students and 45.1% of high school students (Table 2.9) (CDC 2015a). The use of flavored e-cigarettes did not differ by gender and was lowest among Blacks (Table 2.9) (CDC 2015a). The use of flavored e-cigarettes was highest among young adults, according to the 2013-2014 NATS (Table 2.9): among those who reported using e-cigarettes every day or some days, 91.6% of young adults (18-24 years old) reported using an e-cigarette flavored to taste like menthol, mint, clover, spice, candy, fruit, chocolate, or other sweets. On the other hand, 66.6% of adults ( $\geq 25$  years of age) who reported using e-cigarettes every day or some days had used flavored e-cigarettes. No gender differences were noted for young adults, but Blacks, as with middle and high school students, reported the lowest rate of using flavored e-cigarette products.

Data from the 2013-2014 wave of the PATH study revealed that a majority of adolescents who used e-cigarettes use flavors. Of those who had ever tried e-cigarettes, 81% used flavors the first time they tried an e-cigarette; of past-30-day users, 85.3% regularly used flavored e-cigarettes (Ambrose et al. 2015). Ambrose and colleagues (2015) also reported that 81.5% of respondents aged 12-17 reported that they used e-cigarettes because "they come in flavors I like." Elsewhere, among 8th, 10th, and 12th graders in the 2015 MTF study, about 40% said that the primary reason they used e-cigarettes was "because they tasted good." In contrast, about 10% said they used e-cigarettes to guit smoking conventional cigarettes (University of Michigan 2015). In the 2015 MTF study, about two-thirds of 8th-, 10th-, and 12th-grade students said that they used "just flavouring" in their vaporizer when they "last used" a vaporizer, while only 20% reported that they used nicotine (Miech et al. 2016). While the findings specific to nicotine are unexpected, it is important to note that these data are self-reported. It is questionable whether youth know what nicotine is, let alone whether it is contained in the e-cigarette products that they are using. Moreover, even if youth were accurately reporting nicotine strength according to the label on the package, a study by Buettner-Schmidt and colleagues (2016) found that more than half of the labels on assessed e-cigarette products did not accurately reflect actual nicotine content in the product. Therefore, further research on nicotine content using objective measures (e.g., retail sales data) is warranted. Both the PATH and MTF studies, however, reinforce that flavorings may play an important role in the initiation of e-cigarette use.

Other regional studies have reinforced the popularity of flavored e-cigarette use among youth. Table 2.10 summarizes these data on the use of flavored e-cigarettes among youth and young adults. Krishnan-Sarin and colleagues (2015), for example, found that sweet-flavored e-cigarettes were popular among middle and high school students. In another study, which examined nonsmoking middle and high school students and college-aged adults in New Haven County, Connecticut, Kong and colleagues (2015) found that "appealing flavors" was the second most common reason cited for experimenting with e-cigarettes, and in a qualitative study of young adults living in New York City, flavors were identified as an attractive aspect of e-cigarettes (McDonald and Ling 2015). In a study examining nonsmoking teens and adult smokers, the e-cigarette flavors tested appealed more to adults than to teens; nonsmoking teens demonstrated equally low levels of interest in tobacco, fruit, and candy flavors (Shiffman et al. 2015). It should be noted, however, that this study was funded by NJOY, an e-cigarette company and, therefore, may have suffered from commercial bias. Additional concerns about this study concerning selection bias, validity of the survey measures, and reliability of the findings have been raised (Glantz 2015).

## Consumer Perceptions of E-Cigarettes

### **Perceived Harm of E-Cigarettes**

In the general population of U.S. adults, e-cigarettes have been perceived to be generally less harmful (Pearson et al. 2012; Czoli et al. 2014; Gallus et al. 2014; Richardson et al. 2014; Berg et al. 2015; Pokhrel et al. 2015) and less addictive (Dockrell et al. 2013; Li et al. 2013; Brown et al. 2014; Farsalinos et al. 2015; Harrell et al. 2015; Hendricks et al. 2015; Kadimpati et al. 2015; Wackowski and Delnevo 2015) than conventional cigarettes. The perceived harm of e-cigarettes relative to conventional cigarettes was lowest among those who were current smokers, followed by former smokers and then nonsmokers (Pearson et al. Table 2.9 Percentage of youth (middle and high school students), young adults (18–24 years of age), and adults (≥25 years of age) using tobacco products who reported using flavored e-cigarette products, by gender and race/ethnicity; National Youth Tobacco Survey (NYTS)<sup>a</sup> and National Adult Tobacco Survey (NATS)<sup>b</sup>

	NYTS 2015 <sup>a</sup> (you Middle school stud	th): lents	NYTS 2015 <sup>a</sup> (youth) school student	: High	NATS 2013–2014 <sup>b</sup> (y adults): 18–24 years	oung of age	NATS 2013–201 (adults): >25 years	4 <sup>b</sup> of age
Characteristic	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE	% (95% CI)	SE
Overall	42.6 (36.1-49.3)	3.3	45.1 (40.4–49.9)	2.4	91.6 (87.0-94.6)	1.9	66.6 (63.4-69.5)	1.6
Gender								
Female	45.5 (36.2–55.2)	4.8	46.8 (40.5–53.2)	3.2	90.1 (78.6–95.7)	4.1	68.2 (63.7-72.3)	2.2
Male	40.2 (32.2-48.7)	4.2	44.0 (39.3-48.8)	2.4	92.2 (87.0-95.4)	2.1	65.2 (60.7-69.4)	2.2
Race/ethnicity								
White	52.5 (42.0-62.8)	5.3	51.4 (45.7-57.0)	2.9	90.9 (84.7-94.7)	2.5	61.2 (57.5-64.8)	1.9
Black or African American	32.9 (18.5–51.6)	8.6	20.4 (12.8-31.0)	4.5	100 (100–100) <sup>c</sup>	0.0 <sup>c</sup>	92.0 (82.1-96.6)	3.5
Hispanic or Latino	28.5 (20.5-38.1)	4.4	38.8 (32.7-45.3)	3.2	89.8 (75.3–96.2) <sup>c</sup>	5.0 <sup>c</sup>	85.9 (76.6-91.9)	3.8
Other <sup>d</sup>	57.3 (39.4-73.5)	8.9	34.1 (24.8-44.9)	5.1	94.4 (82.1-98.4) <sup>c</sup>	3.5 <sup>c</sup>	67.4 (57.0-76.3)	5.0

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015; NATS 2013–2014).

*Note*: **CI** = confidence interval; **SE** = standard error.

<sup>a</sup>Flavored e-cigarette product use in NYTS was determined by the response to the question, "*Which of the following tobacco products that you used in the past 30 days were flavored to taste like menthol (mint), alcohol (wine, cognac), candy, fruit, chocolate, or other sweets?*" Participants could select from a list of options to designate the flavored tobacco product(s) they used. (Among those who reported any use of e-cigarettes in the preceding 30 days.) Those who selected e-cigarettes were coded as "yes" for flavored e-cigarettes. Those who did not select e-cigarettes were categorized as "no" for flavored e-cigarettes. Excludes 82 current e-cigarette users whose answers were missing for all flavored tobacco response options.

<sup>b</sup>Flavored e-cigarette product use in NATS was determined by the response to the question, "*Were any of the electronic cigarettes that you used in the past 30 days flavored to taste like menthol, mint, clover, spice, candy, fruit, chocolate, or other sweets*?" (Among those who reported using e-cigarettes every day or some days.) Those who selected "yes" were categorized as "yes" for flavored e-cigarettes. Those who selected "no" were categorized as "no" for flavored e-cigarettes. Excludes five every-day or some-day users who reported not using any noncigarette tobacco product in the past 30 days.

<sup>c</sup>Sample size <50. No estimates had a relative SE >.40.

<sup>d</sup>Includes non-Hispanic Asian, non-Hispanic Native Hawaiian/Other Pacific Islander, and non-Hispanic American Indian/Alaska Native. For young adults and adults, this group also includes multiracial.

Study	Design/population	Measures	Outcomes/findings
Ambrose et al. (2015)	<ul> <li>Cross-sectional</li> <li>Wave 1 of PATH study</li> <li>Household-based, nationally representative survey of 13,651 youth 12–17 years of age</li> </ul>	• For each product ever used, youth were asked if it was flavored to taste like menthol, mint, clove, spice, candy, fruit, chocolate, alcohol (such as wine or cognac), or other sweets	<ul> <li>81% of e-cigarette ever users used a flavored product at first use</li> <li>85.3% of past-30-day e-cigarette users used a flavored product</li> <li>81.5% of past-30-day users cited "because they come in flavors I like" as a reason for using e-cigarettes</li> </ul>
Berg et al. (2015)	<ul> <li>Cross-sectional</li> <li>Recruitment through Facebook targeting of tobacco and marijuana users and nonusers</li> <li>2014</li> <li>1,567 participants, 18–34 years of age, living in the United States</li> </ul>	<ul> <li>E-cigarette use (ever tried, number of days in past 30 days)</li> <li>Flavors used or of interest</li> </ul>	<ul> <li>Most commonly used flavor was fruit flavors (67%), which was most commonly reported by never cigarette smokers.</li> <li>Current smokers were most likely to report using tobacco flavors, but least likely to report using caramel, vanilla, chocolate, cream, or candy flavors.</li> </ul>
CDC (2015a)	<ul> <li>Cross-sectional</li> <li>2014 NYTS data</li> <li>Three-stage cluster sampling procedure</li> <li>Nationally representative sample of 22,007 U.S. middle and high school students</li> </ul>	<ul> <li>Participants were asked about any current use of tobacco products that were "flavored to taste like menthol (mint), alcohol (wine, cognac), candy, fruit, chocolate, or other sweets"</li> <li>Participants could select from a list of options</li> </ul>	• Among current e-cigarette users, 63.3% used a flavored product
Kong et al. (2015)	<ul> <li>Cross-sectional</li> <li>18 focus groups, schoolwide survey</li> <li>Recruitment by flyers and active recruitment sessions</li> <li>Years sample drawn: 2012–2013</li> <li>New Haven County, Connecticut</li> <li>Youth: Middle and high school students; focus group n = 127 (youth); survey n = 4,780</li> <li>Young adults: New Haven County, Connecticut, college students; focus group n = 127 (young adults); survey n = 625</li> </ul>	• Why did you try an e-cigarette?	<ul> <li>43.8% of e-cigarette ever users experimented with e-cigarettes for the availability of appealing flavors</li> <li>School-level differences: χ<sup>2</sup>(2, N = 1,157) = 18.63, p ≤0.001</li> <li>Compared with college students, high school students were more likely to experiment with e-cigarettes because of flavors (47% vs. 32.8%): χ<sup>2</sup>(1, N = 1,116) = 13.61, p ≤0.001</li> </ul>

 Table 2.10 Summary of studies on e-cigarette flavors among youth and young adults

Study	Design/population	Measures	Outcomes/findings
Krishnan-Sarin et al. (2015)	<ul> <li>Cross-sectional</li> <li>School-based survey</li> <li>Recruitment by selected district reference groups</li> <li>Year sample drawn: 2013</li> <li>Youth: Connecticut middle (n = 1,166) and high school (n = 3,614) students</li> <li>Young adults: n/a</li> </ul>	• Which of the following flavors of e-cigarettes have you tried?	<ul> <li>Most e-cigarette ever users preferred sweet flavors:</li> <li>Sweet flavors: 56.8%</li> <li>Menthol: 8.7%</li> <li>Combos: 7.7%</li> <li>Tobacco: 3%</li> <li>Other: 2.8%</li> <li>Menthol and tobacco flavors used mostly by e-cigarette users who were also cigarette smokers.</li> <li>Menthol preference: <ul> <li>3.5% (never smokers)</li> <li>5.5% (ever smokers)</li> <li>18.6 (current smokers)</li> <li>Tobacco preference: <ul> <li>0.5% (never smokers)</li> <li>2.4% (ever smokers)</li> <li>7.1% (current smokers)</li> </ul> </li> </ul></li></ul>
McDonald and Ling (2015)	<ul> <li>Focus groups and semistructured interviews</li> <li>Recruitment from bars through screener surveys</li> <li>Years sample drawn: 2012–2013</li> <li>Youth: n/a</li> <li>Young adults: 87 young adults, 18–27 years of age, in the boroughs of Manhattan, Brooklyn, and Queens in New York City</li> </ul>	• Attraction to flavors	• Flavors were an attractive e-cigarette characteristic
Shiffman et al. (2015)	<ul> <li>Cross-sectional</li> <li>Participants drawn from online research panel</li> <li>Year sample drawn: 2014</li> <li>Youth: Nonsmoking teenagers, 13–17 years of age</li> <li>Young adults: n/a</li> </ul>	• Interest in e-cigarettes paired with various flavor descriptors	<ul> <li>Nonsmoking teens' interest in e-cigarettes was very low (mean = 0.41 ± 0.14 [SE] on 0–10 scale).</li> <li>Teen interest did not vary by flavor (p = .75)</li> </ul>

Study	Design/population	Measures	Outcomes/findings
Ford et al. (2016)	<ul> <li>Cross-sectional in-home survey</li> <li>Wave 7 of the Youth Tobacco Policy Survey (YTPS)</li> <li>Random location quota sampling</li> <li>1,205 youth, 11–16 years of age, in the United Kingdom</li> </ul>	<ul> <li>Awareness of e-cigarettes</li> <li>E-cigarette use</li> <li>E-cigarette flavor awareness</li> <li>Perceptions of harm</li> </ul>	<ul> <li>12% had tried e-cigarettes</li> <li>2% were regular users (confined to adolescents who had also smoked tobacco)</li> <li>82% were aware of at least one promotional channel (82%)</li> <li>69% were aware that e-cigarettes came in different flavours</li> <li>Brand awareness was low</li> <li>E-cigarettes were perceived as harmful (mean = 3.54, SD = 1.19)</li> </ul>
Vasiljevic et al. (2016)	<ul> <li>Randomized controlled trial</li> <li>Participants exposed to advertisements of candy- like flavored e-cigarettes, non-flavoured cigarettes, or control</li> <li>Youth: 598 English children, 11–16 years of age</li> </ul>	<ul> <li>Appeal of using e-cigarettes</li> <li>Appeal of e-cigarette ads</li> <li>Interest in buying and trying e-cigarettes following ad exposure</li> </ul>	<ul> <li>Exposure to e-cigarette ads did not seem to increase the appeal of tobacco smoking in children.</li> <li>Exposure to flavoured e-cigarette ads (compared with non-flavoured ads) increased the appeal and interest in buying and trying e-cigarettes in children.</li> </ul>

*Note:* NYTS = National Youth Tobacco Survey; PATH = Population Assessment of Tobacco and Health Study; SD = standard deviation; SE = standard error.

2012; Richardson et al. 2014). In a nationally representative sample of U.S. adults, young adults 18–34 years of age were more likely than their older counterparts to perceive e-cigarettes as being less harmful than conventional cigarettes (Tan and Bigman 2014).

Common theories of health behavior, such as the Theory of Reasoned Action and the Health Belief Model, posit that perceptions of harm influence tobaccouse behavior, with lower perceived harm encouraging higher levels of experimentation and current tobacco use (Primack et al. 2008). Monitoring both absolute perceived harm and perceived harm relative to conventional cigarettes could be an indicator of later product adoption. Table 2.11 presents studies of the perceived harm of e-cigarettes among adolescents and young adults that are included in this chapter.

## Youth

Table 2.12a presents NYTS data from middle school and high school students on the perceived harm of using e-cigarettes on some days but not every day. In 2015, 61.9% of these students, overall, believed that e-cigarettes caused "little or some harm" under such conditions; 14.5%, "no harm"; and 23.6%, "a lot of harm." However, when these data are stratified by students' history of e-cigarette use, important differences become clear. Notably, 34.2% of past-30-day e-cigarette users believed e-cigarettes cause "no harm," compared with 22.4% of ever e-cigarette users and only 9.5% of never e-cigarette users. Conversely, 29.4% of never e-cigarette users believed that e-cigarettes cause "a lot of harm," compared with 8.3% of ever e-cigarette users and 6.8% of past-30-day e-cigarette users. These important differences by e-cigarette use status, which suggest perceptions of no harm related to e-cigarette use, were consistent for both middle school students and high school students (Tables 2.12b and 2.12c).

Three studies that used data from the 2012 NYTS examined the correlates of U.S. adolescents' opinions about the perceived harm of e-cigarettes relative to the harm of conventional cigarettes. Non-Hispanic Whites, students who lived with a smoker (Cardenas et al. 2015) or had a family member who used tobacco (Amrock et al. 2015), and past-30-day users of tobacco products other than cigarettes were more likely to believe that e-cigarettes were safer than conventional cigarettes (Amrock et al. 2015). Conversely, girls and students 17 years of age or older were more likely to believe that e-cigarettes were more harmful than regular cigarettes (Amrock et al. 2015). The perceived harm of e-cigarettes decreased with increasing levels of cigarette smoking, such that in 2012, 25% of adolescent never smokers, 41.3% of adolescent ever smokers,

and 54.2% of adolescent past-30-day smokers believed that e-cigarettes were less harmful than cigarettes (Ambrose et al. 2014). Prior use of e-cigarettes was also associated with perceived harm of that product. Among students who had ever tried e-cigarettes in 2012, 71.8% believed that they were less harmful than cigarettes, 12.1% equally harmful, and 5% more harmful. These estimates were similar to those for students who had used e-cigarettes in the past 30 days (Amrock et al. 2015). In addition, susceptibility to cigarette smoking among never smokers was associated with perceptions of low harm for e-cigarettes (Ambrose et al. 2014).

Although not all studies reviewed in this section included "don't know" as a response option for guestions on the harms of e-cigarettes, those that did, found that a large number of students were unsure of the relative harmfulness of e-cigarettes compared to conventional cigarettes (Ambrose et al. 2014; Amrock et al. 2015). In fact, among U.S. adolescents responding to the 2012 NYTS, "don't know" was the most common response (41.1-53.3%) across all the demographic subgroups examined (gender, age, and race/ethnicity) (Amrock et al. 2015). In this sample, more never smokers (57.4%) than ever smokers (37.5%) or past-30-day smokers (24%) had not heard of or did not know enough about e-cigarettes to make a judgment of harm (Ambrose et al. 2014). Future studies will benefit from examining the effect of harm perception on the use of e-cigarettes and other tobacco-use behaviors among adolescents.

## Young Adults

Table 2.12d presents data from the 2013–2014 NATS on beliefs about harm from e-cigarettes among young adults (18–24 years old). Just over half (53.8%) of young adults believed that e-cigarettes were "moderately harmful," 26.8% believed they were "very harmful," and 19.4% believed they caused "no harm." Levels of belief in moderate harm were quite similar by type of e-cigarette use: 52.8% of never users, 56.8% of ever (but not current) users, and 53.6% of current users. Ever and current users were more likely than never users to report that e-cigarettes were "not at all harmful," while never users were more likely than the other two groups to report that e-cigarettes were "very harmful."

Published studies on perceived harm of e-cigarettes from regional samples, primarily of college and university students, are presented in Table 2.11. A large survey (n = 4,444) of college students in North Carolina conducted in 2009 found that, as with adolescents, perceived harm of e-cigarettes, compared with conventional cigarettes, was lower among college students who had ever used e-cigarettes (45%) than among those who had never used

Study	Design/population	Measures	Outcomes/findings	Comments
Choi et al. (2012)	<ul> <li>Focus groups</li> <li>Recruitment by (1) online advertisements, (2) flyers on one 4-year and two 2-year college campuses, (3) announcements in student life newsletter at a 2-year college, and (4) recruitment booth on a 2-year college campus</li> <li>Year sample drawn: 2010</li> <li>Young adults: Individuals in Minneapolis-St. Paul, MN, enrolled in or who had graduated from 4-year colleges, or those who were enrolled in or had graduated from 2-year colleges, or those who had not enrolled in postsecondary education; N = 66</li> </ul>	• Perceived harmfulness relative to cigarettes	<ul> <li>No consensus among participants</li> <li>Lack of information on <ul> <li>(1) ingredients, (2) health impact,</li> <li>and (3) mechanism used to vaporize nicotine</li> </ul> </li> <li>Some noted e-cigarettes to be as harmful as cigarettes ("all one product, in different forms")</li> </ul>	<ul> <li>Generalizability</li> <li>Limited sample size</li> </ul>
Adkison et al. (2013)	<ul> <li>Parallel prospective cohort</li> <li>Telephone interview and web-based surveys</li> <li>Probability sampling methods (random-digit dialing)</li> <li>Years sample drawn: 2010–2011 (Wave 8), 2008–2009 (Wave 7, where available)</li> <li>Youth: n/a</li> <li>Young adults: current smokers, ≥18 years of age; N = 5,939 (Canada: n = 1,581; United States: n = 1,520; United Kingdom: n = 1,325; Australia: n = 1,513)</li> </ul>	• Are electronic cigarettes more harmful than, less harmful than, or equally harmful as regular cigarettes to one's health?	• Not explicitly reported for young adults	<ul> <li>Inclusion of only current and former cigarette smokers</li> <li>Limited set of questions</li> </ul>

Table 2.11 Summary of studies on perceptions of e-cigarette harm among youth and young adults

Study	Design/population	Measures	Outcomes/findings	Comments
Faletau et al. (2013)	<ul> <li>Qualitative exploratory</li> <li>Structured focus groups and individual interviews</li> <li>Recruited from two low socioeconomic primary schools in East and South Auckland, New Zealand</li> <li>Year sample drawn: 2011</li> <li>Youth: Maori, Tongan, Samoan, Cook Island, and Niuean children, 6–10 years of age; N = 20</li> <li>Young adults: n/a</li> </ul>	• Viewed tobacco cigarette and electronic cigarette videos	• Still allows smokers to smoke, despite its function as a cessation aid	<ul> <li>Generalizability</li> <li>Unknown if saturation was reached in children between focus groups and individual interviews</li> </ul>
Sutfin et al. (2013)	<ul> <li>Cross-sectional</li> <li>Web-based survey (part of a randomized group trial)</li> <li>Stratified random sample</li> <li>Year sample drawn: 2009</li> <li>Youth: n/a</li> <li>Young adults: undergraduate students attending eight universities in North Carolina; N = 4,857 (completers of e-cigarette question, n = 4,444).</li> </ul>	<ul> <li>Compared with a regular cigarette, how harmful do you think e-cigarettes are?</li> <li>Less harmful</li> <li>As harmful</li> <li>More harmful</li> <li>Do not know</li> </ul>	<ul> <li>Among the overall sample: <ul> <li>17% indicated "as harmful"</li> <li>23% indicated "less harmful"</li> <li>2% indicated "less harmful"</li> <li>50% indicated "do not know"</li> </ul> </li> <li>Among ever e-cigarette users: <ul> <li>17% indicated "as harmful"</li> <li>45% indicated "less harmful"</li> <li>3% indicated "less harmful"</li> <li>23% indicated "do not know"</li> </ul> </li> <li>Among never e-cigarette users: <ul> <li>16% indicated "do not know"</li> </ul> </li> <li>Among never e-cigarette users: <ul> <li>16% indicated "do not know"</li> </ul> </li> <li>Among never e-cigarette users: <ul> <li>2% indicated "as harmful"</li> <li>22% indicated "less harmful"</li> <li>22% indicated "less harmful"</li> <li>25% indicated "less harmful"</li> <li>51% indicated "do not know"</li> </ul> </li> <li>Ever e-cigarette use significantly associated with harm perceptions (p &lt;0.001)</li> </ul>	<ul> <li>Low response rate</li> <li>Generalizability</li> <li>Inability to differentiate former smokers from experimenters</li> <li>Cross-sectional analysis</li> </ul>

Table 2	2.11	Continued
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Study	Design/population	Measures	Outcomes/findings	Comments
Ambrose et al. (2014)	<ul> <li>NYTS</li> <li>Cross-sectional</li> <li>School-based survey</li> <li>Three-stage cluster sampling</li> <li>Year sample drawn: 2012</li> <li>Youth: U.S. middle and high school students (grades 6–12); N = 24,658</li> <li>Young adults: n/a</li> </ul>	• Do you believe that electronic cigarettes or e-cigarettes, such as Ruyan or NJOY, are less harmful, equally harmful, or more harmful than regular cigarettes?	<ul> <li>30.6% (CI, 29.3–31.9%) of respondents believed e-cigarettes are less harmful than cigarettes: never smokers: 25% (CI, 23.9–26.2%); ever smokers: 41.3% (CI, 39.1–43.6%); current smokers: 54.2% (CI, 51.0–57.4%)</li> <li>Female and Hispanics were less likely to perceive e-cigarettes as less harmful than cigarettes compared with males and Whites, across all smoking statuses</li> <li>Current smokers that had ever used e-cigarettes were more than twice as likely to perceive e-cigarettes as less harmful, compared with smokers who had never used e-cigarettes (AOR = 2.48; CI, 1.87–3.29)</li> <li>Never smokers who had ever used e-cigarettes were almost six times as likely to perceive e-cigarettes as less harmful, compared with never smokers who had never used e-cigarettes (AOR = 5.88; CI, 3.07–11.25)</li> </ul>	<ul> <li>Perceived graduated risk</li> <li>Self-reported items</li> <li>Social desirability bias</li> <li>Generalizability</li> </ul>

Study Design/population Measure		Measures	Outcomes/findings	Comments	
Czoli et al. (2014)	<ul> <li>Cross-sectional</li> <li>Survey</li> <li>Recruitment through online panel of commercial market research company</li> <li>Year sample drawn: 2012</li> <li>Youth: Canadian youth recruited from online panel, 16–30 years of age; n = 1,188</li> <li>Young adults: Canadian young adults recruited from same online panel (see above)</li> </ul>	<ul> <li>Is this product harmful to your health?</li> <li>Have you ever experienced any side-effects or adverse outcome(s) while using e-cigarettes?</li> </ul>	<ul> <li>Mean score for agreement with e-cigarettes as harmful to your health (higher score indicates greater agreement):</li> <li>Among cigarette nonsmokers: 5.5 (e-cigarette nonuser) vs. 4.4 (e-cigarette ever user)</li> <li>Among former smokers: 5.2 (e-cigarette nonuser) vs. 3.6 (e-cigarette ever user)</li> <li>Among current smokers: 2.6 (e-cigarette nonuser) vs. 3.5 (e-cigarette ever user)</li> </ul>	<ul><li>Cross-sectional analysis</li><li>Generalizability</li></ul>	
Gallus et al. (2014)	<ul> <li>Cross-sectional</li> <li>In-person survey</li> <li>Representative multistage sampling</li> <li>Year sample drawn: 2013</li> <li>Youth: n/a</li> <li>Young adults: Italians ≥15 years of age; N = 3,000</li> </ul>	<ul> <li>Indicate your opinion (true/ false) concerning e-cigarettes on the following: <ul> <li>(1) Are not harmful for health</li> <li>(2) Are less harmful than traditional cigarettes because they do not contain nicotine</li> <li>(3) Are less harmful because there is no tobacco combustion</li> <li>(4) Are less harmful because they contain only nicotine</li> <li>(5) Are more harmful than traditional cigarettes</li> <li>(6) Are an efficient tool to quit smoking</li> <li>(7) Allow smoking even where it is forbidden</li> </ul> </li> </ul>	• Findings not explicitly reported for young adults	<ul> <li>Unstable estimates due to small sample of e-cigarette users</li> <li>Unvalidated survey</li> </ul>	

Study	Design/population	Measures	Outcomes/findings	Comments	
Tan and Bigman (2014)	<ul> <li>Cross-sectional</li> <li>Health Information National Trends Survey 4 Cycle 2</li> <li>Collected between October 2012 and January 2013</li> <li>U.S. adults ≥18 years of age</li> <li>N = 3,630, 29.8% 18–34 years of age</li> </ul>	<ul> <li>Compared to smoking cigarettes, would you say that electronic cigarettes are:         <ul> <li>Much less harmful</li> <li>Less harmful</li> <li>Just as harmful</li> <li>More harmful</li> <li>Much more harmful</li> <li>Five never heard of electronic cigarettes</li> </ul> </li> </ul>	• Compared with younger respondents (18–34 years of age), older respondents had 38%–72% lower odds of believing that e-cigarettes are less harmful than regular cigarettes		
Tucker et al. (2014)	<ul> <li>Cross-sectional</li> <li>Paper-based survey</li> <li>Probability-based sampling</li> <li>Year sample drawn: not reported</li> <li>Youth: n/a</li> <li>Young adults: homeless young adults, 17–25 years of age; N = 292 (subset of lifetime e-cigarette users, n = 83)</li> </ul>	• Rate whether they perceive e-cigarettes to be less harmful, more harmful, or just as harmful as smoking cigarettes	<ul> <li>44.9% viewed e-cigarettes as less harmful than conventional cigarettes</li> <li>26.6% viewed e-cigarettes as just as harmful as conventional cigarettes</li> <li>3.7% viewed e-cigarettes as more harmful than conventional cigarettes</li> <li>24.8% did not know the relative harm</li> </ul>	<ul> <li>Did not collect information on youth's attitudes about alternate tobacco products besides e-cigarettes</li> <li>Did not collect information on the conditions under which they used various products</li> </ul>	
Amrock et al. (2015)	<ul> <li>NYTS</li> <li>Cross-sectional</li> <li>School-based survey</li> <li>Three-stage cluster sampling</li> <li>Year sample drawn: 2012</li> <li>Youth: U.S. middle and high school students (grades 6–12); N = 24,658</li> <li>Young adults: n/a</li> </ul>	• Do you believe that electronic cigarettes or e-cigarettes, such as Ruyan or NJOY, are less harmful, equally harmful, or more harmful than regular cigarettes?	<ul> <li>34.2% (CI, 32.8–35.6%) of adolescents considered e-cigarettes to be less harmful than cigarettes</li> <li>Females were less likely than males to perceive e-cigarettes as less harmful than cigarettes</li> <li>Lifetime e-cigarette users were more likely than never users to report e-cigarettes as less harmful than cigarettes (71.8% vs. 31%)</li> <li>Past-30-day e-cigarette users were more likely than nonrecent users to report e-cigarettes as less harmful than cigarettes (73.8% vs. 33.1%)</li> </ul>	<ul> <li>Missingness</li> <li>Perceived graduated risk</li> <li>Self-reported items</li> <li>Social desirability bias</li> <li>Generalizability</li> </ul>	

Study	Design/population	Measures	Outcomes/findings	Comments	
Berg et al. (2015)	<ul> <li>Cross-sectional</li> <li>Online-based survey</li> <li>Recruitment by random selection</li> <li>Year sample drawn: 2013</li> <li>Youth: n/a</li> <li>Young adults: U.S. university students; n = 2,002</li> </ul>	<ul> <li>How harmful to your health do you think electronic cigarettes are?</li> <li>How addictive do you think electronic cigarettes are?</li> <li>How socially acceptable among your peers do you think electronic cigarettes are?</li> </ul>	<ul> <li>Respondents considered e-cigarettes among the least harmful (4.26 ±1.95), addictive (4.29 ± 2.08), and socially acceptable (4.12 ± 2.03) of the products considered</li> <li>Electronic cigarettes were among the most positively perceived products (11.56 ± 4.22)</li> <li>Predictors of more favorable perceptions included: <ul> <li>Being male (p = 0.03)</li> <li>Parental tobacco smoking (p = 0.02)</li> <li>More friends who smoke cigarettes (p &lt;0.001)</li> <li>More friends who use hookah (p &lt;0.001)</li> <li>More friends who use electronic cigarettes (p = 0.04)</li> </ul> </li> </ul>	<ul> <li>Generalizability</li> <li>Responder bias</li> <li>Cross-sectional analysis</li> </ul>	
Camenga et al. (2015)	<ul> <li>Focus groups</li> <li>Purposive sampling</li> <li>Years sample drawn: 2012–2013</li> <li>Youth: middle and high school students in Connecticut; n = 68</li> <li>Young adults: college students in Connecticut; n = 59</li> </ul>	• Discuss the comparison between e-cigarettes and cigarettes.	<ul> <li>Compared with nonsmokers, college and high school smokers were more likely to believe the use of e-cigarettes could lead to a persistent "craving" that would prevent successful smoking cessation</li> <li>Compared with nonsmokers, college and high school smokers were more likely to believe that e-cigarette use would maintain nicotine addiction</li> </ul>	<ul> <li>Transferability</li> <li>Generalizability</li> <li>Limited definition of e-cigarettes</li> </ul>	

Study Design/population		Measures	Outcomes/findings	Comments
Cardenas et al. (2015)	<ul> <li>Cross-sectional</li> <li>School-based survey</li> <li>Three-stage cluster sampling</li> <li>Year sample drawn: 2012</li> <li>Youth: U.S. middle and high school students; full sample size not reported; subsample of children who never tried smoking cigarettes, n = 14,861</li> <li>Young adults: n/a</li> </ul>	• Do you believe that electronic cigarettes or e-cigarettes, such as Ruyan or NJOY, are less harmful, equally harmful, or more harmful than regular cigarettes?	<ul> <li>Participants who lived with a smoker were more likely to report e-cigarettes are less harmful than regular cigarettes (16.2% vs. 24.8%)</li> <li>E-cigarette users were more likely to believe e-cigarettes are less harmful than regular cigarettes (70.9% vs. 27.5%)</li> </ul>	• No limitations reported
Chaffee et al. (2015)	<ul> <li>Cross-sectional</li> <li>Year sample drawn: 2014</li> <li>Youth: male high school students from San Francisco; n = 104</li> </ul>	• Participants were asked to estimate the probability (0–100%) that specific health or social outcomes would happen to them as a result of e-cigarette use (e.g., heart attack, lung cancer, get into trouble, upset family, etc.)	• Ever use of electronic cigarettes was associated with lower perceived probabilities that unfavorable outcomes would happen	_
Lotrean (2015)	<ul> <li>Cross-sectional</li> <li>2013</li> <li>Students 19–24 years of age from Cluj-Napoca, Romania; n = 480</li> </ul>	• Belief that e-cigarettes are less dangerous than cigarettes: agree, partially agree, disagree, partially disagree, don't know	<ul> <li>55.9% of the total sample agreed or partially agreed that e-cigarettes are less dangerous, 35.8% did not know, and 8.3% disagreed or partially disagreed</li> <li>More smokers than nonsmokers or ex-smokers agreed or partially agreed that e-cigarettes are less dangerous (62.3% vs. 58.7% and 33.3%, respectively)</li> </ul>	<ul> <li>Very small sample</li> <li>Measures not clearly defined</li> </ul>

Study	Design/population	Measures	Outcomes/findings	Comments
McDonald and Ling (2015)	<ul> <li>Focus groups and semistructured interviews</li> <li>Recruitment from bars through screener surveys</li> <li>Years sample drawn: 2012–2013</li> <li>Youth: n/a</li> <li>Young adults: young adults in the boroughs of Manhattan, Brooklyn, and Queens in New York City, 18–27 years of age; N = 87</li> </ul>	• Perceived risks	<ul> <li>Little knowledge of the devices</li> <li>Belief that e-cigarettes contain harmless "water vapor" rather than smoke</li> <li>Belief that "water vapor" is less harmful or even "good" for users</li> </ul>	• No limitations reported
Roditis and Halpern- Felsher (2015)	<ul> <li>Focus groups</li> <li>Recruitment from after-school programs in urban Northern California</li> <li>2–6 participants in each group</li> <li>24 adolescents: 9 female, 15 male</li> </ul>	• Perceived risks and benefits associated with conventional cigarettes versus e-cigarettes	<ul> <li>Little knowledge of risks of e-cigarette use</li> <li>Belief that e-cigarettes have no nicotine</li> </ul>	_
Cooper et al. (2016)	<ul> <li>Cross-sectional</li> <li>Drawn from 2014 Texas Youth Tobacco Survey, a school-based survey</li> <li>Youth: students in grades 6–12 from 27 counties in Texas; N = 13,602</li> </ul>	• "How dangerous do you think it is for a person your age to use electronic cigarettes?"	<ul> <li>Those in the e-cigarette-only group viewed conventional cigarettes as more harmful than did those in the dual user group</li> <li>No differences in how harmful those in the e-cigarette-only group and the dual user group rated e-cigarettes</li> <li>Those in the cigarette-only group rated e-cigarettes as more harmful than did those in the dual user group rated e-cigarettes as more harmful than did those in the dual user group</li> </ul>	

*Note:* Studies in this table are sorted by year of publication and then alphabetically. **AOR** = adjusted odds ratio; **CI** = confidence interval; **NYTS** = National Youth Tobacco Survey.

Table 2.12a	Percentage of middle school and high school students who reported that using e-cigarettes on some days
	but not every day caused no harm, little/some harm, or a lot of harm <sup>a</sup> , by e-cigarette smoking status;
	National Youth Tobacco Survey (NYTS) 2015

	]	No harm		Little/some harm		A lot of harm	
Characteristic	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	
Overall	2,511	14.5 (13.4–15.8)	10,471	61.9 (60.3–63.5)	4,070	23.6 (22.2–25.0)	
E-cigarette use							
Never <sup>b</sup>	1,200	9.5 (8.4–10.8)	7,528	61.0 (59.4–62.6)	3,653	29.4 (28.0-30.9)	
Ever, but not past 30 days <sup>c</sup>	601	22.4 (20.3-24.6)	1,748	69.3 (66.4–72.1)	249	8.3 (7.0-9.9)	
Past 30 days <sup>d</sup>	641	34.2 (31.2–37.3)	1,089	59.0 (55.9-62.0)	126	6.8 (5.4-8.7)	

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

Notes: CI = confidence interval. There were 325 youth excluded due to missing responses for e-cigarette use.

<sup>a</sup>Includes responses to the question, "How much do you think people harm themselves when they use e-cigarettes some days but not every day?" Responses for "little harm" and "some harm" were combined.

<sup>b</sup>Includes those who reported never trying e-cigarettes.

<sup>c</sup>Includes those who reported trying e-cigarettes but not using e-cigarettes on 1 or more days in the past 30 days.

<sup>d</sup>Includes those who reported using e-cigarettes on 1 or more days in the past 30 days.

Table 2.12b	Percentage of middle school students who reported that using e-cigarettes on some days but not every
	day caused no harm, little/some harm, or a lot of harm <sup>a</sup> , by e-cigarette smoking status; National Youth
	Tobacco Survey (NYTS) 2015

	No harm		Little/some harm		A lot of harm	
Characteristic	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Overall	1,089	13.5 (11.9–15.4)	4,579	57.6 (56.1-59.2)	2,260	28.8 (27.1-30.6)
E-cigarette use						
Never <sup>b</sup>	658	9.9 (8.3–11.6)	3,927	58.0 (56.5-59.4)	2,141	32.2 (30.5–33.9)
Ever, but not past 30 days <sup>c</sup>	211	31.9 (27.7–36.3)	383	60.6 (55.7-65.4)	60	7.5 (5.4–10.4)
Past 30 days <sup>d</sup>	193	41.5 (35.6–47.6)	220	50.0 (44.3-55.7)	38	8.5 (6.0–12.0)

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

*Notes:* CI = confidence interval. There were 132 middle students excluded due to missing responses for e-cigarette use.

<sup>a</sup>Includes responses to the question, "How much do you think people harm themselves when they use e-cigarettes some days but not every day?" Responses for "little harm" and "some harm" were combined.

<sup>b</sup>Includes those who reported never trying e-cigarettes.

<sup>c</sup>Includes those who reported trying e-cigarettes but not using e-cigarettes on 1 or more days in the past 30 days.

<sup>d</sup>Includes those who reported using e-cigarettes, on 1 or more days in the past 30 days.

	]	No harm		Little/some harm		A lot of harm	
Characteristic	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	
Overall	1,422	15.3 (14.0–16.7)	5,892	65.3 (63.2–67.3)	1,810	19.4 (18.0-20.9)	
E-cigarette use							
Never <sup>b</sup>	542	9.2 (7.8–10.9)	3,601	64.3 (62.0-66.7)	1,512	26.4 (24.6-28.3)	
Ever, but not past 30 days <sup>c</sup>	390	19.5 (17.5–21.8)	1,365	71.9 (68.6–74.9)	189	8.6 (6.9–10.6)	
Past 30 days <sup>d</sup>	448	32.3 (28.8-35.9)	869	61.3 (57.8-64.8)	88	6.4 (4.8-8.4)	

# Table 2.12cPercentage of high school students who reported that using e-cigarettes on some days but not every<br/>day caused no harm, little/some harm, or a lot of harm<sup>a</sup>, by e-cigarette smoking status; National Youth<br/>Tobacco Survey (NYTS) 2015

Source: Centers for Disease Control and Prevention, unpublished data (data: NYTS 2015).

*Notes:* **CI** = confidence interval. There were 166 high school students excluded due to missing responses for e-cigarette use. <sup>a</sup>Includes responses to the question, *"How much do you think people harm themselves when they use e-cigarettes some days but not every day?"* Responses for "little harm" and "some harm" were combined.

<sup>b</sup>Includes those who reported never trying e-cigarettes.

<sup>c</sup>Includes those who reported trying e-cigarettes but not using electronic cigarettes on 1 or more days in the past 30 days. <sup>d</sup>Includes those who reported using e-cigarettes, on 1 or more days in the past 30 days.

# Table 2.12dPercentage of young adults (18–24 years of age) who reported that e-cigarettes were not at all harmful,<br/>moderately harmful, or very harmful<sup>a</sup>, by e-cigarette smoking status; National Adult Tobacco Study<br/>(NATS) 2013–2014

	Not at all harmful		Moderately harmful		Very harmful	
Characteristic	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Overall	796	19.4 (17.9–20.9)	2,260	53.8 (51.9-55.7)	1,053	26.8 (25.1-28.6)
E-cigarette use						
Never <sup>b</sup>	359	14.3 (12.7–16.2)	1,423	52.8 (50.4-55.2)	814	32.9 (30.6–35.2)
Ever, but not current <sup>c</sup>	210	22.9 (19.7-26.4)	520	56.8 (52.7-60.8)	186	20.3 (17.2-23.8)
Current <sup>d</sup>	227	36.4 (31.8-41.2)	317	53.6 (48.6–58.5)	53	10.0 (7.2–13.9)

Source: Centers for Disease Control and Prevention, unpublished data (data: NATS 2013-2014).

*Notes:* CI = confidence interval. There were three young adults who were excluded because of missing responses for both ECIGEVER and ECIGNOW.

<sup>a</sup>Includes responses to the question, "How harmful do you think using e-cigarettes are to a person's health?"

<sup>b</sup>Includes those who reported having never tried e-cigarettes or having never heard of them.

<sup>c</sup>Includes those who reported having heard of e-cigarettes and tried e-cigarettes but reported using them "not at all" at the time of the interview.

<sup>d</sup>Includes those who reported having heard of e-cigarettes, tried e-cigarettes, and using e-cigarettes some days, every day, or rarely at the time of the interview.

e-cigarettes (22%) (Sutfin et al. 2013). Just over half of the participants in this study who had never tried e-cigarettes, however, said that they did not know enough to judge the relative harm of e-cigarettes compared to conventional cigarettes. In this study and another study, lack of knowledge about the perceived harm of e-cigarettes relative to conventional cigarettes was associated with lower odds of using e-cigarettes (Sutfin et al. 2013; Choi and Forster 2014b). In the study by Choi and Forster (2014b), lower perceived harm of e-cigarettes and the belief at baseline that e-cigarettes can help people quit smoking were both associated at follow-up with a higher likelihood of having tried e-cigarettes.

#### **Reasons for Use and Discontinuation**

#### **Reasons for Use**

Table 2.13 summarizes studies of reasons for using and discontinuing e-cigarettes. The most commonly cited reasons for use by adolescent and young adult e-cigarette users included curiosity (Schmidt et al. 2014; Biener and Hargraves 2015; Biener et al. 2015; Kong et al. 2015; McDonald and Ling 2015; Suris et al. 2015; Sutfin et al. 2015), flavorings/taste (Ambrose et al. 2015; University of Michigan 2015), use as a less harmful/less toxic alternative to conventional cigarettes (Peters et al. 2013; Tucker et al. 2014; Ambrose et al. 2015; Kong et al. 2015; McDonald and Ling 2015; Sutfin et al. 2015), and avoidance of indoor smoking restrictions or disturbing people with secondhand smoke from conventional cigarettes (Tucker et al. 2014; Ambrose et al. 2015; Kong et al. 2015; McDonald and Ling 2015; Suris et al. 2015; Sutfin et al. 2015). Other reasons youth and young adults reported trying or using e-cigarettes included affordability and lower cost than conventional cigarettes (Tucker et al. 2014; Ambrose et al. 2015); accessibility and convenience (Choi et al. 2012; Kong et al. 2015); social approval and/or offer from a family member or friend (Peters et al. 2013; Kong et al. 2015; Suris et al. 2015; Sutfin et al. 2015); perception that e-cigarettes are "cool," "modern," or "high-tech" (Choi et al. 2012; Kong et al. 2015); avoidance of smelling cigarette smoke (Peters et al. 2013; Tucker et al. 2014; Ambrose et al. 2015; Kong et al. 2015; Sutfin et al. 2015); ease of keeping hidden from parents/teachers (Peters et al. 2013; Kong et al. 2015); and weight control (Tucker et al. 2014). Young adults also perceived that e-cigarettes were more socially acceptable than smoking conventional cigarettes in public (Trumbo and Harper 2013).

Some youth and young adults also reported using e-cigarettes as an aid to reducing and/or quitting their use of conventional cigarettes (Li et al. 2013; Schmidt et al. 2014; Tucker et al. 2014; Suris et al. 2015; Sutfin et al. 2015; Bold et al. 2016). Data from the 2012 NYTS, however, suggest that while e-cigarette use among U.S. youth may be associated with intentions to smoke conventional cigarettes, it is not associated with intentions to guit conventional cigarette smoking (Park et al. 2016). This is further reinforced by a study of young adults from Switzerland, which found that after 15 months of follow-up, e-cigarette use was not associated with either cessation or reduction in the use of conventional cigarettes (Gmel et al. 2016). There is some evidence to suggest that curiosity was a stronger driver of an e-cigarette trial among young adults than smoking cessation, and that smoking cessation was a stronger driver of such a trial among older adults (Schmidt et al. 2014). Other evidence suggests that reasons for use were driven by tobacco-use status, with regular adolescent e-cigarette users much more likely than adolescents who had used e-cigarettes just once to give the reason for use as smoking cessation, smoking reduction, or avoidance of smoke-free air regulations (Suris et al. 2015). Nationwide, according to the 2015 MTF (University of Michigan 2015), "because they tasted good" was cited as a reason to use e-cigarettes among 40% of 8th-, 10th-, and 12th-grade users, versus just 10% who reported they used them in an attempt to quit smoking conventional cigarettes. In a New Zealand study, interest in using e-cigarettes to quit using conventional cigarettes was higher among young adults than older adults (Li et al. 2013). Finally, another study, this one conducted among high school, middle school, and college students in Connecticut in 2012–2013, found that although the students were aware that e-cigarettes could be used to aid in smoking cessation, they thought that few smokers had successfully used e-cigarettes to guit smoking (Camenga et al. 2015). However, in an article published by this group (Bold et al. 2016), trying e-cigarettes to quit smoking was the most robust predictor of continued e-cigarette use 6 months later, using a multivariable model that included all reasons simultaneously, though this reason was only endorsed at baseline by 5.9% of youth. Low cost was the most robust predictor of more frequent use 6 months later, though only 10% of students endorsed this reason at baseline (Bold et al. 2016). Therefore, the reasons to experiment with e-cigarettes are likely different from the reasons to continue using them, over time.

No randomized controlled trials specific to the efficacy of using e-cigarettes for quitting conventional cigarette smoking for young adults have been conducted to date. Although use of e-cigarettes as a potential cessation device for conventional cigarette smoking among adults is important to examine (e.g., McRobbie et al. 2014; McNeill et al. 2015), none of this evidence is included here, as it does not directly discuss youth and young adults. Three observational studies specific to this issue, however, have been conducted among young adults to date. Data from

Study	Design/population	Measures	Outcomes/findings
Adkison et al. (2013)	<ul> <li>Parallel prospective cohort</li> <li>Telephone interview and web-based surveys</li> <li>Probability sampling methods (random-digit dialing)</li> <li>Years sample drawn: 2010–2011 (Wave 8), 2008–2009 (Wave 7; where available)</li> <li>Youth: n/a</li> <li>Young adults: current smokers, ≥18 years of age; N = 5,939 (Canada, n = 1,581; U.S., n = 1,520; United Kingdom, n = 1,325; Australia, n = 1,513)</li> </ul>	<ul> <li>Four questions were asked regarding reasons for use (yes/no):</li> <li>1. Electronic cigarettes may not be as bad as cigarettes for your health</li> <li>2. Easier to cut down on the number of cigarettes you smoke</li> <li>3. Can smoke in places where smoking conventional cigarettes is prohibited</li> <li>4. Might help you quit</li> </ul>	• Not explicitly reported for young adults
Choi et al. (2012)	<ul> <li>Focus groups</li> <li>Recruitment by (1) online advertisements, (2) flyers on one 4-year and two 2-year college campuses, (3) announcements in student life newsletter at a 2-year college, and (4) recruitment booth on a 2-year college campus</li> <li>Year sample drawn: 2010</li> <li>Youth: n/a</li> <li>Young adults: Individuals in Minneapolis-St. Paul, MN, enrolled in or who had graduated from 4-year colleges, or those who were enrolled in or had graduated from 2-year colleges, or those who had not enrolled in postsecondary education; N = 66</li> </ul>	• Potential as quit aids	<ul> <li>Ineffective as quit aids because:</li> <li>Contain nicotine</li> <li>Potential to be addicted to e-cigarettes</li> <li>Eliminate social interaction aspect</li> <li>Potential to help quit smoking because:</li> <li>Potential for gradual reduction in nicotine</li> </ul>

Table	2.13	Continued
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Study	Design/population	Measures	Outcomes/findings
Choi and Forster (2013)	<ul> <li>Population-based prospective cohort study</li> <li>Interview</li> <li>Cluster random sampling</li> <li>Years sample drawn: 2010–2011</li> <li>Youth: n/a</li> <li>Young adults: U.S. midwestern adults, 20–28 years of age; n = 2,624 (sample from Minnesota)</li> </ul>	<ul> <li>Indicate your level of agreement: <ol> <li>E-cigarettes can help people quit smoking</li> <li>E-cigarettes are less harmful than cigarettes</li> <li>E-cigarettes are less addictive than cigarettes</li> </ol> </li> </ul>	<ul> <li>44.5% agreed e-cigarettes can help quit smoking; associated with the following characteristics: <ul> <li>Not being non-Hispanic White (AOR = 0.60; CI, 0.44–0.84)</li> <li>Enrolled/graduated from 2-year college (AOR = 1.47; CI, 1.09–1.98)</li> <li>Current smoker (AOR = 1.35; CI, 1.05–1.73)</li> <li>At least one close friend who smokes (AOR = 1.27; CI, 1.03–1.57)</li> </ul> </li> <li>52.9% agreed e-cigarettes are less harmful than cigarettes; associated with the following characteristics: <ul> <li>Not being non-Hispanic White (AOR = 0.73; CI, 0.53–0.99)</li> <li>Male (AOR = 1.39; CI, 1.15–1.67)</li> <li>Current smoker (AOR = 1.42; CI, 1.11–1.83)</li> </ul> </li> <li>26.4% agreed e-cigarettes are less addictive than cigarettes; associated with the following characteristics: <ul> <li>Current smoker (AOR = 1.51; CI, 1.15–1.99)</li> <li>Former smoker (AOR = 1.64; CI, 1.19–2.25)</li> <li>At least one close friend who smokes (AOR = 1.28; CI, 1.00–1.63)</li> </ul> </li> </ul>
Faletau et al. (2013)	<ul> <li>Qualitative exploratory</li> <li>Structured focus groups and individual interviews</li> <li>Recruited from two low socioeconomic primary schools in East and South Auckland, New Zealand</li> <li>Year sample drawn: 2011</li> <li>Youth: Maori, Tongan, Samoan, Cook Island, and Niuean children, 6–10 years of age; N = 20</li> <li>Young adults: n/a</li> </ul>	• Viewed tobacco cigarette and electronic cigarette videos	<ul> <li>Stops people from smoking</li> <li>People won't die</li> <li>Protects those around e-cigarette users from sickness</li> </ul>

Study	Design/population	Measures	Outcomes/findings
Li et al. (2013)	<ul> <li>Cross-sectional</li> <li>Telephone-based survey</li> <li>Random-digit-dial sampling</li> <li>Years sample drawn: 2011–2012</li> <li>Youth: n/a</li> <li>Young adults: current smokers and recent quitters, ≥18 years of age, in New Zealand; N = 840</li> </ul>	<ul> <li>Indicate your level of agreement:</li> <li>1. E-cigarettes are safer to use than tobacco cigarettes (n = 317)</li> <li>2. E-cigarettes can help people quit smoking tobacco (n = 313)</li> </ul>	<ul> <li>OR = 1.81 (.78–4.18) among participants 18–24 years of age for perceived safety of e-cigarettes compared with participants ≥45 years of age</li> <li>OR = 0.50 (0.21–1.17) among participants 18–24 years of age for perceived efficacy of e-cigarettes compared with participants ≥45 years of age</li> </ul>
Pepper et al. (2013)	<ul> <li>Cross-sectional</li> <li>Web-based survey</li> <li>Recruited through parents who were members of an online panel assembled by random-digit dialing and address- based sampling.</li> <li>Year sample drawn: 2011</li> <li>Youth: U.S. males, 11–17 years of age; N = 228</li> <li>Young adults: n/a</li> </ul>	<ul> <li>If one of your best friends were to offer you an e-cigarette, would you try it?</li> <li>If one of your best friends were to offer you a flavored e-cigarette (chocolate, mint, apple, etc.), would you try it?</li> </ul>	<ul> <li>Overall, 18% were willing to try an e-cigarette if offered by a best friend: <ul> <li>13% willing to try a plain e-cigarette</li> <li>5% willing to try flavored e-cigarettes or both kinds</li> </ul> </li> <li>Willingness to try e-cigarettes by age: <ul> <li>11–13: 11%</li> <li>14–16: 15%</li> <li>17–19: 29%</li> </ul> </li> <li>OR = 3.26 (CI, 1.27–8.35) among those 17–19 years of age for willingness to try an e-cigarette, compared with those 11–13 years of age</li> <li>Willingness to try e-cigarettes by smoking status: <ul> <li>Nonsmoker: 13%</li> <li>Smoker: 74%</li> </ul> </li> <li>OR = 18.67 (6.22–55.98) among smokers for willingness to try an e-cigarette, compared with nonsmokers</li> </ul>
Peters et al. (2013)	<ul> <li>Focus groups</li> <li>Recruitment through large, diverse high school in southwestern United States</li> <li>Year sample drawn: 2012</li> <li>Youth: U.S. teenage boys; N = 47</li> <li>Young adults: n/a</li> </ul>	<ul> <li>Why do youth use electronic cigarettes?</li> <li>What do your friends think about electronic cigarettes?</li> <li>Why are electronic cigarettes so popular?</li> </ul>	<ul> <li>Reported reasons for use among youth: <ul> <li>Expeditious consumption and concealment: 40%</li> <li>High school approval: 26%</li> <li>Healthier than cigarettes: 19%</li> <li>Odorless: 15%</li> </ul> </li> <li>Reported perceptions of friends: <ul> <li>High school approval: 49%</li> <li>Healthier than cigarettes: 36%</li> <li>Safe high: 15%</li> </ul> </li> <li>Reported reasons for popularity: <ul> <li>Accessibility: 43%</li> <li>Healthier than cigarettes: 30%</li> <li>Aesthetics: 23%</li> </ul> </li> </ul>

Study	Design/population	Measures	Outcomes/findings
Trumbo and Harper (2013)	<ul> <li>Cross-sectional</li> <li>Web-based survey</li> <li>Recruitment by offer of extra credit to students in a 100-level course</li> <li>Year sample drawn: 2011</li> <li>Youth: n/a</li> <li>Young adults: freshmen and sophomores in a 100-level mass media in society course; n = 244</li> </ul>	<ul> <li>Indicate your level of agreement with relative advantage: <ol> <li>I think e-cigarettes are safer in terms of "secondhand" smoke compared to tobacco cigarettes</li> <li>I think e-cigarettes are not as harmful to users as tobacco cigarettes</li> </ol> </li> <li>Indicate your level of agreement with compatibility: <ol> <li>I think e-cigarette users can easily make use of existing smoking areas</li> <li>I believe using e-cigarettes would fit in well with the lifestyle of most smokers</li> </ol> </li> <li>Indicate your level of agreement with complexity: <ol> <li>I believe it will not be difficult for smokers to learn how to use e-cigarettes</li> <li>Overall, e-cigarettes are no more complicated to use than ordinary tobacco cigarettes</li> </ol> </li> <li>Indicate your level of agreement with "trialability": <ol> <li>I think it will be easy for people to purchase e-cigarettes</li> <li>Smokers could easily give e-cigarettes a try to see if they like them better than tobacco</li> </ol> </li> </ul>	• Mean score (SD) of innovation items: 36.0 (4.7)
Zhu et al. (2013)	<ul> <li>Population</li> <li>Online-based surveys</li> <li>National probability sample</li> <li>Year sample drawn: 2012</li> <li>Youth: n/a</li> <li>Young adults: U.S. adults, &gt;18 years of age; N = 10,041</li> </ul>	<ul> <li>Why did you use e-cigarettes (yes/no)?</li> <li>1. Safer than cigarettes</li> <li>2. Cheaper than cigarettes</li> <li>3. Easy to use when I can't smoke</li> <li>4. To try to quit smoking cigarettes</li> <li>5. Just because</li> </ul>	• Not explicitly reported for young adults

Study	Design/population	Measures	Outcomes/findings
Choi and Forster (2014b)	<ul> <li>Population-based prospective cohort study</li> <li>Survey</li> <li>Cluster random sampling</li> <li>Years sample drawn: 2011–2012</li> <li>Youth: n/a</li> <li>Young adults: participants in Minnesota Adolescent Community Cohort; n = 1,379</li> </ul>	<ul> <li>Indicate your level of agreement with the following:</li> <li>1. Using e-cigarettes can help people quit smoking</li> <li>2. Using e-cigarettes is less harmful to health of the user than smoking cigarettes</li> <li>3. E-cigarettes are less addictive than cigarettes</li> </ul>	<ul> <li>10% agreed that e-cigarettes can help people quit smoking; associated with e-cigarette experimentation at follow-up (AOR = 1.98; CI, 1.29–3.04)</li> <li>10.1% agreed that e-cigarettes are less harmful than cigarettes; associated with e-cigarette experimentation at follow-up (AOR = 2.34; CI, 1.49–3.69)</li> <li>9.3% agreed that e-cigarettes are less addictive than cigarettes</li> </ul>
Czoli et al. (2014)	<ul> <li>Cross-sectional</li> <li>Survey</li> <li>Recruitment through online panel of commercial market research company</li> <li>Year sample drawn: 2012</li> <li>Youth: Canadian youth recruited from online panel, 16–30 years of age; n = 1,188</li> <li>Young adults: Canadian young adults recruited from same online panel</li> </ul>	<ul> <li>Indicate your agreement with the following reasons for trying e-cigarettes: <ol> <li>In places where you can't smoke cigarettes</li> <li>For times when you don't want to smoke around others</li> <li>To help you cut back on the amount you smoke</li> <li>To help you while you are trying to quit smoking</li> <li>As a long-term replacement for cigarettes</li> <li>As a cheaper alternative to cigarettes</li> </ol> </li> </ul>	<ul> <li>Reasons for trying e-cigarettes among current cigarette smokers: <ul> <li>To help cut back on the amount they smoked (77.7%)</li> <li>As a long-term replacement for cigarettes (77.8%)</li> <li>For the times when they don't want to smoke around others (78.8%)</li> <li>To help them while they are trying to quit smoking (80.4%)</li> <li>As a cheaper alternative to cigarettes (80.7%)</li> <li>In places where they can't smoke cigarettes (80.9%)</li> </ul> </li> </ul>
Li et al. (2014)	<ul> <li>Cross-sectional</li> <li>Telephone-based survey</li> <li>Recruitment by telephone-based omnibus survey and quitline client database</li> <li>Year sample drawn: 2013</li> <li>Youth: n/a</li> <li>Young adults: current smokers and recent quitters, ≥18 years of age, in New Zealand; N = 267</li> </ul>	<ul> <li>Indicate your level of agreement:</li> <li>1. Electronic cigarettes are for people who want to stop smoking completely</li> <li>2. Electronic cigarettes are for people who want to cut down on their smoking</li> <li>3. Electronic cigarettes are for people who want to still smoke in restricted public places such as inside a cafe, restaurant, or pub</li> </ul>	<ul> <li>OR = 1.99 (CI, 0.99–3.97) among those 18–34 years of age for agreeing that "electronic cigarettes are for people who want to stop smoking completely," compared with individuals ≥35 years of age</li> <li>OR = 0.72 (CI, 0.24–2.21) among those 18–34 years of age for agreeing that "electronic cigarettes are for people who want to cut down on their smoking," compared with individuals ≥35 years of age</li> <li>OR = 0.93 (0.47–1.85) among those 18–34 years of agreeing that "electronic cigarettes are for people who want to still smoke in restricted public places such as inside a cafe, restaurant or pub," compared with individuals ≥35 years of age</li> </ul>

Study	Design/population	Measures	Outcomes/findings
Schmidt et al. (2014)	<ul> <li>Cross-sectional</li> <li>Telephone-based survey</li> <li>Random-digit-dial sampling</li> <li>Year sample drawn: 2013</li> <li>Youth: n/a</li> <li>Young adults: noninstitutionalized adults in Montana; n = 5,000</li> </ul>	<ul> <li>Select all of the reasons you initiated use of e-cigarettes: <ol> <li>To quit smoking cigarettes</li> <li>To reduce cigarette consumption</li> <li>To try something new (curiosity)</li> <li>To not disturb other people with smoke</li> <li>To smoke in a place where cigarette smoking is prohibited</li> <li>To save money</li> <li>E-cigarettes might be less harmful than cigarettes</li> <li>E-cigarettes taste better</li> <li>Other</li> </ol> </li> </ul>	<ul> <li>Among those 18–34 years of age, approximately 50% reported trying e-cigarettes to quit or reduce cigarette use</li> <li>Among those 18–34 years of age, approximately 70% reported trying e-cigarettes to try something new (curiosity)</li> </ul>
Tucker et al. (2014)	<ul> <li>Cross-sectional</li> <li>Paper-based survey</li> <li>Probability-based sampling</li> <li>Year sample drawn: not reported</li> <li>Youth: n/a</li> <li>Young adults: homeless young adults, 17–25 years of age; N = 292 (subset of lifetime e-cigarette users, n = 83)</li> </ul>	• 18-item measure of reasons for using e-cigarettes, rating each reason on a 4-point scale (1 = not at all true, 4 = very true)	<ul> <li>Most common reasons for use included: <ul> <li>Not having to go outside to smoke cigarettes (38%)</li> <li>To deal with situations or places where they cannot smoke (36%)</li> <li>To avoid bothering other people with tobacco smoke (31%)</li> </ul> </li> <li>Less common to report using e-cigarettes was to quit smoking (17–18%)</li> </ul>
Ambrose et al. (2015)	<ul> <li>Cross-sectional</li> <li>Wave 1 of PATH study</li> <li>Household-based, nationally representative survey</li> <li>Youth: 12–17 years of age; n = 13,651</li> <li>Young adults: n/a</li> </ul>	• Past 30-day e-cigarette users were asked to report reasons for product use, including "it comes in flavors I like"	<ul> <li>81.5% of past-30-day users cited "because they come in flavors I like" as a reason for using e-cigarettes</li> <li>Other common reasons for use were "they might be less harmful to me than cigarettes" (79.1%); "they might be less harmful to people around me than cigarettes" (78.1%); and "I can smoke/use them at times when or in places where smoking cigarettes isn't allowed" (58.9%)</li> </ul>
Biener et al. (2015)	<ul> <li>Cross-sectional</li> <li>Population-based mail survey</li> <li>Dual-frame sample</li> <li>Youth: n/a</li> <li>Young adults: 18–25 years of age; n = 4,740</li> </ul>	<ul> <li>Reasons for trying: curiosity, use by friends, health risks relative to cigarettes, absence of smell, for use where smoking is prohibited, and to quit or cut down on smoking</li> <li>Reasons for stopping e-cigarette use: health concerns, negative reactions to taste and feeling sick, inferiority to other forms of tobacco, expense, lack of availability, and social disapproval</li> </ul>	• Most common reason cited was curiosity, with never smokers more likely to cite this (77.3%) than former or current cigarette smokers (59% and 61%)

Study	Design/population	Measures	Outcomes/findings
Camenga et al. (2015)	<ul> <li>Focus groups</li> <li>Purposive sampling</li> <li>Years sample drawn: 2012–2013</li> <li>Youth: middle and high school students in Connecticut; n = 68</li> <li>Young adults: college students in Connecticut; n = 59</li> </ul>	• Discuss your motivations to use e-cigarettes	<ul> <li>Maintain smoking actions while allowing individuals to use a "healthier" nicotine product</li> <li>Maintain tactile sensations to help with conditioned- smoking cues</li> <li>College students believed e-cigarettes to be healthier than cigarettes</li> </ul>
Kong et al. (2015)	<ul> <li>Cross-sectional</li> <li>Focus groups, schoolwide survey</li> <li>Recruitment by flyers and active recruitment sessions</li> <li>Years sample drawn: 2012–2013</li> <li>Youth: New Haven County, Connecticut, middle and high school students; focus group n = 127 (youth and young adults); survey n = 4,780</li> <li>Young adults: New Haven County, Connecticut, college students; focus group n = 127 (youth and young adults); survey n = 625</li> </ul>	<ul> <li>Focus group:</li> <li>Why do you think people your age would use e-cigarettes?</li> <li>Survey: <ul> <li>Why did you try an e-cigarette?</li> <li>If you tried an e-cigarette but stopped using it, why did you stop?</li> </ul> </li> </ul>	<ul> <li>Focus group responses: <ul> <li>Reasons for use:</li> <li>Influence of family and friends</li> <li>To be "cool"</li> <li>Curiosity</li> <li>Readily available</li> <li>Flavors</li> </ul> </li> <li>Comparison to cigarettes: <ul> <li>Healthier</li> <li>Less harsh</li> <li>Cheaper</li> <li>Smells better</li> <li>More convenient</li> <li>Can hide it</li> <li>Use it indoors</li> </ul> </li> <li>Reasons for discontinuation: <ul> <li>Losing interest</li> <li>Negative physical effects (e.g., light-headed)</li> <li>Bad taste</li> <li>High cost</li> <li>Less satisfying than cigarettes</li> </ul> </li> <li>Survey responses: <ul> <li>Reasons for experimentation (among lifetime e-cigarette users):</li> <li>Curiosity (54.4%)</li> <li>Friends' influence (31.6%)</li> <li>Reasons for discontinuation: <ul> <li>Uncool (16.3%)</li> <li>Health risks (12.1%)</li> </ul> </li> </ul></li></ul>

Study	Design/population	Measures	Outcomes/findings
Li et al. (2015)	<ul> <li>Cross-sectional</li> <li>2014</li> <li>Nationwide, in-home survey in New Zealand</li> <li>Multistage, stratified, clustered, and random probability sampling method (oversampling of Maori and Pacific peoples)</li> <li>Participants ≥15 years of age; n = 2,594: <ul> <li>Youth: 15–17 years of age, 3.8% of sample</li> <li>Young adults: 18–24 years of age, 13.4% of sample</li> </ul> </li> </ul>	• Why did you try using an electronic cigarette? (Multiple responses allowed— wanted to quit smoking cigarettes completely/wanted to replace smoking cigarettes some of the time/wanted to smoke in places where cigarette smoking is not allowed/cheaper than tobacco cigarettes/ safer than tobacco cigarettes/curiosity/ recommendation/other)	<ul> <li>57.1% of ever users cited curiosity as a reason for first trying, followed by 31.3% of ever users who cited wanting to quit smoking completely</li> <li>Current e-cigarette users were more likely than noncurrent users to report wanting to quit smoking completely as a reason for using e-cigarettes</li> </ul>
McDonald and Ling (2015)	<ul> <li>Focus groups and semistructured interviews</li> <li>Recruitment from bars through screener surveys</li> <li>Years sample drawn: 2012–2013</li> <li>Youth: n/a</li> <li>Young adults: young adults in the boroughs of Manhattan, Brooklyn, and Queens in New York City, 18–27 years of age; N = 87</li> </ul>	<ul><li>Bodily sensations</li><li>Use in response to clean air laws</li></ul>	<ul> <li>Vapor described as "harsh" or "burning"</li> <li>Discontinued use because believed it would cause one to smoke more</li> <li>Discontinued use due to fear of nicotine hangover</li> <li>Use to smoke in places where conventional smoking is not allowed</li> </ul>
Pokhrel et al. (2015)	<ul> <li>Cross-sectional</li> <li>Web-based survey</li> <li>Recruitment by flyers across three college campuses</li> <li>Year sample drawn: 2013</li> <li>Youth: n/a</li> <li>Young adults: U.S. students from a 4-year university and two 2-year community colleges in Oahu, Hawaii; n = 307</li> </ul>	<ul> <li>Fourteen items, scored on a scale of 1 (do not agree) to 7 (agree), address three main beliefs. E-cigarettes:</li> <li>Are less harmful than cigarettes</li> <li>Improve the health of current smokers</li> <li>May be used to quit smoking</li> </ul>	<ul> <li>Participants generally scored harm-reduction items higher</li> <li>Among health benefit items, "e-cigarettes improve breathing and reduce coughing" received the highest average score: mean (SD) = 3.9 (1.6)</li> <li>Among smoking-cessation items, "e-cigarettes are a good compromise for people trying to quit smoking" received the highest average score: mean (SD) = 4.6 (1.8)</li> <li>Across all items, "e-cigarettes cut down on the harmful effects of secondhand smoke" was scored the highest: mean (SD) = 5.3 (1.7)</li> <li>69% of participants agreed with the above item</li> </ul>

Study	Design/population	Measures	Outcomes/findings
Suris (2015)	<ul> <li>Cross-sectional</li> <li>Data drawn from spring 2014 wave of <i>ado</i> @ <i>internet.ch</i>, a longitudinal study on Internet use</li> <li>Representative sample of students in French-speaking part of Switzerland</li> <li>Sample of 621 students included never e-cigarette users (n = 353), experimenters (n = 120), and users (n = 148); mean age = 16.2 years</li> </ul>	<ul> <li>Reason for having used e-cigarettes?</li> <li>Curiosity</li> <li>To smoke where it is forbidden</li> <li>To reduce smoking</li> <li>To do like my friends</li> <li>To quit smoking</li> <li>Other</li> </ul>	• Experimenters were significantly more likely to have used e-cigarettes for curiosity while users were more likely to use them where it is forbidden to smoke (p<.01)
Sutfin (2015)	<ul> <li>Longitudinal cohort study</li> <li>Data from the Smokeless Tobacco Use in College Students Study</li> <li>College students from North Carolina and Virginia</li> <li>Reasons for e-cigarette use were evaluated at Wave 6 of the study, n = 271</li> </ul>	<ul> <li>Why did you try e-cigarettes? (check all that apply):</li> <li>"I was curious about the product"</li> <li>"It might be better for my health than smoking cigarettes"</li> <li>"My friends use e-cigarettes"</li> <li>"I can use it in places where cigarette smoking is not allowed"</li> <li>"To help me quit smoking"</li> <li>"To cut down on smoking"</li> <li>"It doesn't smell bad"</li> </ul>	<ul> <li>The majority (91.6%) reported curiosity as a reason for trying e-cigarettes</li> <li>More than 70% tried e-cigarettes because their friends used them</li> <li>About 70% tried e-cigarettes because they believed them to be better for their health than cigarettes</li> <li>Fifty percent cited, "It doesn't smell bad," and "I can use it where cigarette smoking is not allowed"</li> <li>About 31% said that they used e-cigarettes to cut down on smoking</li> <li>Twenty percent said that they tried e-cigarettes to help them quit smoking</li> </ul>
University of Michigan (2015)	<ul> <li>Cross-sectional</li> <li>Data from the Monitoring the Future Study</li> <li>School-based, self-administered, paper- and-pencil questionnaire with cross- sectional and longitudinal components</li> <li>Students from 8th, 10th, and 12th grades</li> <li>Weighted sample of students responding to the "reasons for use of electronic vaporizer" question: 603 (8th grade), 846 (10th grade), and 1,449 (12th grade)</li> </ul>	<ul> <li>"What have been the most important reasons for your using an electronic vaporizer, such as an e-cigarette?" <ul> <li>To help me quit regular cigarettes</li> <li>Because regular cigarette use is not permitted</li> <li>To experiment to see what it's like</li> <li>To relax or relieve tension</li> <li>To feel good or get high</li> <li>Because it looks cool</li> <li>To have a good time with my friends</li> <li>Because it tastes good</li> <li>Because I am "hooked"—I have to have it</li> </ul> </li> </ul>	<ul> <li>More than half of all students in 8th, 10th, and 12th grades reported that curiosity to see what they were like was a primary reason for use</li> <li>Forty percent said that they used e-cigarettes because they tasted good</li> <li>About 10% said they used them in an attempt to quit smoking regular cigarettes</li> </ul>

Study	Design/population	Measures	Outcomes/findings
Berg (2016)	<ul> <li>Cross-sectional</li> <li>Recruitment through Facebook targeting of tobacco and marijuana users and nonusers</li> <li>2014</li> <li>Youth: n/a</li> <li>Young adults: 18–34 years of age, living in the United States; N = 1,567</li> </ul>	<ul> <li>Reasons for use: For what reasons do you/ might you use e-cigarettes?</li> <li>Reasons for discontinued use: Why have you not used recently?</li> </ul>	<ul> <li>Reasons for use among current e-cigarette users: <ul> <li>"They might be less harmful than cigarettes" (77%)</li> <li>"They do not smell" (77%)</li> <li>"They help people quit smoking" (66%)</li> <li>"They cost less than other forms of tobacco" (62%)</li> </ul> </li> <li>Reasons for use among nonusers: <ul> <li>"They might be less harmful than cigarettes" (41%)</li> <li>"They don't smell" (34%)</li> </ul> </li> <li>Reasons for discontinuation: <ul> <li>"Using other tobacco products instead" (43%)</li> <li>"They are too expensive" (35%)</li> <li>"I just don't think about it" (31%)</li> </ul> </li> </ul>
Bold (2016)	<ul> <li>Longitudinal</li> <li>Youth: New Haven County, Connecticut, middle and high school students</li> <li>2013–2014</li> <li>340 e-cigarette users at baseline</li> </ul>	<ul> <li>Reasons for first trying e-cigarettes: <ul> <li>Curiosity</li> <li>It is cool</li> <li>Good flavors</li> <li>Does not smell bad</li> <li>Can hide it from adults</li> <li>Low cost</li> <li>My friends use it</li> <li>My parents/family use it</li> <li>Can use it anywhere</li> <li>To quit smoking regular cigarettes</li> <li>It is healthier than regular cigarettes</li> </ul> </li> </ul>	<ul> <li>In multivariable model, including all reasons simultaneously, trying e-cigarettes to quit smoking was the most robust predictor of current (i.e., past 30 days) e-cigarette use 6 months later; however, this reason was endorsed by very few youth (5.9%)</li> <li>In multivariable model, including all reasons simultaneously, trying e-cigarettes because of low cost was the most robust predictor of more frequent e-cigarette use (i.e., more days/month) 6 months later; this reason was endorsed by few youth (10%)</li> </ul>

*Note:* Studies in this table are sorted by year of publication and then alphabetically. AOR = adjusted odds ratio; OR = odds ratio; PATH = Population Assessment of Tobacco and Health Study; SD = standard deviation.

a population-based cohort study of U.S. young adults in the Midwest suggest that e-cigarettes are not effective as a technique for guitting the use of conventional cigarettes. In that study, 11% of cigarette smokers who had used e-cigarettes in the past 30 days at baseline quit smoking at the 1-year follow-up, compared with 17% of cigarette smokers who had never used e-cigarettes (OR = 0.93, p = 0.93) (Choi and Forster 2014a). Another cohort study of Swiss young adult men concluded that there were no beneficial effects of vaping for conventional cigarette smoking cessation or smoking reduction (Gmel et al. 2016). In this study, e-cigarette users reported lower cigarette smoking cessation rates at follow-up among those who were occasional cigarette smokers at baseline (OR = 0.43; 95% CI, 0.19-0.96). No differences between e-cigarette users and nonusers were noted among those who were daily cigarette smokers at baseline (OR = 0.42; 95% CI, 0.15-1.18). No differential changes between e-cigarette users and nonusers in the number of conventional cigarettes smoked per week were noted at followup, either (Gmel et al. 2016). In a study by Unger and colleagues (2016), which focused on Hispanic young adults in California, e-cigarette use at baseline (2014) was not

## **Evidence Summary**

The most recent estimates available show that 13.5% of middle school students (2015), 37.7% of high school students (2015), and 35.8% of young adults (2013–2014) had ever used an e-cigarette (Tables 2.1a, 2.1b, and 2.4a). The most recent data also show that past-30-day use of e-cigarettes is higher among high school students (16% in 2015) and young adults (13.6% in 2013–2014) than among middle school students (5.3% in 2015) and adults (25 years of age and older) (5.7% in 2013-2014) (Tables 2.1b, 2.4a, and 2.4b). Among youth and young adults, rates of ever and past-30-day use of e-cigarettes have increased greatly since the earliest e-cigarette surveillance efforts began in 2011. The increases among adults 25 years of age and older, by comparison, have been less steep. Among middle school and high school students, both ever use and past-30-day use of e-cigarettes more than tripled from 2011 to 2015 (NYTS 2011–2015; Figures 2.1 and 2.2) (CDC 2013a; Ambrose et al. 2014; Lippert 2015), and among young adults (18–24 years of age), the prevalence of ever use more than doubled from 2013 to 2014 (Styles 2013–2014; Figure 2.3).

Among youth, past-30-day exclusive use of e-cigarettes among 8th, 10th, and 12 graders (6.8%, 10.4%, and 10.4%, respectively) was more common than exclusive use of conventional cigarettes (1.4%, 2.2%, and 5.3% in those grades) or dual use of e-cigarettes and conventional

associated with cessation of cigarette smoking (OR = 1.31; 95% CI, 0.73–2.36) or marijuana use (OR = 1.05; 95% CI, 0.54–2.01) at follow-up (2015), though e-cigarette use at baseline did increase the likelihood of transitioning from nonuser to user of cigarettes (OR = 3.32; 95% CI, 1.55–7.10) and marijuana (OR = 1.97; 95% CI, 1.01–3.86) (Unger et al. 2016). Additional research is required to determine any potential efficacy of e-cigarette use for conventional cigarette smoking cessation in young adults.

## **Reason for Discontinuation**

In the small number of published studies on reasons for discontinuation of e-cigarette use in young users, adolescent and young adult smokers have cited lack of satisfaction and e-cigarettes' poor taste and cost (Kong et al. 2015) as reasons for discontinuing. Additional reasons have included negative physical effects (e.g., feeling lightheaded) (Kong et al. 2015) and loss of interest. In one study of young adults aged 18–35, former and never smokers of conventional cigarettes also cited the idea that e-cigarettes were "bad for their health" as a reason for discontinuation (Biener and Hargraves 2015; Biener et al. 2015).

cigarettes (2.4%, 3.5%, and 5.8% in those grades) (Table 2.5; Figure 2.4). However, among young adults 18–24 years of age, the patterns were different. In that group, exclusive use of conventional cigarettes surpassed exclusive use of e-cigarettes and use of both types of products (Figure 2.8). For example, in 2013–2014, 9.6% of young adults smoked conventional cigarettes exclusively, 6.1% were current users of e-cigarettes, and 7.5% currently used both. The use of e-cigarettes and other tobacco products, such as combustibles, appeared to co-vary among youth and young adults (Figures 2.6, 2.7, and 2.8). Although five longitudinal studies suggest that e-cigarette use is related to the onset of other tobacco product and marijuana use among youth and young adults (Leventhal et al. 2015; Primack et al. 2015; Barrington-Trimis et al. 2016; Unger et al. 2016; Wills et al. 2016), some studies had limitations in their ability to distinguish experimental smokers from regular smokers at follow-up (Leventhal et al. 2015; Primack et al. 2015; Barrington-Trimis et al. 2016; Wills et al. 2016). Therefore, more studies are needed to elucidate the nature of any true causal relationship between e-cigarette use and combustible tobacco products. Investigation of whether e-cigarette use is related to other types of substance abuse (e.g., marijuana, alcohol) might help distinguish the extent to which e-cigarette use may precede or follow other forms of substance use in the context of the common liability/ vulnerability model (Vanyukov et al. 2012).

Although use of other tobacco products has been the strongest correlate of ever and past-30-day e-cigarette use among youth and young adults, sociodemographic characteristics have also been associated with the use of these products. Across both ever use and past-30-day use measures, e-cigarette use has been more common among high school than middle school students, a pattern similar to trends seen in other categories of tobacco products (CDC 2015c). Among middle school students in 2014 and 2015 (CDC 2016), ever e-cigarette use was highest for Hispanics (Table 2.1a); among high school students, ever use was highest among Hispanics and Whites (Table 2.1b). No differences between boys and girls were observed among middle school students in 2015 (Tables 2.1a, 2.1b). However, in 2015 male high school students were significantly more likely to report past-30-day use than their female counterparts (Table 2.2b) (CDC 2016). For young adults, ever and past-30-day use of e-cigarettes were significantly higher among males than females (Table 2.4a). Current e-cigarette use was significantly lower among Blacks than in other racial/ethnic groups (Table 2.4a). Ever and past-30-day e-cigarette use was also significantly lower among those with a college education. Continued research is warranted to monitor patterns of e-cigarette use across population groups by gender, age, race/ethnicity, and education, as well as by sociodemographic characteristics for which disparities in tobacco use have been noted. Availability of data on e-cigarette use among youth and young adults is currently limited, including geography (e.g., subnational data at the state or local levels), sexual orientation and gender identity (e.g., lesbian, gay, bisexual, transgender), and socioeconomic status (e.g., household income, poverty status) (CDC 2014a; Johnson et al. 2016).

Research on youth and adults' young e-cigarette-related knowledge, attitudes, and beliefs is still developing and remains relatively sparse. Perceived harm is the most developed area of research. Most youth and young adults believe e-cigarettes are "less harmful" than conventional cigarettes (Table 2.11). However, up to 50% of respondents in some of these studies felt they did not know enough about the potential dangers associated with e-cigarettes to answer questions about perceived harm (Ambrose et al. 2014; Amrock et al. 2015). Although relative harm compared with cigarettes is important to assess, equally important is determining young people's perception of the absolute harm from e-cigarettes. National data show that only 23.6% of middle and high school students combined believed that e-cigarettes cause "a lot of harm" (Table 2.12a), and only 26.8% of young adults believed e-cigarettes are "very harmful" (Table 2.12d). However, significant differences emerge in these perceptions of harm when examined by whether or not youth and young adults use e-cigarettes. Among both middle and high school students and young adults, perceptions of "no harm" were much more prevalent among those with prior experience with e-cigarettes (Tables 2.12b-2.12d). Current e-cigarette users were two to three times more likely to report that e-cigarettes convey "no harm" compared to never e-cigarette users, for both age groups (Tables 2.12a and 2.12d).

The most commonly cited reasons that youth and young adults reported using e-cigarettes included curiosity (Schmidt et al. 2014; Biener and Hargraves 2015; Biener et al. 2015; Kong et al. 2015; McDonald and Ling 2015; Suris et al. 2015; Sutfin et al. 2015), flavorings/taste (Ambrose et al. 2015; University of Michigan 2015), use as a less harmful/less toxic alternative to conventional cigarettes (Peters et al. 2013; Tucker et al. 2014; Ambrose et al. 2015; Kong et al. 2015; McDonald and Ling 2015; Sutfin et al. 2015), and avoidance of indoor smoking restrictions or disturbing people with secondhand smoke from conventional cigarettes (Tucker et al. 2014; Ambrose et al. 2015; Kong et al. 2015; McDonald and Ling 2015; Suris et al. 2015; Sutfin et al. 2015). Using e-cigarettes as an aid to conventional cigarette smoking reduction/cessation (Li et al. 2013; Schmidt et al. 2014; Tucker et al. 2014) was not a primary motivator among youth and young adults. Youth and young adult smokers cited lack of satisfaction, poor taste, and cost (Kong et al. 2015) as reasons for discontinuing e-cigarette use. Additional research is needed to examine how reasons for use, including the appeal of flavored e-cigarettes, are causally related to the onset and progression of e-cigarette use among youth and young adults. Data from the first wave of the PATH study suggest that flavors may play an important role in the initiation of e-cigarette use among youth (Ambrose et al. 2015), while data from the 2014 NYTS (Corev et al. 2015) and 2013–2014 NATS (Table 2.9) underscore that use of flavored e-cigarettes remains prevalent among youth and young adults who currently use e-cigarettes.

## Conclusions

- 1. Among middle and high school students, both ever and past-30-day e-cigarette use have more than tripled since 2011. Among young adults 18–24 years of age, ever e-cigarette use more than doubled from 2013 to 2014 following a period of relative stability from 2011 to 2013.
- 2. The most recent data available show that the prevalence of past-30-day use of e-cigarettes is similar among high school students (16% in 2015, 13.4% in 2014) and young adults 18–24 years of age (13.6% in 2013–2014) compared to middle school students (5.3% in 2015, 3.9% in 2014) and adults 25 years of age and older (5.7% in 2013–2014).
- 3. Exclusive, past-30-day use of e-cigarettes among 8th-, 10th-, and 12th-grade students (6.8%, 10.4%, and 10.4%, respectively) exceeded exclusive, past-30-day use of conventional cigarettes in 2015 (1.4%, 2.2%, and 5.3%, respectively). In contrast in 2013–2014 among young adults 18–24 years of age—exclusive, past-30-day use of conventional cigarettes (9.6%) exceeded exclusive, past-30-day use of e-cigarettes (6.1%). For both age groups, dual use of these products is common.
- 4. E-cigarette use is strongly associated with the use of other tobacco products among youth and young adults, particularly the use of combustible tobacco products. For example, in 2015, 58.8% of high school students who were current users of

combustible tobacco products were also current users of e-cigarettes.

- 5. Among youth—older students, Hispanics, and Whites are more likely to use e-cigarettes than younger students and Blacks. Among young adults—males, Hispanics, Whites, and those with lower levels of education are more likely to use e-cigarettes than females, Blacks, and those with higher levels of education.
- 6. The most commonly cited reasons for using e-cigarettes among both youth and young adults are curiosity, flavoring/taste, and low perceived harm compared to other tobacco products. The use of e-cigarettes as an aid to quit conventional cigarettes is not reported as a primary reason for use among youth and young adults.
- 7. Flavored e-cigarette use among young adult current users (18–24 years of age) exceeds that of older adult current users (25 years of age and older). Moreover, among youth who have ever tried an e-cigarette, a majority used a flavored product the first time they tried an e-cigarette.
- 8. E-cigarette products can be used as a delivery system for cannabinoids and potentially for other illicit drugs. More specific surveillance measures are needed to assess the use of drugs other than nicotine in e-cigarettes.

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