JANUARY 2016

CDC Vitalsigns™

E-cigarette Ads and Youth

About 2.4 million middle and high school students were current (past 30-day) users of electronic cigarettes, or e-cigarettes, in 2014. Most e-cigarettes contain nicotine, which causes addiction, may harm brain development, and could lead to continued tobacco product use among youth. Tobacco product advertising can entice youth to use tobacco, and spending to advertise e-cigarettes has increased rapidly since 2011. About 69% of middle and high school students were exposed to e-cigarette advertisements in retail stores, on the Internet, in magazines/newspapers, or on TV/movies. Exposure to e-cigarette advertisements may be contributing to increases in e-cigarette use among youth. Efforts by states, communities, and others could reduce this exposure.

States and communities can:

- Fund tobacco prevention and control programs at CDC-recommended levels to prevent youth use of all tobacco products, including e-cigarettes.
- Work to limit where and how all tobacco products, including e-cigarettes, are sold to reduce youth e-cigarette use, as well as ad exposure.
- Support efforts to implement and sustain proven youth tobacco prevention actions such as tobacco price increases, comprehensive smoke-free laws, and high-impact mass media campaigns.

18 Million

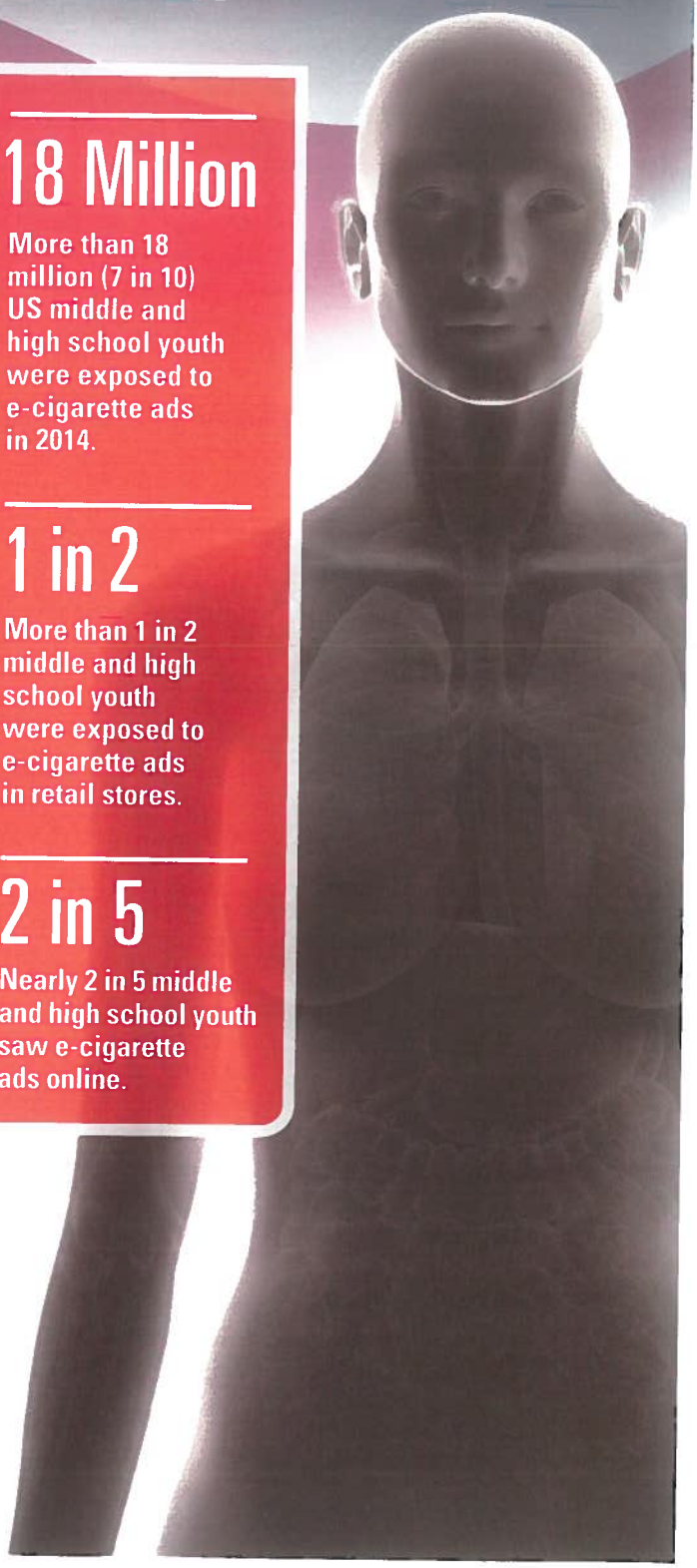
More than 18 million (7 in 10) US middle and high school youth were exposed to e-cigarette ads in 2014.

1 in 2

More than 1 in 2 middle and high school youth were exposed to e-cigarette ads in retail stores.

2 in 5

Nearly 2 in 5 middle and high school youth saw e-cigarette ads online.



Want to learn more? **www.cdc.gov/vitalsigns/ecigarette-ads**

Centers for Disease Control and Prevention
National Center for Chronic Disease Prevention and Health Promotion

Problem:

Youth are vulnerable to e-cigarette ads.

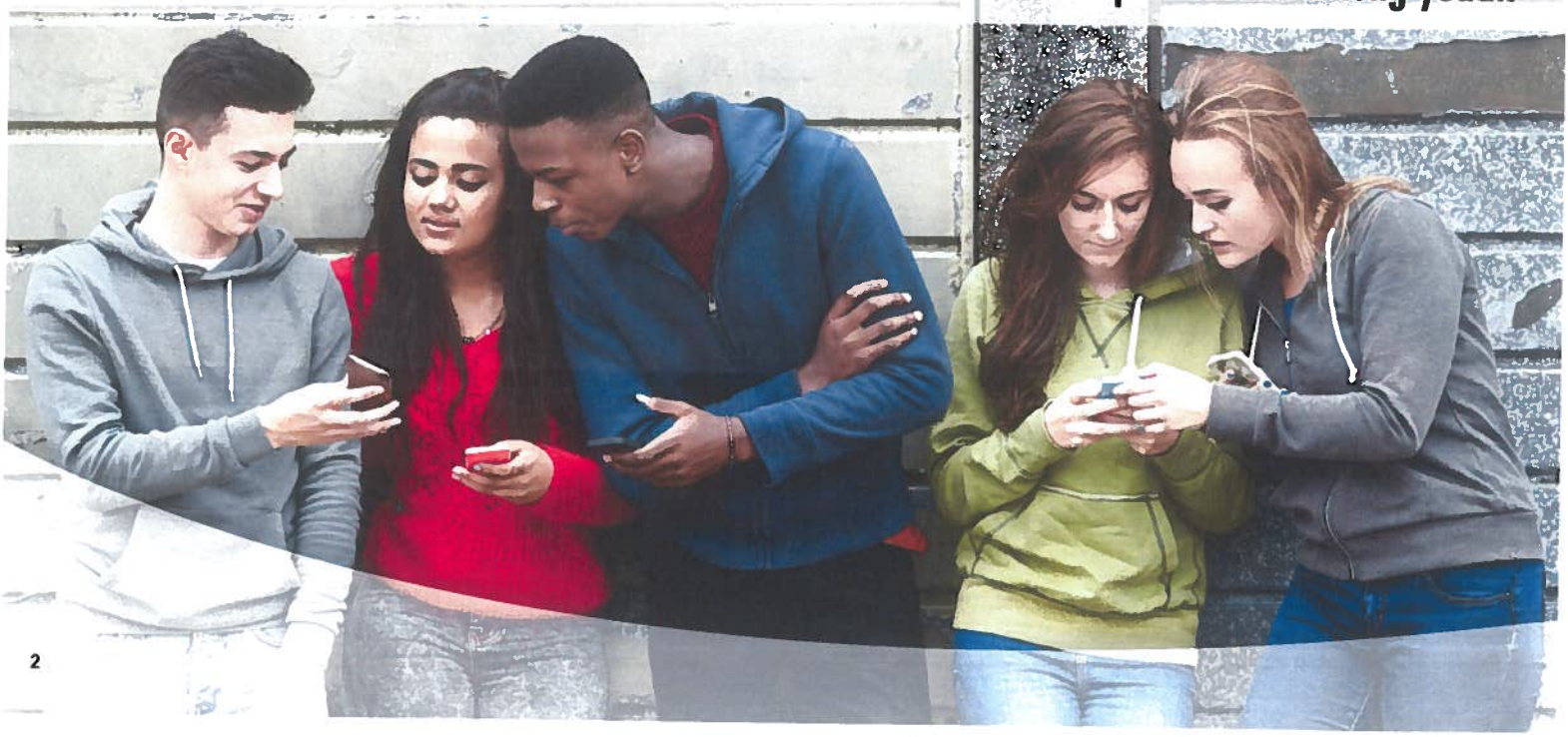
18 million youth were exposed to e-cigarette ads in 2014.

- More than 10 million high school students and nearly 8 million middle school students were exposed to e-cigarette ads in 2014.
- More than half of high school students (about 8 million) saw e-cigarette ads in retail stores, and more than 6 million saw them on the Internet.
- More than half of middle school students (6 million) saw e-cigarettes ads in retail stores, and more than 4 million saw them on the Internet.
- About 15% of all students reported seeing e-cigarette ads from all four sources, including retail stores, the Internet, magazines/newspapers, and TV/movies.

Exposure to e-cigarette ads may contribute to youth e-cigarette use:

- E-cigarette companies have rapidly increased advertising spending, from $6.4 million in 2011 to $115 million in 2014.
- Many of the themes used in advertising for cigarettes are also now used to advertise e-cigarettes – including sex, independence, and rebellion.
- During the time e-cigarette ads have increased, there are also increases in e-cigarette use among US youth. From 2011-2014, e-cigarette use in the past 30 days increased from less than 1% to almost 4% among middle school students and from less than 2% to 13% among high school students.

Most e-cigarettes contain NICOTINE, which causes ADDICTION, may harm brain development, and could lead to continued tobacco product use among youth.



Youth are exposed to e-cigarette advertisements from multiple sources.

Sources of e-cigarette advertisement exposure

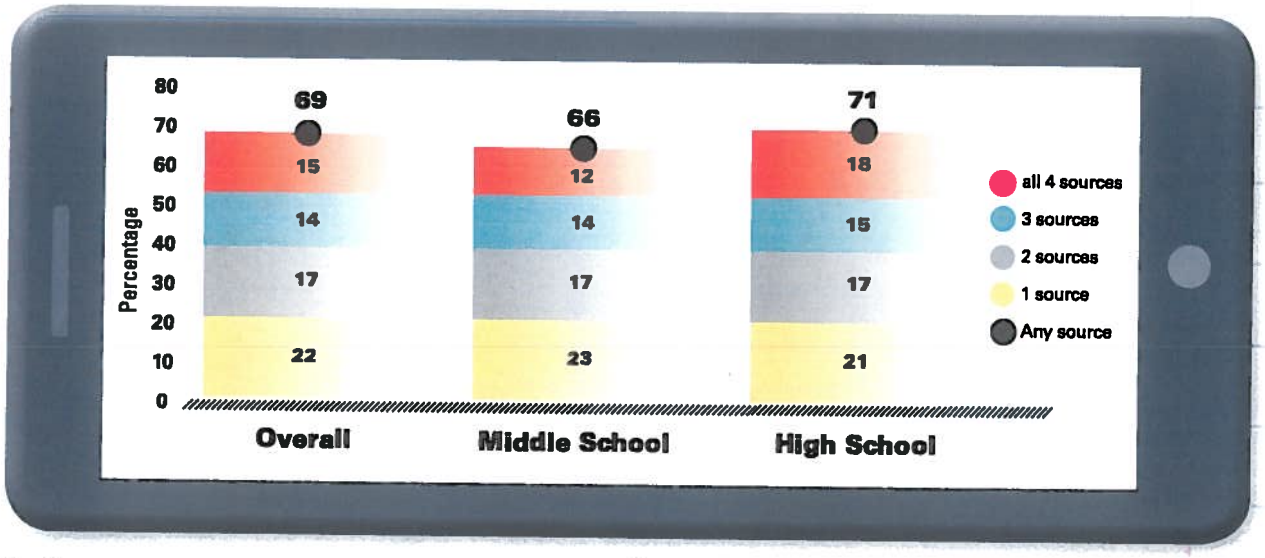
14.4 MILLION
youth are exposed at retail stores

10.5 MILLION
youth are exposed through the Internet

9.6 MILLION
youth are exposed through TV/movies

8 MILLION
youth are exposed through magazines/newspapers

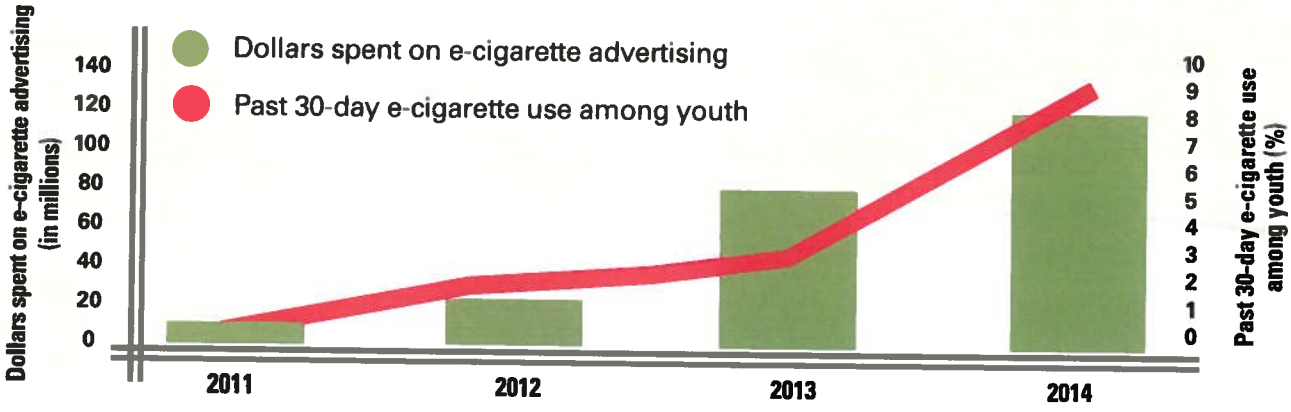
US students exposed to e-cigarette advertisements, by school type and number of sources of exposure



* *Percentages may not add up exactly to any source due to rounding.*

SOURCE: National Youth Tobacco Survey 2014

E-cigarette use among youth is rising as e-cigarette advertising grows



SOURCE: National Youth Tobacco Survey, 2011-2014; Kim et al (2014), Truth Initiative (2015).

What Can Be Done?

The Federal government is

- Supporting state tobacco prevention and control programs to prevent any youth use of tobacco products, including e-cigarettes.
- Tracking e-cigarette use; supporting research on the health effects and factors contributing to youth e-cigarette use; and providing information to the public, including health care providers.
- Developing regulations for e-cigarettes and other currently unregulated tobacco products to reduce the disease and death from tobacco use, including by preventing youth tobacco use.
- Funding and promoting campaigns that inform people about the dangers of tobacco use, such as FDA's *The Real Cost* and *Fresh Empire* for youth and CDC's *Tips From Former Smokers* for adults.

States and communities can

- Fund tobacco prevention and control programs at CDC-recommended levels to prevent youth use of all tobacco products, including e-cigarettes.
- Work to limit where and how all tobacco products, including e-cigarettes, are sold to reduce youth e-cigarette use, as well as ad exposure. This may include:
  - Requiring age verification to enter e-cigarette vendor's websites, make purchases, and accept deliveries of e-cigarettes.
  - Restricting the number of stores that sell tobacco and how close they can be to schools.
  - Requiring that e-cigarettes be sold only through face-to-face transactions, not on the Internet.
  - Limiting tobacco product sales to facilities that never admit youth.
- Support efforts to implement and continue proven youth tobacco prevention approaches, including tobacco price increases, comprehensive smoke-free laws, and high-impact mass media campaigns.

Pediatricians, nurses, and other health care providers can

- Ask about youths' e-cigarette use and counsel them about the dangers of nicotine, e-cigarettes, and all other tobacco use.
- Ask all patients whether they use tobacco products, encourage those who do to quit, and provide help with quitting.
- Ask about youths' media and Internet use. Advise parents and caregivers to take an active role in deciding which websites and media children may view and teaching critical viewing skills.

Parents and caregivers can

- Set a positive example by being tobacco-free. For free help, call 1-800-QUIT-NOW or visit www.smokefree.gov
- Talk to youth about why they shouldn't use any tobacco products, including e-cigarettes.
- Know what media their children are viewing, and decide what programs and websites are appropriate for their age. Watch programs together and discuss content.

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Vital Signs: Exposure to Electronic Cigarette Advertising Among Middle School and High School Students — United States, 2014

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On January 5, 2016, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

Abstract

Introduction: Electronic cigarette (e-cigarette) use has increased considerably among U.S. youths since 2011. Tobacco use among youths in any form, including e-cigarettes, is unsafe. Tobacco product advertising can persuade youths to start using tobacco. CDC analyzed data from the 2014 National Youth Tobacco Survey to estimate the prevalence of e-cigarette advertisement exposure among U.S. middle school and high school students.

Methods: The 2014 National Youth Tobacco Survey, a school-based survey of middle school and high school students in grades 6–12, included 22,007 participants. Exposure to e-cigarette advertisements (categorized as "sometimes," "most of the time," or "always") was assessed for four sources: retail stores, Internet, TV and movies, and newspapers and magazines. Weighted exposure estimates were assessed overall and by school type, sex, race/ethnicity, and grade.

Results: In 2014, 68.9% of middle and high school students (18.3 million) were exposed to e-cigarette advertisements from at least one source. Among middle school students, exposure was highest for retail stores (52.8%), followed by Internet (35.8%), TV and movies (34.1%), and newspapers and magazines (25.0%). Among high school students, exposure was highest for retail stores (56.3%), followed by Internet (42.9%), TV and movies (38.4%), and newspapers and magazines (34.6%). Among middle school students, 23.4% reported exposure to e-cigarette advertising from one source, 17.4% from two sources, 13.7% from three sources, and 11.9% from four sources. Among high school students, 21.1% reported exposure to e-cigarette advertising from one source, 17.0% from two sources, 14.5% from three sources, and 18.2% from four sources.

Conclusions and Implications for Public Health Practice: Approximately seven in 10 U.S. middle and high school students were exposed to e-cigarette advertisements in 2014. Exposure to e-cigarette advertisements might contribute to increased use of e-cigarettes among youths. Multiple approaches are warranted to reduce youth e-cigarette use and exposure to e-cigarette advertisements, including efforts to reduce youth access to settings where tobacco products, such as e-cigarettes, are sold, and regulation of youth-oriented e-cigarette marketing.

Introduction

Electronic cigarettes (e-cigarettes) are battery-powered devices capable of delivering nicotine and other additives (e.g., flavorings) to the user in an aerosol form. E-cigarette use has increased considerably among U.S. youths in recent years. During 2011–2014, past-30-day e-cigarette use increased from 0.6% to 3.9% among middle school students and from 1.5% to 13.4% among high school students; in 2014, e-cigarettes became the most commonly used tobacco product among middle school and high school students (*1*). Youth use of tobacco in any form (combustible, noncombustible, or electronic) is unsafe (*2,3*). E-cigarettes typically deliver nicotine derived from tobacco, which is highly addictive, might harm brain development, and could lead to sustained tobacco product use among youths (*2*). In April 2014, the Food and Drug Administration (FDA) issued a proposed rule to deem all products made or derived from tobacco subject to FDA jurisdiction (*4*).

In the United States, e-cigarette sales have increased rapidly since entering the U.S. marketplace in 2007, reaching an estimated $2.5 billion in sales in 2014 (*5,6*). Corresponding increases have occurred in e-cigarette advertising expenditures, which increased from $6.4 million in 2011 to an estimated $115 million in 2014 (*7,8*). Tobacco product advertising is causally related to tobacco product initiation among youths (*9*). Many of the themes used in conventional tobacco product advertising, including independence, rebellion, and sexual attractiveness, also are used to advertise e-cigarettes (*9,10*). Moreover, almost all tobacco use begins before age 18 years, during which time there is great vulnerability to social

influences, such as youth-oriented advertisements and youth-generated social media posts (*9*). This report assesses exposure to e-cigarette advertisements among U.S. middle school and high school students.

Methods

Data from the 2014 National Youth Tobacco Survey (NYTS) were analyzed to assess exposure to e-cigarette advertisements from four sources: retail stores (convenience stores, supermarkets, or gas stations); Internet; TV and movies; and newspapers and magazines. NYTS is a cross-sectional, school-based, self-administered, pencil-and-paper questionnaire administered to U.S. middle school (grades 6–8) and high school (grades 9–12) students.* A three-stage cluster sampling procedure was used to generate a nationally representative sample of U.S. students who attend public and private schools in grades 6–12. In 2014, 207 of 258 selected schools (80.2%) participated, yielding a sample of 22,007 participants (91.4%) among 24,084 eligible students; the overall response rate was 73.3%.

Sources of exposure to e-cigarette advertisements were assessed by participants' responses to the following four questions: 1) Internet: "When you are using the Internet, how often do you see advertisements or promotions for electronic cigarettes or e-cigarettes?" 2) Newspapers and magazines: "When you read newspapers or magazines, how often do you see advertisements or promotions for electronic cigarettes or e-cigarettes?" 3) Retail stores: "When you go to a convenience store, supermarket, or gas station, how often do you see advertisements or promotions for electronic cigarettes or e-cigarettes?" 4) TV and movies: "When you watch TV or go to the movies, how often do you see advertisements or promotions for electronic cigarettes or e-cigarettes?" For each question, respondents could select the following options: they do not use the specific source (e.g., "I do not read newspapers or magazines"), "never," "rarely," "sometimes," "most of the time," or "always." Respondents who said they saw promotions or advertisements "sometimes," "most of the time," or "always" were considered to have been exposed to advertisements from the source; those who selected "never" or "rarely" were considered not exposed. Respondents who did not use a source were also classified as not exposed.† Data were weighted to account for the complex survey design and adjusted for nonresponse. National prevalence estimates with 95% confidence intervals and population estimates were computed; population estimates were rounded down to the nearest tenth of a million. Estimates of exposure for each source were assessed overall and by school type, sex, race/ethnicity, and grade. T-tests were used to calculate differences between groups; a p-value <0.05 was considered statistically significant. The number of exposure sources were summed for each student and reported as the proportion who were exposed to one, two, three, or four sources.

Results

All students. Overall, 68.9% of participants (an estimated 18.3 million students) were exposed to e-cigarette advertisements from ≥1 source (Figure). Retail stores were the most frequently reported exposure source (54.8% of respondents, or an estimated 14.4 million students), followed by the Internet (39.8%, 10.5 million), TV and movies (36.5%, 9.6 million), and newspapers and magazines (30.4%, 8.0 million) (Table). Exposure to e-cigarette advertisements on the Internet and in newspapers and magazines was reported more frequently by females than males. Exposure in retail stores was higher among non-Hispanic whites (whites) than non-Hispanic blacks (blacks) and students of other non-Hispanic races/ethnicities. Exposure from TV and movies was higher among blacks and Hispanics than whites. Exposure was higher among students in higher grade levels for all sources. Overall, 22.1% of participants (5.8 million students) reported exposure to e-cigarette advertising from one source, 17.2% (4.5 million) from two sources, 14.1% (3.7 million) from three sources, and 15.4% (4.1 million) from four sources (Figure).

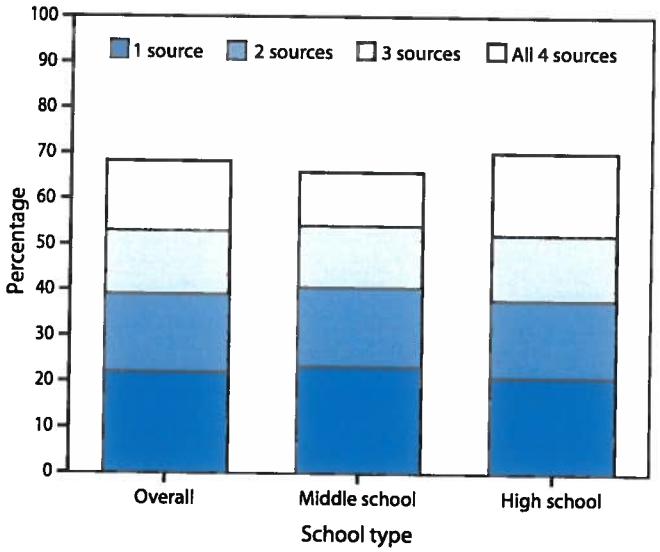
Middle school students. Among middle school students, 66.4% (7.7 million) were exposed to e-cigarette advertisements from at least one source (Figure). Retail stores were the most frequently reported source of exposure (52.8% of respondents, or an estimated 6.0 million middle school students), followed by the Internet (35.8%, 4.1 million), TV and movies (34.1%, 3.9 million), and newspapers and magazines (25.0%, 2.8 million) (Table). Exposure to e-cigarette advertisements on the Internet was higher among female than male middle school students. Exposure in retail stores was higher among whites than blacks and other non-Hispanic race/ethnicities. Exposure from TV or movies was higher among blacks than whites. A single source of exposure was reported by 23.4% of participants (2.7 million middle school students); two sources by 17.4% (2.0 million), three sources by 13.7% (1.5 million), and four sources by 11.9% (1.3 million) (Figure).

High school students. Among high school students, 70.9% of respondents (an estimated 10.5 million high school students) reported exposure to e-cigarette advertisements from at least one source (Figure). Similar to middle school students, more than half of reported e-cigarette advertising exposures (56.3%, 8.3 million) occurred in retail stores, followed by the Internet

* Additional information available at http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/index.htm.

† Respondents who indicated that they did not use the specified source, and who were reclassified as not exposed, included 717 (3.3%) who did not visit retail stores, 715 (3.3%) who did not use the Internet, 697 (3.2%) who did not watch TV/movies, and 5,567 (25.3%) who did not read newspapers/magazines.

FIGURE. Proportion of U.S. students exposed to electronic cigarette (e-cigarette) advertisements, by school type and number of exposure sources* — National Youth Tobacco Survey, 2014



* The four sources were retail stores, Internet, TV and movies, and newspapers and magazines.

(42.9%, 6.3 million), TV and movies (38.4%, 5.6 million), and newspapers and magazines (34.6%, 5.1 million) (Table). Exposure in retail stores was higher among whites than blacks and other non-Hispanic race/ethnicities. Exposure from TV and movies was higher among blacks than whites. One source of exposure was reported by 21.1% of participants (3.1 million high school students), two sources by 17.0% (2.5 million), three sources by 14.5% (2.1 million), and four sources by 18.2% (2.7 million) (Figure).

Conclusions and Comments

In 2014, nearly seven in 10 (18.3 million) U.S. middle school and high school students were exposed to e-cigarette advertisements from at least one source, and approximately 15%, or 4.1 million students, were exposed to e-cigarette advertisements from all four sources. Approximately half were exposed to e-cigarette advertisements in retail stores, whereas approximately one in three were exposed on the Internet, on TV or at the movies, or while reading newspapers or magazines. Although there were slight variations by sex and race/ethnicity, the magnitude of exposure was consistent across groups. Implementation of comprehensive efforts to reduce youth exposure to e-cigarette advertising and promotion is critical to reduce e-cigarette experimentation and use among youths.

Retail store exposure to e-cigarette advertising in this study (54.8%) was lower than levels of exposure to conventional cigarette and other tobacco product advertising reported in the NYTS in 2014 (80.6%), but comparable to exposure on the Internet (39.8% versus 46.8%, respectively) and in newspapers and magazines (30.4% versus 34.3%, respectively) (*11*).[§] Advertising for conventional tobacco products, such as cigarettes, has been shown to prompt experimentation as well as increase and maintain tobacco product use among youths (*9*). Similarly, according to a recent randomized controlled study, adolescents who were exposed to e-cigarette advertisements on TV were 54% more likely to say they would try an e-cigarette soon, and 43% more likely to say they would try an e-cigarette within the next year, compared with adolescents who were not exposed to e-cigarette advertisements (*12*). The study also determined that youths exposed to e-cigarette advertisements were more likely to agree that e-cigarettes can be used in places where smoking is not allowed (*12*). This is consistent with findings that certain e-cigarette marketers are using advertising tactics similar to those used in the past to market conventional cigarettes, including youth-oriented themes, and promoting e-cigarette use as an alternative in places where smoking is not allowed (*2,9,10*). An analysis of 57 online e-cigarette vendors determined that 70.2% of vendors used more than one social network service to market e-cigarettes (*13*). Moreover, 61.4% of vendors only required users to click a pop-up or dialog box to self-verify age, and 35.1% of vendors had no detectable age verification process. This unrestricted marketing of e-cigarettes, coupled with rising use of these products among youths (*1*), has the potential to compromise decades of progress in preventing tobacco use and promoting a tobacco-free lifestyle among youths (*2,9*).

Research supports the importance of a multifaceted approach to youth tobacco prevention involving multiple levels of government (*2,9,14*). Local, state, and federal efforts to reduce youth access to the settings where tobacco products, including e-cigarettes, are sold could reduce youth e-cigarette initiation and consumption, as well as advertising exposure. Potential strategies include requiring that tobacco products, including e-cigarettes, be sold only in facilities that never admit youths; limiting tobacco outlet density or proximity to schools; and requiring that e-cigarette purchases be made only through face-to-face transactions. Adding e-cigarettes and other tobacco products to the list of current tobacco products prohibited from being sent through U.S. mail and requiring age verification for online sales at purchase and delivery could also prevent sales to youths. In addition, potential strategies at the federal or state level include regulation of e-cigarette advertising in media, Internet, and retail settings that are demonstrated to appeal to youths or are viewed by a substantial number of youths. The evidence base for restricting advertisements for conventional

[§] A question assessing exposure to advertisements for cigarettes and other tobacco products from TV and movies is not available for the 2014 NYTS.

TABLE. Electronic cigarette (e-cigarette) advertisement exposure among U.S. middle school and high school students, by sources of exposure — National Youth Tobacco Survey, 2014

Characteristic	Retail stores		Internet		TV and movies		Newspapers and magazines	
	% (95% CI)	Population estimate (millions)*	% (95% CI)	Population estimate (millions)	% (95% CI)	Population estimate (millions)	% (95% CI)	Population estimate (millions)
Overall								
Total	**54.8 (53.6–56.0)**	**14.4**	**39.8 (38.5–41.1)**	**10.5**	**36.5 (35.3–37.7)**	**9.6**	**30.4 (29.3–31.6)**	**8.0**
Sex								
Female (referent)	54.9 (53.5–56.3)	7.2	41.1 (39.4–42.9)	5.4	36.4 (34.8–38.0)	4.7	32.1 (30.2–34.1)	4.2
Male	54.6 (52.9–56.4)	7.1	38.5† (37.1–39.8)	5.0	36.7 (35.2–38.2)	4.8	28.7† (27.6–29.9)	3.7
Race/Ethnicity								
Non-Hispanic white (referent)	56.7 (55.0–58.4)	8.4	40.2 (38.5–42.0)	5.9	35.2 (33.7–36.6)	5.2	31.1 (29.7–32.5)	4.6
Non-Hispanic black	51.7§ (49.4–53.9)	1.9	41.3 (38.5–44.2)	1.5	42.2§ (40.0–44.3)	1.5	32.2 (30.0–34.5)	1.2
Hispanic	55.6 (53.8–57.4)	3.0	39.4 (37.8–41.1)	2.1	37.4§ (35.6–39.4)	2.0	29.2 (27.1–31.3)	1.5
Other (non-Hispanic)	44.4§ (39.2–49.7)	0.5	32.6§ (28.3–37.2)	0.3	29.9§ (26.1–33.9)	0.3	25.3§ (22.1–28.7)	0.2
Grade								
6	50.6¶ (47.2–54.0)	1.8	32.8¶ (30.8–34.8)	1.1	31.8¶ (29.4–34.3)	1.1	24.1¶ (22.1–26.2)	0.8
7	55.0 (51.7–58.3)	2.1	36.7¶ (34.4–39.0)	1.4	35.6 (32.8–38.5)	1.4	25.9¶ (24.0–28.0)	1.0
8	52.6 (48.9–56.3)	2.0	37.6¶ (34.7–40.5)	1.4	34.6 (32.2–37.1)	1.3	25.0¶ (21.5–28.9)	0.9
9	54.7 (52.1–57.2)	2.1	39.2¶ (37.0–42.8)	1.5	37.2 (32.2–37.1)	1.4	32.0¶ (30.1–34.0)	1.2
10	56.2 (53.6–58.8)	2.1	43.4 (40.9–45.8)	1.6	38.9 (36.5–41.3)	1.4	34.0¶ (31.6–36.5)	1.2
11	57.8 (54.9–60.6)	2.0	45.5 (43.3–47.6)	1.6	39.9 (37.1–42.7)	1.4	35.9 (33.7–38.1)	1.2
12 (referent)	56.8 (54.2–59.3)	1.9	44.1 (41.7–46.6)	1.5	37.8 (34.5–41.3)	1.3	37.1 (34.7–39.5)	1.2
Middle School								
Total	**52.8 (50.9–54.7)**	**6.0**	**35.8 (34.2–37.4)**	**4.1**	**34.1 (32.3–35.8)**	**3.9**	**25.0 (23.8–26.3)**	**2.8**
Sex								
Female (referent)	52.1 (50.0–54.1)	2.9	37.6 (35.4–39.8)	2.1	33.3 (31.4–35.3)	1.8	26.2 (23.8–28.8)	1.4
Male	53.5 (50.8–56.2)	3.1	34.0§ (32.1–36.0)	1.9	34.9 (32.4–37.4)	2.0	24.0 (22.4–25.6)	1.4
Race/Ethnicity								
Non-Hispanic white (referent)	55.1 (52.7–57.5)	3.4	36.5 (34.4–38.5)	2.3	32.6 (30.2–35.2)	2.0	25.7 (23.9–27.5)	1.6
Non-Hispanic black	50.6§ (47.6–53.5)	0.7	36.4 (33.2–39.7)	0.5	40.4§ (36.8–44.1)	0.6	26.5 (23.6–29.7)	0.4
Hispanic	53.7 (50.9–56.5)	1.3	36.0 (33.9–38.2)	0.9	35.1 (33.1–37.1)	0.8	24.5 (22.3–26.9)	0.6
Other (non-Hispanic)	41.2§ (32.9–50.1)	0.2	28.8§ (23.7–34.6)	0.1	30.3 (24.8–36.6)	0.1	21.0§ (16.9–25.8)	0.1
High School								
Total	**56.3 (54.7–57.9)**	**8.3**	**42.9 (41.4–44.4)**	**6.3**	**38.4 (36.8–40.1)**	**5.6**	**34.6 (33.3–36.0)**	**5.1**
Sex								
Female (referent)	57.1 (55.0–59.1)	4.2	43.8 (41.5–46.1)	3.2	38.8 (36.6–41.0)	2.8	36.7 (34.7–38.7)	2.7
Male	55.5 (53.5–57.5)	4.0	42.0 (40.4–43.6)	3.0	38.1 (36.0–40.2)	2.7	32.5§ (42.2–45.5)	2.3
Race/Ethnicity								
Non-Hispanic white (referent)	57.8 (55.6–60.0)	4.9	43.0 (40.7–45.4)	3.6	37.1 (35.2–39.1)	3.1	35.2 (33.8–36.6)	3.0
Non-Hispanic black	52.4§ (49.4–55.4)	1.1	44.6 (41.0–48.4)	0.9	43.3§ (39.7–46.9)	0.9	36.1 (32.8–39.5)	0.8
Hispanic	57.3 (54.9–59.7)	1.6	42.3 (40.1–44.5)	1.2	39.5 (36.4–42.7)	1.1	33.1 (30.0–36.4)	0.9
Other (non-Hispanic)	46.6§ (41.6–51.5)	0.3	35.2§ (29.8–40.9)	0.2	29.5§ (25.9–33.4)	0.1	28.7§ (24.6–33.2)	0.1

Abbreviation: CI = confidence interval.
* Population estimate (rounded down to the nearest 0.1 million).
† Statistically significant difference from referent (female) (p-value <0.05).
§ Statistically significant difference from referent (non-Hispanic white) (p-value <0.05).
¶ Statistically significant difference from referent (12th grade) (p-value <0.05).

tobacco products indicates that these interventions would be expected to contribute to reductions in e-cigarette advertisement exposure and use among youths as well (*2,9*). To effectively implement these strategies, there is a need for fully funded and sustained comprehensive state tobacco control programs that address all forms of tobacco use, including e-cigarettes (*14*). These programs are critical to support the implementation and maintenance of proven population-based interventions to reduce tobacco use among youths, including tobacco price increases, comprehensive smoke-free laws, and high impact mass media campaigns (*14*). However, in 2015, states appropriated only 1.9% ($490.4 million) of combined revenues of $25.6 billion from settlement payments and tobacco taxes for all states on comprehensive tobacco control

Key Points

- E-cigarette advertising expenditures have increased dramatically in the United States in recent years, from approximately $6.4 million in 2011 to $115 million in 2014.
- Approximately 18.3 million U.S. middle school and high school students were exposed to at least one source of e-cigarette advertising in 2014.
- Approximately half of all middle school and high school students (an estimated 14.4 million students) were exposed to e-cigarette advertisements in retail stores.
- Approximately one third of middle school and high school students were exposed to e-cigarette advertisements on the Internet (10.5 million), on TV or at the movies (9.6 million), or while reading newspapers or magazines (8.0 million).
- Tobacco product advertising can entice youth to start using tobacco. Comprehensive efforts to reduce youth exposure to e-cigarette marketing would be expected to reduce this burden, and consequently reduce youth use of these products.
- Additional information is available at http://www.cdc.gov/vitalsigns.

programs,[¶] representing <15% of the CDC-recommended level of funding ($3.3 billion) for all states combined (*14*). Only two states (Alaska and North Dakota) currently fund tobacco control programs at CDC-recommended levels. Additionally, parents, caregivers, and health care providers can talk to children about the dangers of tobacco use, encourage or set limits on media use, and teach children critical media viewing skills to increase their resistance to pro-tobacco messages (*15*).

These findings are subject to at least three limitations. First, advertising exposure was self-reported and is subject to recall bias. Second, data were collected only from students who attended public or private schools and might not be generalizable to middle school- and high school-aged youths who are being homeschooled, youths who have dropped out of school, or youths in detention centers. However, data from the Current Population Survey indicate that 97.5% of U.S. youths aged 10–13 years and 95.4% of those aged 14–17 years were enrolled in a traditional school in 2014.[**] Finally, exposure to e-cigarette advertisements might have been underestimated, as survey questions asked only about exposure from four sources, and did not assess exposure from other potential sources such as sporting events, radio, or billboards.

This report highlights youth exposure to e-cigarette advertisements, which might be contributing to increasing youth experimentation with and use of e-cigarettes in recent years. Multiple approaches are warranted to reduce youth e-cigarette use and exposure to e-cigarette advertisements, including efforts to reduce youth access to the settings where tobacco products, including e-cigarettes, are sold, and regulation of youth-oriented e-cigarette marketing. The implementation of these approaches, in coordination with fully funded and sustained comprehensive state tobacco control programs, has the potential to reduce all forms of tobacco use among youths, including e-cigarette use.

[¶] Available at http://www.tobaccofreekids.org/microsites/statereport2015/.
[**] Available at http://www.census.gov/hhes/school/data/cps/2014/tables.html.

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Electronic Nicotine Delivery Systems: Key Facts
CDC Office on Smoking and Health

July 2015

This document outlines key facts related to electronic nicotine delivery systems (ENDS), including e-cigarettes.

- **Youth use of ENDS continues to rise rapidly in the U.S.**
  - From 2011 to 2014, past 30-day use of e-cigarettes increased nine-fold for high school students (1.5% to 13.4%) and more than six-fold for middle school students (0.6% to 3.9%).[1]
  - Nearly 2.5 million U.S. middle and high school students were past 30-day e-cigarette users in 2014, including about 1 in 7 high school students.[1]
  - In 2013, more than a quarter of a million (263,000) middle and high school students who had never smoked cigarettes had ever used e-cigarettes.[2]

- **Most adult ENDS users also smoke conventional cigarettes, which is referred to as "dual use."**
  - In 2012/2013, 1.9% of adults were past 30 day e-cigarette users, including 9.4% of conventional cigarette smokers.[3] Among adult past 30 day e-cigarette users, 76.8% were also current cigarette smokers (i.e., "dual users") in 2012/2013.[3]

- **Nicotine poses dangers to pregnant women and fetuses, children, and adolescents. Youth use of nicotine in any form, including ENDS, is unsafe.**[4,5]
  - Nicotine is highly addictive.[4]
  - Nicotine is toxic to developing fetuses and impairs fetal brain and lung development.[4,5]
  - Because the adolescent brain is still developing, nicotine use during adolescence can disrupt the formation of brain circuits that control attention, learning, and susceptibility to addiction.[5]
  - Poisonings have resulted among users and non-users due to ingestion of nicotine liquid, absorption through the skin, and inhalation.[6] E-cigarette exposure calls to poison centers increased from one per month in September 2010 to 215 per month in February 2014, and over half of those calls were regarding children ages 5 and under.[6]
  - According to the Surgeon General, the evidence is already sufficient to warn pregnant women, women of reproductive age, and adolescents about the use of nicotine-containing products such as smokeless tobacco, dissolvables, and ENDS as alternatives to smoking.[4]

- **Any combusted tobacco use at any age is dangerous.**
    - The burden of death and disease from tobacco use in the U.S. is overwhelmingly caused by cigarettes and other combusted tobacco products.[4]
    - There is no safe level of exposure to secondhand tobacco smoke.[7]

- **In order for adult smokers to benefit from ENDS, they must completely quit combusted tobacco use. Smoking even a few cigarettes per day is dangerous to your health.**
    - Smokers who cut back on cigarettes by using ENDS, but who don't completely quit smoking cigarettes, aren't fully protecting their health:
        - Smoking just 1-4 cigarettes a day doubles the risk of dying from heart disease.[8]
        - Heavy smokers who reduce their cigarette use by half still have a very high risk for early death.[9]
    - Benefits of quitting smoking completely:
        - Heart disease risk is cut in half 1 year after quitting and continues to drop over time.[4]
        - Even quitting at age 50 cuts your risk in half for early death from a smoking-related disease.[4]

- **ENDS are not an FDA-approved quit aid.**
    - The evidence is currently insufficient to conclude that ENDS are effective for smoking cessation.
    - Seven medicines are approved by the FDA for smoking cessation, and are proven safe and effective when used as directed.[10]

- **ENDS aerosol is NOT harmless "water vapor" and is NOT as safe as clean air.[18]**
    - ENDS generally emit lower levels of dangerous toxins than combusted cigarettes. However, in addition to nicotine, ENDS aerosols can contain heavy metals, ultrafine particulate, and cancer-causing agents like acrolein.[11]
    - ENDS aerosols also contain propylene glycol or glycerin and flavorings. Some ENDS manufacturers claim that the use of propylene glycol, glycerin, and food flavorings is safe because they meet the FDA definition of "Generally Recognized as Safe" (GRAS). However, GRAS status applies to additives for use in foods, NOT for inhalation. The health effects of inhaling these substances are currently unknown.

- **ENDS are aggressively marketed using similar tactics as those proven to lead to youth cigarette smoking.**
    - Although the advertisement of cigarettes has been banned from television in the United States since 1971, ENDS are now marketed on television and other mainstream media channels.

- Spending on advertising of ENDS tripled each year from 2011 to 2013.[12,13] Sales of ENDS also increased dramatically over a similar period.[14]
- ENDS marketing has included unproven claims of safety and use for smoking cessation, and statements that they are exempt from clean air policies that restrict smoking.[4] These messages could:
  - Promote situational substitution of ENDS when smokers cannot smoke cigarettes, rather than complete substitution of ENDS for cigarettes.
  - Undermine clean indoor air standards, smokefree policy enforcement, and tobacco-free social norms.
- In a randomized controlled trial, adolescents who viewed e-cigarette TV advertisements reported a significantly greater likelihood of future e-cigarette use compared with the control group. They were also more likely to agree that e-cigarettes can be used in places where smoking is not allowed.[15]
- Some ENDS companies are using techniques similar to those used by cigarette companies that have been shown in the 2012 Surgeon General's Report to increase use of cigarettes by youth, including: candy-flavored products; youth-resonant themes such as rebellion, glamour, and sex; celebrity endorsements; and sports and music sponsorships.[13,16]
- Visual depictions of ENDS use in advertisements may serve as smoking cues to smokers and former smokers, increasing the urge to smoke and undermining efforts to quit or abstain from smoking.[17]

- **Given the currently available evidence on ENDS, several policy levers are appropriate to protect public health:**

  - Prohibitions on marketing or sales of ENDS that result in youth use of any tobacco product, including ENDS.
    - States laws prohibiting sales of ENDS to minors that feature strong enforcement provisions and allow localities to develop more stringent policies are more likely to help prevent youth access.[18]
  - Prohibitions on ENDS use in indoor areas where conventional smoking is not allowed could:[18]
    - Preserve clean indoor air standards and protect bystanders from exposure to secondhand ENDS aerosol.
    - Support tobacco-free norms.
    - Support enforcement of smoke-free laws.
  - When addressing potential public health harms associated with ENDS, it is important to simultaneously uphold and accelerate strategies found by the Surgeon General to prevent and reduce combustible tobacco use, including tobacco price increases, comprehensive smoke-free laws, high-impact media campaigns, barrier-free cessation treatment and services, and comprehensive statewide tobacco control programs.[4,18]

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CDC Office on Smoking and Health
E-cigarette Information
November 2015

E-cigarettes have the potential for harm and benefit to the public's health. It is important to consider their effects on specific populations, including youth, pregnant women, and adult smokers.

Table: Examples of how e-cigarettes could benefit or harm the public's health

E-cigarettes could cause public health HARM if they:	**E-cigarettes could lead to public health BENEFIT if:**
• Lead to use of nicotine and/or other tobacco products by youth and nontobacco users. • Are used by pregnant women. • Lead former smokers to relapse to nicotine use or use of other tobacco products. • Delay complete smoking cessation among current smokers. • Result in nicotine poisonings (e.g., through ingestion of e-cigarette liquid, absorption of e-cigarette liquid through the skin, or inhalation of e-cigarette aerosol). • Expose nonusers to secondhand aerosol.	• Individual adult smokers switch *completely* from combustible tobacco products to e-cigarettes. • They assist in rapid transition to a society with little or no combustible tobacco use.

For YOUTH:

- Use of tobacco and nicotine pose known harms for youth. Therefore, youth should not use *any* tobacco product, regardless of whether it's combustible, noncombustible, or electronic.
    - Nicotine is highly addictive.
    - Nicotine exposure may harm the developing adolescent brain.
    - E-cigarette use by youth could also cause harm if it leads to use of other tobacco products.

For NON-PREGNANT ADULT SMOKERS:

- Any combusted tobacco use at any age is dangerous. According to the US Surgeon General, the burden of death and disease from tobacco use in the United States is overwhelmingly caused by cigarettes and other combusted tobacco products.
- For adult smokers to benefit from e-cigarettes, they must *completely* quit combusted tobacco use. Smoking even a few cigarettes per day is dangerous to health.
- E-cigarettes are not an FDA-approved smoking cessation aid.
    - The US Preventive Services Task Force, a group of health experts that makes recommendations about preventive health care, has concluded that evidence is insufficient to recommend e-cigarettes for smoking cessation in adults, including pregnant women.

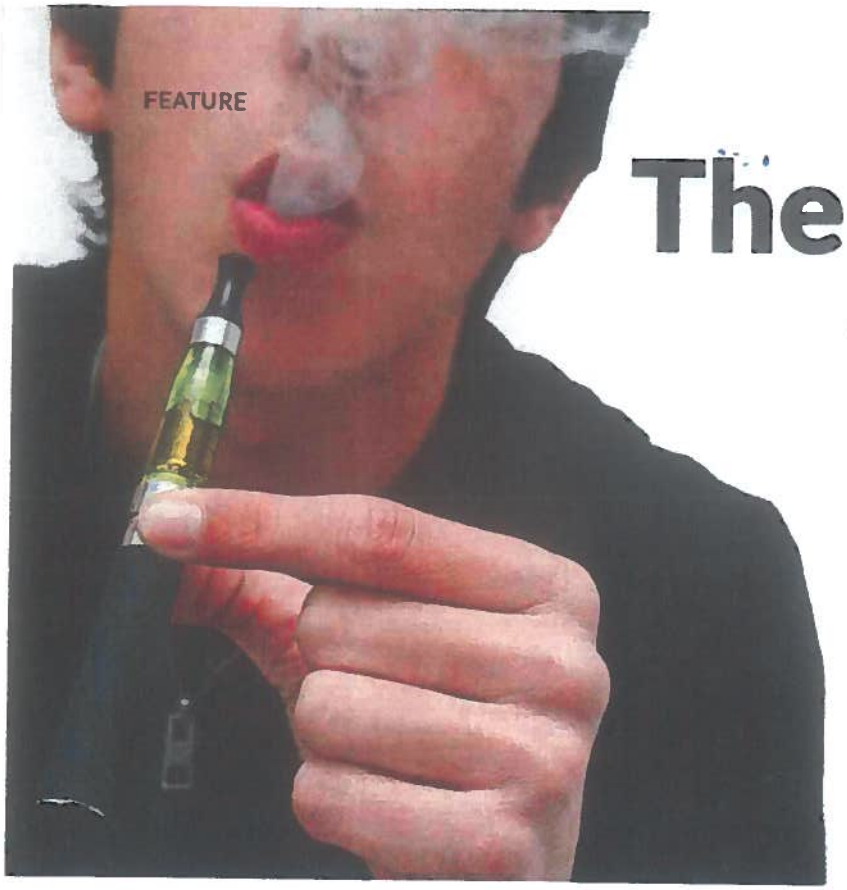
For PREGNANT WOMEN:

- Nicotine is a health danger for pregnant women and their developing fetuses.
- Pregnant women should not use any tobacco product, including e-cigarettes, because nicotine is toxic to developing fetuses and impairs fetal brain and lung development.

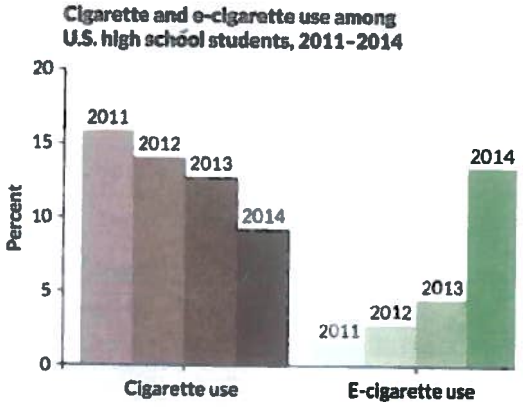
- Pregnant women who haven't been able to quit smoking on their own or with counseling can discuss the risks and benefits of using cessation products, such as nicotine replacement therapy, with their health care provider.

For ADULT NONTOBACCO USERS:

- E-cigarette aerosol is not harmless water vapor. In addition to nicotine, e-cigarette aerosol can contain heavy metals, ultrafine particulates that can be inhaled deep into the lungs, and cancer-causing agents like acrolein.
- E-cigarette aerosols also contain propylene glycol or glycerin and flavorings. Some e-cigarette manufacturers claim that the use of these ingredients is safe because they meet the FDA definition of "generally recognized as safe" (GRAS). However, GRAS status applies to ingestion of these ingredients (i.e., in food), *not* inhalation. The health effects of inhaling these substances, including from an e-cigarette, are unknown.
- Inhaling e-cigarette aerosol directly from the device or from secondhand aerosol that is exhaled by users is potentially harmful to health. Therefore, adult nontobacco users should not use e-cigarettes or be exposed to secondhand aerosol from these products.



The Dangers of Vaping



Teens are falling for flavored e-cigs, but the vapors they inhale may be toxic

By Janet Raloff

They've appeared on television and in magazines — Katy Perry, Johnny Depp and other celebrities vaping electronic cigarettes. The high-tech gadgets, marketed as a healthier alternative to traditional cigarettes, seem to be available everywhere, from Internet suppliers and specialty vaping shops to 24-hour convenience marts.

E-cigarettes have become the fashionable new electronic toy. With vape flavorings like bubble gum, Dr Pepper and cotton candy, teens have been taking the bait. In 2014, e-cigarettes surpassed cigarettes as the most commonly used tobacco product by middle school and high school students, according to an annual U.S. survey.

Teens' fascination with this nicotine-dispensing smoking alternative worries physicians and toxicologists. Data from a growing number of studies indicate that electronic cigarettes are far from harmless. They also pose their own addiction risk.

Chemicals in e-cigarettes can damage lung tissue and reduce the lungs' ability to keep germs and other harmful substances from entering the body, studies have found (*SN: 12/27/14, p. 20*). The flavored e-cig liquids can do their own damage. And the lungs — not to mention the young brain (see "Nico-teen brain," Page 20) — may be particularly vulnerable to nicotine's effects.

"What I can say definitively is that nicotine is harmful to the developing teenage brain," says Mitch Zeller, director of the Center for Tobacco Products at the U.S. Food and Drug Administration in Silver Spring, Md. "No teenager, no young person, should be using any tobacco or nicotine-containing products." E-cigarettes, he says, are among the products that should be kept firmly out of the hands — and mouths — of adolescents.

Soaring popularity

In the last year, e-cigarette use by U.S. teenagers tripled — from 4.5 to 13.4 percent among high school students and from 1.1 to 3.9 percent among middle schoolers, according to data from the annual National Youth Tobacco Surveys (sponsored by the FDA and the Centers for Disease Control and Prevention). Other surveys, some national, some state-level, offer even more troubling figures.

A 2014 survey of U.S. teens, for example, found that almost 9 percent of eighth-graders had vaped in the 30 days before they were questioned. Among 10th-graders, 16.2 percent had vaped in the previous 30 days versus 7.2 percent who had smoked. Teens don't see e-cigs as dangerous, suggest the data from a University of Michigan study, released last December. Only 14.2 percent of 12th-graders surveyed viewed vaping as harmful.

In some parts of the country, e-cigarette use by young people is especially high. In Hawaii, 29 percent of more than 1,900 ninth- and 10th-grade students in five schools had at some time

In 2014, e-cigarettes became the most commonly used tobacco product among teens. The devices surpassed cigarettes, which have been on the decline, according to a national survey by the CDC and FDA.
SOURCE: 2011–2014 NYTS

JOHN VAN HASSELT/CORBIS

used e-cigarettes, according to a survey published in *Pediatrics* in January.

And teen vaping is hardly restricted to Americans. A new survey of nearly 2,700 German seventh-graders finds that almost 5 percent have vaped. A May report in the *Journal of Adolescent Health* describes a near tripling in vaping among teens in New Zealand between 2012 and 2014. By 2014, one in five 14- to 15-year-olds there had given it a try. Reported use by high school teens in Poland is even higher: 23.5 percent.

Such trends, Zeller says, "should raise alarm bells for parents and educators."

Smokeless nicotine

Unlike true cigarettes, electronic cigarettes don't burn tobacco. They don't burn anything. Instead, the battery-operated devices turn a flavored liquid into a vapor. Users inhale, or vape, the mist. The liquid usually contains nicotine, a natural stimulant in tobacco that is highly addictive. Also in the liquid are solvents, flavorings and who knows what else.

E-cigarettes first appeared in the U.S. market in 2007, designed to help tobacco addicts wean themselves from smoking. Recent research, however, indicates that vaping does not boost quit rates (*SN Online: 3/24/14*).

Irina Petrache of the Indiana University School of Medicine in Indianapolis studies the impact of nicotine in e-cigs. She and her colleagues recently exposed lung tissue in the lab to nicotine alone, to cigarette smoke or to e-cigarette vapors. Compared with tissues treated with a nicotine-free soluble extract, all three types of exposures caused lung cells to become more permeable. The cells were no longer an effective barrier to outside substances.

In follow-up tests, the researchers exposed lab animals to nicotine and e-cig liquids. These exposures caused increased oxidative stress and resulted in a buildup of inflammatory cells in the lungs of the mice. "We were surprised at how quickly we saw this inflammation," she says. In fact, the affected lung surface cells "became activated" by the exposures, Petrache explains, "which means they became an active participant in the inflammation."

Her team's findings show that nicotine alone – independent of anything else in cigarette smoke or e-cig vapors – can harm lung tissue. While neither nicotine nor the vapors were quite as potent as the cigarette smoke, all three were triggers. "It took a somewhat larger amount of e-cigarette vapor or nicotine to cause the damage," she explains. Her group reported its findings online May 15 in the *American Journal of Physiology – Lung Cellular and Molecular Physiology*.

In an "unexpected and disturbing" result, Petrache's team found that even an e-cigarette liquid with no nicotine can disrupt the barrier function of lung cells. Her group suspects this problem may have to do with soluble components, such as nicotine or the compound acrolein, in the flavored liquids that are inhaled through e-cigarettes. Despite a public perception to the contrary, vaping "does not seem to be harmless," Petrache concludes.

Irfan Rahman of the University of Rochester Medical Center in New York has a good idea of what was behind the inflammation witnessed by the Indiana team: free radicals spawned as the flavored e-cigarette liquids vaporized. Indeed, he was surprised to learn how potent a source of free radicals e-cigarettes can be. Free radicals, with one unpaired electron, can damage cells and derail the immune system (*SN: 4/18/15, p. 9*).

Rahman, a biochemist, and his team drew the vapors from e-cigarettes into sophisticated test equipment that his lab uses to measure free radicals. Some vaped puffs created from flavored e-liquids – with or without nicotine – produced high concentrations of free radicals. In fact, the nicotine-free vape liquid produced a substantially higher concentration of free radicals, Rahman's team reported in February in *PLOS ONE*.

In other experiments, Rahman's team quantified the free radicals from vaping and smoking. Puffs from both contained free radicals aplenty; the quantity in each vaped puff exceeded those in a puff of cigarette smoke.

To further explore e-cigarette use, Rahman and students from his lab began frequenting vape shops and talking to the teens and young adults who had come to buy supplies. The vapers bragged about being able to use e-cigarettes indoors where smoking was banned, that e-cigs could cost far less than cigarettes and that their colors, potency and flavors could be personalized to deliver a truly "individual" experience.

Some vapers described how they customize the vaping experience by eliminating the cartridge of e-liquid, also known as "e-juice," and using an eye dropper to drip a flavored solution directly onto the e-cigarette's heating element. Then they breathe in the vapors that rise off the coils. This technique, called "dripping," delivers a more potent hit of nicotine, users told Rahman. It also allows them to switch between flavors more easily

—an advantage at parties and in groups where people share an e-cigarette.

Rahman and colleagues investigated how dripping (see image, left) might affect the vapor profile. They found that it upped production of free radicals dramatically.

Many teens and young adults told Rahman and colleagues that their throats became dry and scratchy with vaping. Some said that vaping made them cough or choke and that their mouths bled. Rahman says he decided, "We've got to start looking into these things and see what's going on."

So his team exposed human lung cells and mice to e-cigarette vapors. The vapors triggered intense inflammation in both. Preliminary data from Rahman's team indicate that vaping can cause DNA damage in test tube–grown cells. More worrisome: In one of his team's lung cancer cell lines, e-cigarette vapors triggered precancerous cells to act more like malignant cells. "They go from bad to worse," Rahman says. Surprisingly, he says, cigarette smoke did not show this effect.

Studies by his group and others, Rahman says, suggest that vaping is not safer than smoking: "It's equally bad."

Weakened defenses

Last year in San Diego at a meeting of the American Thoracic Society, Laura Crotty Alexander reported that vaping can make it harder for the body to kill germs (*SN: 6/28/14, p. 9*). Crotty Alexander, a pulmonologist, works at the Veterans Affairs San Diego Healthcare System.

In the lab, she exposed *Staphylococcus aureus* bacteria to e-cigarette vapors, hoping to create conditions that would somewhat mimic what the germs might encounter in the lungs of an e-cig user. The bacteria exposed to high levels of nicotine covered themselves with a thicker biofilm coating than normal, which bolstered their protection.

Crotty Alexander then allowed mice to breathe in air containing these vaping-exposed bacteria. By the next day, the mice had three times as many bacteria in their lungs as did mice exposed to normal Staph bacteria. Fighting off the germs exposed to e-cigarette vapors proved hard for the mice.

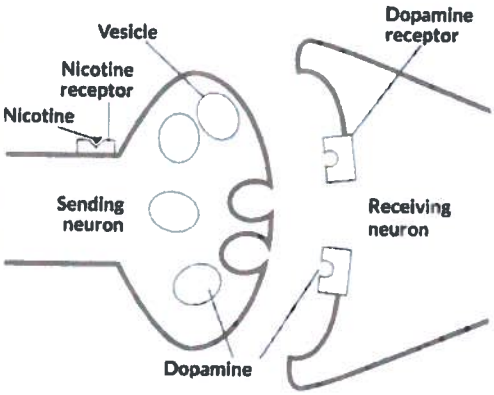
Inflamed lungs with an impaired barrier might help explain why more germs made it into the mice's lungs. Thomas Sussan of the Johns Hopkins University Bloomberg School of Public Health and colleagues found similar connections between vaping and immune dysfunction.

Sussan's team tallied the free radicals from vaping, measuring 700 billion or so free radicals per puff (*SN Online: 2/4/15*). Then, as Rahman's group had done, Sussan and collaborators pumped e-cig vapors into a shoebox-sized chamber. They placed mice in the box for 90 minutes, twice daily, over a two-week period to inhale those vapors.

Nico-teen brain

The teenage brain is no place for nicotine. The prefrontal cortex, the area of the brain responsible for emotions and impulse control, doesn't finish developing until age 25 or so. It's an area especially vulnerable to nicotine addiction.

Exposing the developing adolescent brain to nicotine "could lead to a high risk of lifelong addiction," says Garry Sigman, who heads adolescent medicine at the Loyola University Chicago Stritch School of Medicine in Maywood, Ill.



Brain interrupted Nicotine (black triangle) tricks the nerve cell sending a message into releasing more dopamine (yellow dots) into the synapse than it would normally, giving users a feel-good high, but potentially creating addiction and other problems down the road.

Nicotine can reach the brain within seven seconds of inhaling. The drug then acts like a key, unlocking special receptor molecules that cause nerve cells in the prefrontal cortex and other parts of the brain to release neurotransmitters, such as dopamine and serotonin, into the synapse, where nerve cells communicate. Users get a feel-good high. After repeated exposure to nicotine, however, fundamental changes in the brain can interfere with the body's ability to release natural pleasure-giving chemicals on its own. Teen brains will also create more receptors to handle the flood of nicotine. As the number of receptors increases, teens need more nicotine to get the same high. That makes nicotine users seek hit after hit. In teens, behavioral consequences, including impaired attention and bouts of depression and anxiety, can emerge, research suggests.

While some of the negative effects of nicotine on the young brain can fade with time if exposure ends, others may persist. Neuroscientists at VU University Amsterdam found that nicotine treatment in adolescent rats increased impulsive behavior and impaired attention during adulthood. — *Teresa Shipley Feldhausen*

FROM TOP: CINDY YAMANAKA/CORBIS; NATIONAL INSTITUTE ON DRUG ABUSE; ADAPTED BY I. HIRSHFELD

Afterward, the animals' lungs showed substantial signs of oxidative stress and inflammation. Compared with unexposed mice, the vaping mice had "a nearly 60 percent increase in inflammatory cells," Sussan says. The influx of immune system macrophages in the airways was similar to what his group had seen in mice exposed to cigarette smoke.

To test whether this lung damage affected immunity, Sussan's team exposed some of the "vaped" animals to either flu virus or *Streptococcus pneumonia* bacteria. Normally, macrophages would gobble up and kill the pathogens. The vaped animals produced plenty of macrophages, but the scavenger cells didn't do their job. The result: "defective bacterial clearance," the researchers reported in February in *PLOS ONE*.

Similarly, mice that had breathed in e-cig vapors proved less able than nonvaping mice to fight off the flu virus. Some of the mice exposed to the e-cigarette vapors died. All nonvaping mice survived.

The emerging animal data show that "clearly, these e-cigarettes aren't safe," concludes Sussan, a toxicologist. In fact, he says, any vapers "who think they are not doing any harm are fooling themselves."

The Wild West

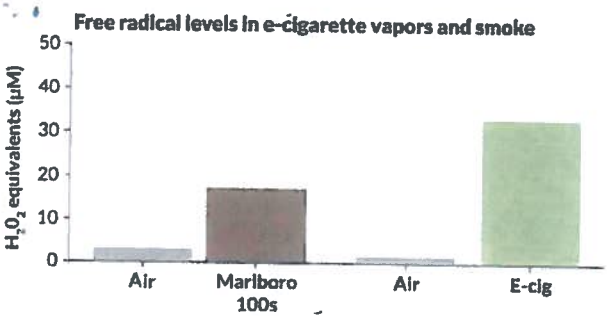
A challenge to probing any risks associated with e-cigs is the lightning pace with which the vaping environment has been evolving. In January 2014, at least 466 brands of e-cigarettes were for sale, according to a recent Internet survey by researchers at the University of California, San Diego. Each brand had its own website. That same survey turned up 7,764 uniquely named flavored e-liquids, with hundreds of new flavors appearing each month.

Sussan calls the e-cig market "the Wild West." Tests on one device or flavored liquid may not extrapolate to others being sold. Makers of e-liquids don't have to list their ingredients and nicotine amounts. And when listed, they aren't reliable, several studies have found. Few flavorings in the e-juices have been evaluated for risks to the lungs.

A few research teams are trying to get a handle on what's out there. Researchers at Portland State University in Oregon recently purchased and analyzed 30 e-juices. "The levels of flavorings that we found in some of the fluids were high — sometimes as much as 4 percent of the material," says chemist James Pankow. That was unexpected, he says. His team published its findings online April 15 in *Tobacco Control*.

Industrial safety guidelines recommend workplace inhalation limits for some of the chemicals his team found in vaping liquids. Examples include the aldehydes vanillin and benzaldehyde. Based on the quantities of some of these chemicals found in the e-juices, people who chronically vape could inhale amounts greater than those recommended for employees, Pankow notes.

In addition, he says, breathing something is very different from eating it. The gastrointestinal tract is better able than the lungs to tolerate incoming materials. Even the Flavor Extracts



Oxidative stress Tobacco-flavored e-cig vapor (10-minute exposure) contained more free radicals than smoke from conventional cigarettes (five-minute exposure) or air. SOURCE: CHAD LERNER ET AL/ENV POLL 2015

Manufacturers Association, he says, argues that it would be "false and misleading" to claim that food-grade flavorings are inherently safe to vape.

Certain other chemicals added to cigarettes to make them easier to smoke are found in e-cigs as well, a team at the Harvard School of Public Health reports. The researchers sifted through a mountain of tobacco company documents released to the public in the 1990s as part of a legal settlement.

"What we found," says Hillel Alpert, "is that they added ingredients — particularly pyrazines — that appear to have contributed to the 'smooth' flavor, reducing the harshness of certain cigarettes." Pyrazines are also being added to e-cigarette fluids, his team wrote online June 10 in *Tobacco Control*. Such chemicals may mask the body's natural aversion to irritating aspects of vapors, making them easier to inhale. This might indirectly foster addiction, Alpert says. Simply put: Pyrazines can make it easier for teens to comfortably take in nicotine.

Arguing for regulations

Vaping products remain largely unregulated in the United States and elsewhere. The FDA announced in April 2014 that it plans to extend its regulation of tobacco products to include e-cigarettes. The agency has not yet acted on that proposal.

As of December 2014, in 10 states and the District of Columbia, children can legally buy e-cigs. And to buy them on the Internet, minors just have to claim they are adults.

On April 28, a broad consortium of 31 organizations — from the American Lung Association and American Academy of Pediatrics to the United Methodist Church — sent an open letter to President Obama asking him to light a fire under the FDA about regulation of e-cigarettes and other unregulated tobacco products. Without action, the groups charged, "there are no restrictions in place to protect public health against the risks these products pose, particularly to the health of our children." ■

Explore more

- Shu-Hong Zhu *et al.* "Four hundred and sixty brands of e-cigarettes and counting: Implications for product regulation." *Tobacco Control*. July 2014.