

E-cigarette Marketing Exposure and Subsequent Experimentation Among Youth and Young Adults

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abstract

OBJECTIVES: Electronic cigarette (e-cigarette) use has become increasingly prevalent among US youth and young adults in recent years. Exposure to e-cigarette marketing may stimulate e-cigarette use. In this study, we estimated the longitudinal association between e-cigarette marketing exposure and e-cigarette experimentation among US youth and young adult never tobacco users.

METHODS: The analysis included nationally representative samples of youth (ages 12–17; $n = 8121$) and young adult (ages 18–24; $n = 1683$) never tobacco users from wave 2 (2014–2015) and wave 3 (2015–2016) of the Population Assessment of Tobacco and Health Study. In the study, researchers measured past-month exposure to e-cigarette marketing through various places (eg, Web sites and events) at wave 2 and e-cigarette experimentation at wave 3. Statistical analysis included multivariable regressions to examine the associations between wave 2 e-cigarette marketing exposure and wave 3 e-cigarette experimentation.

RESULTS: At wave 2, 70.7% of youth and 73.9% of young adult never tobacco users reported past-month exposure to e-cigarette marketing; at wave 3, 4.9% and 4.5% of youth and young adults experimented with e-cigarettes, respectively. Youth and young adults exposed to e-cigarette marketing at wave 2 were more likely (adjusted odds ratio = 1.53, 95% confidence interval = 1.07–2.17; and adjusted odds ratio = 2.73, 95% confidence interval = 1.16–6.42, respectively) to have experimented with e-cigarettes at wave 3 than those not exposed. Marketing exposure through each place at wave 2 was associated with e-cigarette experimentation at wave 3.

CONCLUSIONS: E-cigarette marketing exposure predicted subsequent e-cigarette experimentation among youth and young adult never tobacco users. Increased restrictions on marketing through various channels may help minimize their exposure to e-cigarette marketing messages.



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WHAT'S KNOWN ON THIS SUBJECT: Electronic cigarette (e-cigarette) marketing exposure is associated with e-cigarette use among youth in cross-sectional studies. It is yet unknown whether exposure to e-cigarette marketing prospectively predicts e-cigarette use experimentation among nationally representative samples of tobacco-naïve youth and young adults.

WHAT THIS STUDY ADDS: With this study, we provide the first prospective longitudinal evidence indicating that exposure to e-cigarette marketing through various marketing channels is positively associated with subsequent e-cigarette experimentation among US youth and young adult never tobacco users.

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Electronic cigarette (e-cigarette) use has become more prevalent among youth and young adults in the United States in recent years. In 2018, ~5% and 21% of US middle and high school students, respectively, reported using e-cigarettes in the past 30 days, rising from 1% to 2% in 2011¹; and, in 2017, ~5% of young adults (ages 18–24) used e-cigarettes “some days” or “every day,” rising from 2% in 2012.² E-cigarette products often contain nicotine, and nicotine exposure during adolescence and early adulthood can harm the developing brain.³ Although e-cigarette use alone is considered to produce fewer toxicants than smoking cigarettes,⁴ e-cigarette use can still cause respiratory health issues⁴ and may lead to nicotine addiction.⁵ Additionally, e-cigarette use among tobacco-naive young people, even just experimentation, is associated with subsequent uptake of combustible cigarettes,^{6–8} which remains the leading cause of preventable death in the United States.⁹ Therefore, minimizing the likelihood that tobacco-naive young people experiment with e-cigarettes is a critical component of the effort to prevent adverse tobacco-related health outcomes nationwide.

One possible strategy to reduce e-cigarette use among this population is to reduce their exposure to e-cigarette marketing. E-cigarette marketing expenditures have continued to rise rapidly in the United States,^{10,11} with a corresponding increase observed in e-cigarette sales.¹² In 2016, the US Food and Drug Administration (FDA)^{13,14} finalized a rule extending its regulatory authority to e-cigarettes.⁷ New regulations by the agency require all e-cigarette packages and advertisements to include a prominent warning message about the presence and addictiveness of nicotine, although no restrictions have been applied to the placement or volume of e-cigarette

marketing.^{13,14} In previous studies, it has been shown that significant proportions of youth and young adults are exposed to e-cigarette marketing through the Internet, newspapers and magazines, TV and movies, radio, and retail stores.^{15–18} In 1 study, it was found that as many as 80% of US youth (~21 million) were exposed to e-cigarette advertisements in 2016.¹⁵ Exposure to e-cigarette marketing may promote e-cigarette experimentation by forging positive perceptions about the behavior in the minds of youth and young adults, a pattern that has been observed for combustible cigarettes.¹⁹ Informed by theories of social influence and persuasion, a growing body of work has examined linkages between e-cigarette marketing exposure and e-cigarette use progression.^{16,20–24}

These studies, however, have several limitations. First, in many of these studies, researchers have either used regional or convenience samples,^{16,22,24} which may have limited generalizability, or a cross-sectional design,^{20,22} which cannot rule out reverse causation. Second, in the existing longitudinal studies,^{16,21,23} researchers did not assess whether the associations between e-cigarette marketing exposure and e-cigarette use progression differ by e-cigarette use susceptibility at baseline. Theory and research on the stages of tobacco use progression indicate that tobacco use susceptibility serves as a precursor for subsequent tobacco use.²⁵ Consequently, it is critical to assess whether those who are susceptible to e-cigarette use differ in the risk for future use after marketing exposure compared with those who are not susceptible. Third, in most of the studies in which e-cigarette marketing exposure was examined, researchers have focused on youth^{16,20,23,24} but not young adults. Young adults have become increasingly vulnerable to the tobacco

industry’s marketing tactics²⁶ and are likely to initiate tobacco products (including e-cigarettes).²⁷

To overcome these limitations, in this current study, we analyzed secondary data from the Population Assessment of Tobacco and Health (PATH) Study²⁸ to assess longitudinal associations between e-cigarette marketing exposure and subsequent e-cigarette experimentation among youth (ages 12–17) and young adult (ages 18–24) never tobacco users, stratified by e-cigarette use susceptibility at the baseline. We hypothesized that the exposure to e-cigarette marketing at baseline may increase the likelihood of e-cigarette use experimentation among youth and young adults at 1-year follow-up.

METHODS

Study Samples

In this study, we used data from wave 2 (2014–2015) and wave 3 (2015–2016) youth and adult survey public-use files of the PATH Study, which includes nationally representative, longitudinal cohorts of civilian, noninstitutionalized youth and adults in the United States.²⁸ The PATH Study’s weighted response rates at wave 1 were 74.0% and 78.4% for adults and youth, respectively.²⁹ The weighted retention rates for waves 2 and 3 among wave 1 respondents were 83.2% and 78.4% for adults and 87.3% and 83.3% for youth, respectively.²⁹ More details about the PATH Study, including both youth and adult surveys, can be found elsewhere.^{28,29} For this prospective analysis, we restricted the sample to youth (ages 12–17; $n = 8121$) and young adult (ages 18–24; $n = 1683$) respondents who completed both waves 2 and 3 surveys and had never used any type of tobacco products (cigarettes, e-cigarettes, cigars, hookah, smokeless tobacco, tobacco pipes, bidis, and kreteks) at wave 2. Ever tobacco users were excluded

from the analysis to remove the potential confounding effect of previous tobacco use experience as an alternate pathway for e-cigarette use.

Response Variable: E-cigarette Experimentation Between Waves 2 and 3

In waves 2 and 3 of the survey, youth and young adult respondents were asked: “Have you ever used an electronic nicotine product, even once or two times (electronic nicotine products include e-cigarettes, e-cigars, e-hookahs, personal vaporizers, vape pens, and hookah pens)?” We considered those who responded “Yes” at wave 3 as having used e-cigarettes between waves 2 and 3.

Predictor Variables: E-cigarette Marketing Exposure at Wave 2

At wave 2, respondents were asked: “In the past 30 days, have you noticed e-cigarettes being advertised in any of the following places?” (“Yes” and “No” options were displayed for each of these places): “On posters or billboards,” “In newspapers or magazines,” “On Web sites or social media sites,” “On radio,” “On television,” and “At events like fairs, festivals, or sporting events.” We considered respondents who chose at least 1 place of exposure as exposed to e-cigarette marketing at baseline; conversely, we considered respondents who did not choose any of the places as unexposed. We also treated the number of places for e-cigarette marketing exposure as a continuous variable (range: 0–6).

Covariates

We used the following sociodemographic characteristics measured at wave 2 as covariates: age, gender identity, race and ethnicity, annual household income, and highest educational attainment of the young adults or, in the case of the youth, their parents (see Table 1 for variable categories). Psychosocial

covariates used for the analysis were past-month, self-reported internalizing problems (eg, depression, anxiety, and distress) and externalizing problems (eg, having a hard time paying attention, having a hard time listening to directions).³⁰ Internalizing and externalizing problems, measured by the Global Appraisal of Individual Needs Short Screener,³¹ were found to predict a heightened likelihood of substance use (including tobacco products).^{30,32} The Global Appraisal of Individual Needs Short Screener demonstrated moderate to high reliability using youth and young adult samples.³³

Stratification Variable: E-cigarette Use Susceptibility at Wave 2

We measured e-cigarette use susceptibility, defined as the absence of a firm commitment not to use e-cigarettes,²⁵ using the following questions, each of which had 4 response options (definitely not, probably not, probably yes, and definitely yes): (1) At any time in the next year, do you think you will use these products? (2) Do you think in the future you will experiment with these products? And (3) if one of your best friends were to offer you these products, would you use them? Consistent with previous work,²⁵ we classified respondents as not susceptible to future e-cigarette use if they answered “definitely not” to all 3 questions; otherwise, we classified them as susceptible.

Statistical Analysis

We conducted the following statistical analyses using Stata 14.0 (Stata Corp, College Station, TX) in both youth and young adult samples. First, we examined the respondent characteristics. Second, we gauged the prevalence of exposure to e-cigarette marketing via specific places of exposure. Third, we used multivariable regression models to examine the characteristics associated with e-cigarette marketing exposure at wave 2. Lastly, we

conducted separate multivariable logistic regressions to assess the associations between wave 2 e-cigarette marketing exposure and wave 3 e-cigarette experimentation. The predictor variables for these models included exposure to any e-cigarette marketing (yes or no), the number of places of marketing exposure (range: 0–6), and whether exposure occurred in each of the 6 places (yes or no). We stratified the samples by wave 2 e-cigarette use susceptibility. Furthermore, we conducted sensitivity analysis to examine whether the relationships between exposure to e-cigarette marketing and experimentation change after controlling for having at least 1 close friend using e-cigarettes for youth and living with at least 1 person using e-cigarettes for young adults. Because the results were highly consistent, we kept simpler models for parsimony.

We used the wave 3 weights when calculating proportions with 95% confidence intervals (CI), adopting the balanced repeated replications method with a Fay adjustment of 0.3.²⁹ Wave 3 weights also accounted for loss to follow-up from wave 2 to wave 3.²⁹ We used imputed socioeconomic covariates and included an “undetermined” category for variables with missing values >5%. For the regression procedures, we excluded observations with missing values by listwise deletion.³⁴ This research only involved the use of deidentified data, which is not considered human subjects research and requires no Institutional Review Board review or approval per National Institutes of Health policy and 45 CFR 46.

RESULTS

Demographic Characteristics

The sample of youth was balanced on sex (female: 50.4%; male: 49.6%) but had a higher proportion of younger youth (12–14 years: 65.7%; 15–17

TABLE 1 Weighted Sociodemographics, Psychosocial Characteristics, and E-cigarette Experimentation by E-cigarette Use Susceptibility, PATH Study (Waves 2 and 3 Interviews) 2014–2016

| | Youth and Young Adult Sample Characteristics | | | | | |
|-----------------------------------|--|--------------------------------|------------------------------------|--------------------------|--------------------------------|------------------------------------|
| | Youth (Ages 12–17) | | | Young Adult (Ages 18–24) | | |
| | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use |
| | <i>n</i> = 8121 | <i>n</i> = 1218 | <i>n</i> = 6530 | <i>n</i> = 1683 | <i>n</i> = 454 | <i>n</i> = 1228 |
| Wave 2 interview | | | | | | |
| Age, y | | | | | | |
| 12–14 | 65.7 (65.0–66.3) | 54.0 (51.1–57.0) | 65.7 (64.9–66.6) | — ^a | — ^a | — ^a |
| 15–17 | 34.3 (33.7–35.0) | 46.0 (43.1–48.9) | 34.3 (33.4–35.2) | — ^a | — ^a | — ^a |
| Gender identity | | | | | | |
| Male | 50.4 (49.8–51.1) | 51.0 (47.8–54.3) | 50.6 (49.6–51.5) | 43.9 (41.5–46.4) | 45.6 (39.5–51.8) | 43.4 (40.2–46.5) |
| Female | 49.6 (48.9–50.2) | 49.0 (45.8–52.2) | 49.4 (48.5–50.4) | 56.1 (53.6–58.5) | 54.4 (48.2–60.5) | 56.6 (53.5–59.8) |
| Race and ethnicity | | | | | | |
| Non-Hispanic White | 53.6 (52.5–54.8) | 56.8 (52.2–61.3) | 51.4 (45.1–57.6) | 52.8 (48.7–56.9) | 48.4 (42.6–54.2) | 54.3 (49.2–59.4) |
| Non-Hispanic African American | 14.2 (13.4–15.0) | 13.1 (11.1–15.5) | 13.6 (10.4–17.6) | 14.4 (12.4–16.7) | 14.4 (11.3–18.4) | 14.5 (12.1–17.2) |
| Hispanic | 22.9 (22.0–23.9) | 18.3 (15.3–21.8) | 21.1 (17.1–25.8) | 19.4 (16.8–22.2) | 23.0 (19.2–27.2) | 18.1 (15.2–21.5) |
| Non-Hispanic Other | 9.3 (8.5–10.1) | 11.8 (8.4–16.2) | 13.9 (9.3–20.3) | 13.4 (10.3–17.2) | 14.2 (10.0–19.9) | 13.1 (9.8–17.3) |
| Annual household income | | | | | | |
| <\$50 000 | 39.3 (37.6–41.2) | 44.9 (41.5–48.4) | 37.5 (35.6–39.5) | 57.8 (55.0–60.6) | 52.4 (46.3–58.4) | 59.6 (56.2–63.0) |
| ≥\$50 000 | 48.6 (46.9–50.3) | 44.7 (41.1–48.5) | 50.3 (48.4–52.1) | 30.0 (27.5–32.6) | 35.5 (29.7–41.8) | 28.2 (25.2–31.3) |
| Undetermined | 12.1 (11.1–13.0) | 10.4 (8.1–13.2) | 12.2 (11.2–13.3) | 12.2 (10.3–14.5) | 12.1 (8.9–16.2) | 12.2 (9.9–14.9) |
| Highest educational attainment | | | | | | |
| ≤High school | 29.7 (28.0–31.5) | 35.2 (31.9–38.6) | 28.1 (26.3–29.9) | 42.3 (39.5–45.2) | 41.5 (36.3–46.9) | 42.5 (39.1–46.0) |
| >High school | 62.7 (60.9–64.4) | 57.9 (54.6–61.2) | 64.2 (62.4–66.0) | 57.7 (54.8–60.5) | 58.5 (53.1–63.7) | 57.5 (54.0–60.9) |
| Undetermined | 7.6 (6.9–8.3) | 6.9 (5.0–9.3) | 7.7 (7.1–8.4) | — | — | — |
| Past-month internalizing problems | | | | | | |
| Yes | 50.8 (49.4–52.2) | 63.1 (59.7–66.5) | 49.4 (48.0–50.9) | 38.4 (35.5–41.3) | 46.9 (41.0–52.8) | 35.6 (32.3–39.0) |
| No | 49.2 (47.9–50.6) | 36.9 (33.5–40.4) | 50.6 (49.1–52.0) | 61.6 (58.7–64.5) | 53.1 (47.2–59.0) | 64.4 (61.0–67.7) |
| Past-month externalizing problems | | | | | | |
| Yes | 58.8 (57.5–60.2) | 71.6 (68.2–74.9) | 57.6 (56.2–59.1) | 46.4 (43.4–49.5) | 59.5 (54.0–64.7) | 42.0 (38.6–45.5) |
| No | 41.2 (39.8–42.6) | 28.4 (25.1–31.8) | 42.4 (40.9–43.8) | 53.6 (50.5–56.6) | 40.5 (35.3–46.0) | 58.0 (54.5–61.4) |
| E-cigarette use susceptibility | | | | | | |
| Yes | 14.5 (13.6–15.4) | — | — | 24.9 (22.5–27.5) | — | — |
| No | 85.5 (84.6–86.4) | — | — | 75.1 (72.5–77.5) | — | — |
| Wave 3 interview | | | | | | |

TABLE 1 Continued

| | Youth and Young Adult Sample Characteristics | | | | | |
|-----------------------------|--|--------------------------------|------------------------------------|--------------------------|--------------------------------|------------------------------------|
| | Youth (Ages 12–17) | | | Young Adult (Ages 18–24) | | |
| | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use |
| | <i>n</i> = 8121 | <i>n</i> = 1218 | <i>n</i> = 6530 | <i>n</i> = 1683 | <i>n</i> = 454 | <i>n</i> = 1228 |
| E-cigarette experimentation | | | | | | |
| Yes | 4.9 (4.3–5.5) | 15.2 (13.0–17.9) | 3.4 (2.9–3.9) | 4.5 (3.5–5.6) | 9.0 (6.5–12.4) | 3.0 (2.1–4.1) |
| No | 95.1 (94.5–95.7) | 84.8 (82.1–87.1) | 96.6 (96.1–97.1) | 95.5 (94.4–96.5) | 91.0 (87.6–93.5) | 97.0 (95.9–97.9) |

All data presented as weighted % (95% CI). Percentages and CIs are all weighted estimates. —, not applicable.

^a Age categorization was not available for young adults (ages 18–24) from the PATH public-use data files.

years: 34.3%) (Table 1). The sample of young adults had slightly more women (women: 56.1%; men: 43.9%). About 14.5% and 24.9% of youth and young adults who had never used tobacco before were susceptible to e-cigarette use, respectively.

E-cigarette Marketing Exposure

Overall, 70.7% and 73.9% of youth and young adult never tobacco users (~11 million and 7 million in the United States, respectively) reported e-cigarette marketing exposure in the past month (Table 2). Those who were susceptible to e-cigarette use were more likely to report e-cigarette marketing exposure than those who were not susceptible for both samples

(80.7% vs 70.6% for youth; and 84.4% vs 70.4% for young adults).

In Table 3, we show that in the multivariable regression model for youth, being non-Hispanic African American (adjusted odds ratio [aOR] = 1.20; 95% CI = 1.01–1.44), having past-month internalizing (aOR = 1.50; 95% CI = 1.30–1.73) and externalizing (aOR = 1.81; 95% CI = 1.31–1.82) problems, and being susceptible to e-cigarette use (aOR = 1.54; 95% CI = 1.31–1.82) were associated with e-cigarette marketing exposure. The results from the stratified analysis were similar to the results from the overall model for youth. As for young adults in general, being non-Hispanic African American

(aOR = 0.59; 95% CI = 0.42–0.85) and non-Hispanic other (aOR = 0.47; 95% CI = 0.25–0.89) were less likely to be associated with e-cigarette marketing exposure as compared with being non-Hispanic white. Similar risk factors were found for nonsusceptible young adults. No significant covariates were found for susceptible young adults.

Associations Between E-cigarette Marketing Exposure and E-cigarette Experimentation

Between waves 2 and 3, 4.9% and 4.5% of the overall youth and young adult never tobacco users experimented with e-cigarettes, respectively. Among youth, 5.7% and 3.0% of those who reported and did

TABLE 2 Prevalence of Exposure to E-cigarette Marketing in the Past Month at Wave 2, PATH Study (Wave 2 Interview) 2014–2015

| | Youth (Ages 12–17) | | | Young Adults (Ages 18–24) | | |
|---|--------------------|--------------------------------|------------------------------------|---------------------------|--------------------------------|------------------------------------|
| | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use |
| E-cigarette marketing exposure to any places, weighted % (95% CI) | 70.7 (69.3–72.1) | 80.7 (78.2–82.9) | 70.6 (69.1–72.0) | 73.9 (71.1–76.6) | 84.4 (80.4–87.8) | 70.4 (67.1–73.5) |
| No. places for e-cigarette marketing exposure, weighted mean (95% CI) | 1.91 (1.86–1.96) | 2.42 (2.32–2.52) | 1.88 (1.82–1.94) | 2.11 (2.01–2.22) | 2.49 (2.29–2.69) | 1.99 (1.87–2.10) |
| Places of marketing exposure, weighted % (95% CI) | | | | | | |
| Television | 60.6 (58.9–62.2) | 73.8 (70.7–76.7) | 60.0 (58.2–61.8) | 61.3 (57.6–64.9) | 74.8 (68.2–80.4) | 57.3 (53.1–61.5) |
| Posters or billboards | 60.3 (58.5–62.0) | 73.4 (70.1–76.4) | 60.1 (58.2–62.0) | 65.1 (61.6–68.5) | 77.7 (71.9–82.5) | 61.3 (57.4–65.0) |
| Web sites or social media | 56.5 (54.7–58.4) | 73.6 (70.4–76.5) | 55.5 (53.5–57.5) | 64.0 (60.4–67.4) | 78.4 (72.9–83.1) | 59.3 (55.1–63.3) |
| Newspapers or magazines | 55.9 (54.4–57.5) | 70.5 (66.9–73.9) | 55.6 (53.9–57.3) | 61.2 (57.4–64.8) | 76.0 (70.0–81.2) | 56.4 (52.2–60.5) |
| Radio | 32.8 (30.6–35.0) | 48.0 (43.4–52.6) | 32.5 (30.2–35.0) | 39.8 (35.7–44.1) | 55.1 (45.9–64.0) | 35.9 (31.7–40.4) |
| Event like fairs and festivals | 30.3 (28.4–32.4) | 46.4 (41.7–51.1) | 29.8 (27.5–32.2) | 39.0 (34.9–43.2) | 60.5 (52.0–68.4) | 32.4 (28.0–37.2) |

TABLE 3 Logistic Regressions for E-cigarette Marketing Exposure by E-cigarette Use Susceptibility at Wave 2, PATH Study (Wave 2 and 3 Interviews) 2014–2016

| | E-cigarette Marketing Exposure at Wave 2 | | | | | |
|--------------------------------|--|--------------------------------|------------------------------------|--------------------------|--------------------------------|------------------------------------|
| | Youth (Ages 12–17) | | | Young Adult (Ages 18–24) | | |
| | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use |
| Age, y | | | | | | |
| 12–14 | Reference | Reference | Reference | — ^a | — ^a | — ^a |
| 15–17 | 1.08 (0.95–1.23) | 0.94 (0.64–1.40) | 1.10 (0.96–1.26) | — ^a | — ^a | — ^a |
| Gender identity | | | | | | |
| Male | Reference | Reference | Reference | Reference | Reference | Reference |
| Female | 1.03 (0.90–1.17) | 0.96 (0.68–1.35) | 1.04 (0.91–1.19) | 1.19 (0.89–1.58) | 1.27 (0.59–2.73) | 1.16 (0.84–1.61) |
| Race and ethnicity | | | | | | |
| Non-Hispanic White | Reference | Reference | Reference | Reference | Reference | Reference |
| Non-Hispanic African American | 1.20 (1.01–1.44) | 0.89 (0.57–1.36) | 1.27 (1.04–1.55) | 0.59 (0.42–0.85) | 0.53 (0.21–1.34) | 0.60 (0.40–0.90) |
| Hispanic | 1.13 (0.96–1.32) | 1.55 (1.01–2.41) | 1.08 (0.91–1.27) | 0.70 (0.47–1.05) | 0.49 (0.24–1.02) | 0.77 (0.51–1.16) |
| Non-Hispanic other | 0.80 (0.61–1.03) | 0.60 (0.31–1.10) | 0.82 (0.63–1.06) | 0.47 (0.25–0.89) | 0.55 (0.16–1.94) | 0.45 (0.22–0.92) |
| Annual household income | | | | | | |
| <\$50 000 | Reference | Reference | Reference | Reference | Reference | Reference |
| ≥\$50 000 | 1.05 (0.92–1.20) | 1.05 (0.66–1.65) | 1.06 (0.92–1.24) | 1.61 (1.04–2.50) | 1.79 (0.68–4.70) | 1.56 (0.98–2.48) |
| Undetermined | 0.91 (0.68–1.22) | 2.66 (0.44–16.07) | 0.85 (0.61–1.18) | 0.80 (0.53–1.20) | 1.22 (0.48–3.09) | 0.74 (0.46–1.18) |
| Highest educational attainment | | | | | | |
| ≤High school | Reference | Reference | Reference | Reference | Reference | Reference |
| >High school | 1.06 (0.91–1.24) | 1.34 (0.87–2.07) | 1.02 (0.86–1.21) | 1.32 (0.99–1.77) | 1.42 (0.73–2.78) | 1.33 (0.98–1.79) |
| Undetermined | 1.00 (0.70–1.44) | 0.28 (0.04–1.94) | 1.10 (0.76–1.60) | — | — | — |
| Internalizing problems | | | | | | |
| Yes | 1.50 (1.30–1.73) | 1.49 (0.93–2.39) | 1.51 (1.28–1.77) | 1.33 (0.94–1.88) | 1.31 (0.66–2.60) | 1.35 (0.93–1.95) |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Externalizing problems | | | | | | |
| Yes | 1.81 (1.55–2.11) | 1.56 (1.03–2.36) | 1.84 (1.56–2.17) | 1.80 (1.39–2.32) | 1.31 (0.66–2.60) | 1.83 (1.31–2.57) |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| E-cigarette use susceptibility | | | | | | |
| Yes | 1.54 (1.31–1.82) | — | — | 2.05 (1.52–2.78) | — | — |
| No | Reference | — | — | Reference | — | — |

All data are presented as aOR (95% CI). CIs are weighted estimates. —, not applicable.

^a Age categorization was not available for young adults (ages 18–24) from the PATH public-use data files.

not report exposure, respectively, to e-cigarette marketing at wave 2 experimented with e-cigarettes at wave 3. These percentages were 5.4% and 2.0%, respectively, for young adults.

In Table 4, we show that in separate multivariable regression models for

overall youth, e-cigarette marketing exposure (aOR = 1.53; 95% CI = 1.07–2.17) and a higher reported number of places for marketing exposure (aOR = 1.17; 95% CI = 1.09–1.25) were associated with e-cigarette experimentation. For the susceptible youth, e-cigarette marketing exposure was not

associated with e-cigarette experimentation, whereas an increase in the number of places for marketing exposure increased the odds of using e-cigarettes (aOR = 1.17; 95% CI = 1.04–1.32). For nonsusceptible youth, exposure to e-cigarette marketing (aOR = 1.68; 95% CI = 1.07–2.64) and each additional place (aOR = 1.16;

TABLE 4 Logistic Regressions for E-cigarette Experimentation at Wave 3 by E-cigarette Use Susceptibility at Wave 2, PATH Study (Wave 2 and 3 Interviews) 2014–2016

| | E-cigarette Experimentation at Wave 3 | | | | | |
|--|---------------------------------------|--------------------------------|------------------------------------|---------------------------|--------------------------------|------------------------------------|
| | Youth (Ages 12–17) | | | Young Adults (Ages 18–24) | | |
| | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use | Overall | Susceptible to E-cigarette Use | Not Susceptible to E-cigarette Use |
| Model 1 | | | | | | |
| E-cigarette marketing exposure to any places at wave 2 | | | | | | |
| No exposure | Reference | Reference | Reference | Reference | Reference | Reference |
| Exposure | 1.53 (1.07–2.17) | 1.25 (0.73–2.16) | 1.68 (1.07–2.64) | 2.73 (1.16–6.42) | 7.74 (1.63–36.80) | 1.95 (0.71–5.36) |
| Model 2 | | | | | | |
| No. places for e-cigarette marketing exposure at wave 2 | 1.17 (1.09–1.25) | 1.17 (1.04–1.32) | 1.16 (1.06–1.26) | 1.13 (0.99–1.28) | 1.14 (0.92–1.40) | 1.12 (0.93–1.34) |
| Model 3 | | | | | | |
| E-cigarette marketing exposure to individual place at wave 2 | | | | | | |
| Television | | | | | | |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Yes | 1.62 (1.11–2.38) | 1.54 (0.86–2.77) | 1.67 (1.02–2.74) | 2.54 (1.04–6.18) | 9.22 (1.96–43.36) | 1.47 (0.47–4.63) |
| Posters or billboards | | | | | | |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Yes | 1.65 (1.14–2.40) | 1.37 (0.78–2.43) | 1.83 (1.13–2.95) | 2.59 (1.09–6.13) | 7.00 (1.43–34.43) | 1.81 (0.64–5.11) |
| Web sites or social media sites | | | | | | |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Yes | 1.81 (1.24–2.63) | 1.41 (0.80–2.50) | 2.05 (1.28–3.27) | 3.30 (1.40–7.78) | 8.52 (1.69–42.97) | 2.48 (0.90–6.87) |
| Newspapers or magazines | | | | | | |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Yes | 1.60 (1.09–2.34) | 1.38 (0.78–2.44) | 1.76 (1.06–2.94) | 2.66 (1.06–6.64) | 6.11 (1.21–30.89) | 2.13 (0.66–6.85) |
| Radio | | | | | | |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Yes | 1.89 (1.23–2.89) | 1.72 (0.86–3.44) | 1.92 (1.08–3.41) | 3.01 (1.38–6.59) | 6.36 (1.57–25.66) | 1.77 (0.62–5.08) |
| Event like fairs and festivals | | | | | | |
| No | Reference | Reference | Reference | Reference | Reference | Reference |
| Yes | 1.72 (1.09–2.73) | 0.96 (0.56–1.63) | 2.18 (1.25–3.78) | 4.21 (1.49–11.96) | 9.98 (1.44–69.17) | 3.04 (0.79–11.71) |

All data are presented as aOR (95% CI). The logistic regression models controlled for age (youth only), gender identity, race and ethnicity, annual household income, highest educational attainment, past-month internalizing problems, past-month externalizing problem, and e-cigarette use susceptibility (for the overall models only). CIs are weighted estimates.

95% CI = 1.06–1.26) increased the odds of e-cigarette experimentation. Reported exposure to each place of e-cigarette marketing was associated with subsequent e-cigarette experimentation among youth in general as well as nonsusceptible youth.

In the multivariable regression models for overall young adults, e-cigarette marketing exposure (aOR = 2.73; 95% CI = 1.16–6.42) was associated with subsequent

e-cigarette use. Susceptible young adults exposed to e-cigarette marketing were ~8 times as likely (aOR = 7.74; 95% CI = 1.63–36.80) to have experimented with e-cigarettes than those not exposed. No association, however, was found for nonsusceptible young adults. More places of marketing exposure was not associated with e-cigarette experimentation among young adults, regardless of their baseline susceptibility. Reported exposure to each place of e-cigarette marketing

was associated with subsequent e-cigarette experimentation among young adults in general as well as susceptible young adults.

DISCUSSION

With this study, we add to the body of evidence consistent with the hypothesis that exposure to e-cigarette marketing may promote subsequent e-cigarette experimentation among US youth and young adult never tobacco users.

Youth and young adults reported pervasive exposure to e-cigarette marketing despite having limited tobacco use experience: >70% of youth and young adults in our sample (equivalent to ~18 million of the US population) reported exposure to e-cigarette marketing in the past month. Combined, these results signify the need for the US Food and Drug Administration to reconsider the regulatory structures surrounding e-cigarette marketing. The minimal restrictions currently in place do not adequately prevent tobacco-naive youth and young adults from frequently encountering e-cigarette marketing, and this exposure may indeed be consequential for uptake of e-cigarettes among otherwise nontobacco users.³⁵

Overall, e-cigarette marketing exposure was associated with increased odds of e-cigarette use among youth never tobacco users. This result was driven by nonsusceptible youth who initially reported no interest in trying the product. With this finding, it is suggested that exposure to e-cigarette marketing may lead nonsusceptible youth to develop e-cigarette use susceptibility within a 1-year period or prompt this group to make nonrational decisions of trying e-cigarette products on impulse. In previous research, authors have found a positive relationship between e-cigarette advertising exposure and increased e-cigarette use susceptibility among US youth²⁴ and identified links between exposure to tobacco advertising and impulse purchasing of tobacco products.³⁶ Our results also showed that exposure to e-cigarette marketing, however, was not associated with subsequent e-cigarette experimentation among susceptible youth, although this finding may be attributable to a lack of statistical power: only 15% of the youth in our sample ($n = 1218$) were susceptible to e-cigarette use. Regardless,

susceptible youth reported greater exposure to e-cigarette marketing across multiple places, suggesting the possibility that this exposure may play a role in increasing their susceptibility to use the product in the future.

As for young adults, although marketing exposure increased the odds of e-cigarette experimentation among the overall sample, the association did not remain significant among those who were not susceptible to e-cigarettes. In contrast, among susceptible young adults, e-cigarette marketing exposure was associated with almost 8 times greater odds of trying e-cigarettes. This finding suggests that e-cigarette marketing may serve as a final propelling force that pushes susceptible young adults to try the product and identifies susceptible young adults as an important target for public health prevention efforts aimed at alleviating the influence of e-cigarette marketing. Additionally, because exposure to additional marketing channels did not further increase the odds of e-cigarette use among susceptible young adults, eliminating the presence of e-cigarette marketing (rather than just diminishing the breadth of its presence across many channels) may be necessary for e-cigarette use prevention among this group. Additionally, with our results, we show that exposure to e-cigarette marketing through events like music festivals puts young adults at heightened risks of e-cigarette experimentation, signifying the need to develop and enforce regulations on experiential tobacco marketing strategies often used to attract young adults.³⁷ Lastly, investigating the factors that protect the nonsusceptible young adults from trying e-cigarettes may help inform counter-marketing messages geared toward the young adult population more generally.

In this study, we also identified varying risks of e-cigarette marketing exposure by race and ethnicity. Non-Hispanic African American youth were more likely to report exposure to e-cigarette marketing than non-Hispanic white youth, whereas we observed an inverse relationship for young adults. We can only speculate that this pattern of results could be attributable to the media preferences,³⁸ specific channels of marketing exposure,³⁹ and tobacco marketing exposure recall and engagement⁴⁰ that are different by race and ethnicity and age. Nevertheless, additional research is needed to understand the reasons for racial and ethnic differences in exposure to e-cigarette marketing, especially among youth never tobacco users, to mitigate potential health disparities experienced by racial and ethnic minority populations.

This study should be viewed with the following limitations. First, because of the unavailability of survey data, this study may not have accounted for all the confounders that explain the examined relationships. For example, sensation-seeking tendencies, which were not included in PATH wave 2 surveys, may be related to both e-cigarette marketing exposure and experimentation. Second, the study results relied on respondents' self-report of e-cigarette use and recalled e-cigarette marketing exposure without biochemical or observed validation. Recalled exposure to tobacco marketing may be closely linked to favorable responses (eg, attention and liking) to tobacco marketing and/or tobacco products,⁴¹ thus introducing potential bias to these results. Lastly, in this study, we may not have fully captured all e-cigarette advertising seen by young people. For example, young people are likely to see e-cigarette advertising from tobacco retail settings,¹⁵ which is not included in the PATH Study survey. This may result in an underestimate of the

prevalence of e-cigarette marketing exposure among the target population and potentially weaken the investigated association between e-cigarette marketing exposure and e-cigarette use behavior, given the long-established strong relationship between tobacco marketing exposure in retail settings and tobacco use among young people.^{42–44}

Additionally, online e-cigarette promotion messages disseminated through social media influencers and brand ambassadors⁴⁵ may not be perceived as e-cigarette advertising by young people.

Further research is also warranted to investigate the specific features of e-cigarette marketing strategies that may influence a young viewer's positive perceptions about e-cigarette use, which may consequently lead to e-cigarette experimentation. On the basis of previous work,^{17,46–48} we suspect that e-cigarette marketing may shape viewers' behavior by introducing attractive flavors, reinforcing the alluring social benefits of vaping, illuminating the lifestyles of celebrities and young models, and offering price promotions and direct

access to e-cigarette retail Web sites. Counter-marketing messages designed to address particularly impactful marketing features may help reduce the influence of e-cigarette marketing among the target populations.

ABBREVIATIONS

aOR: adjusted odds ratio
CI: confidence interval
e-cigarette: electronic cigarette
PATH: Population Assessment of Tobacco and Health

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