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Original article

Engagement With Online Tobacco Marketing and Associations With Tobacco Product Use Among U.S. Youth

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ABSTRACT

Purpose: Youth who engage with online tobacco marketing may be more susceptible to tobacco use than unengaged youth. This study examines online engagement with tobacco marketing and its association with tobacco use patterns.

Methods: Cross-sectional analysis of youths aged 12–17 years who participated in wave 1 of the Population Assessment of Tobacco and Health Study (N = 13,651). Engagement with tobacco marketing was based on 10 survey items including signing up for email alerts about tobacco products in the past 6 months. Logistic regression was used to examine the association of online engagement with tobacco marketing and susceptibility to use any tobacco product among never-tobacco users, ever having tried tobacco, and past 30-day tobacco use.

Results: An estimated 2.94 million U.S. youth (12%) engaged with \geq one forms of online tobacco marketing. Compared with no engagement, the odds of susceptibility to the use of any tobacco product among never-tobacco users was independently associated with the level of online engagement: adjusted odds ratio (AOR) = 1.48 (95% confidence interval [CI], 1.24–1.76) for one form of engagement and AOR = 2.37 (95% CI, 1.53–3.68) for \geq two forms of engagement. The odds of ever having tried tobacco were also independently associated with the level of online engagement: AOR = 1.33 (95% CI: 1.11–1.60) for one form of engagement and AOR = 1.54 (95% CI, 1.16–2.03) for \geq two forms of engagement. The level of online engagement was not independently associated with past 30-day tobacco use.

Conclusions: Online engagement with tobacco marketing may represent an important risk factor for the onset of tobacco use in youth.

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IMPLICATIONS AND CONTRIBUTION

Findings from this nationally representative sample suggest that youth who engage with online tobacco marketing may be more susceptible to tobacco use than unengaged youth. Continued monitoring of online engagement may help identify those at risk for future tobacco use.

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Tobacco advertising expenditure on the Internet including tobacco company Web sites grew more than 30-fold, from \$0.7 million dollars in 1999 to \$23.1 million dollars in 2013 [1,2]. In addition to marketing on tobacco company Web sites, tobacco brand and product promotions abound on social media platforms such as Facebook, Twitter, and YouTube [3–6]. Online advertising affords new opportunities to reach potential and current tobacco users and to offer product discounts in a largely unregulated environment [7–9]. Online marketing may be even more effective than traditional marketing in promoting tobacco use among youth because it provides consumers greater opportunities for engagement and interaction with pro-tobacco content [10–12].

We do not yet know the extent to which youth—both those who currently use tobacco and those who have never used tobacco—engage with online tobacco marketing. Current youth tobacco users may seek online venues to purchase tobacco products and bypass age verification measures [13]. Youth who have never used tobacco may engage with tobacco marketing while online, and this engagement may increase their susceptibility to tobacco use that may lead to experimentation with tobacco products. Although public education efforts aim to disrupt these attitudinal changes among youth, such efforts may be less effective against online forms of marketing. In addition, the voluntary Master Settlement Agreement between tobacco companies and state governments that restricted tobacco product marketing was developed for traditional products (mainly cigarettes) and traditional media channels (e.g., print media) and was implemented well before the proliferation of online marketing. Thus, quantifying the scope of youth exposure to online marketing and its relation with tobacco use intention and behavior can provide evidence for the development and implementation of future regulations [14].

This analysis examines this research gap with data from a large, nationally representative population-based study that assesses online engagement and the use of multiple tobacco products. It is hypothesized that, among youth, greater levels of online engagement will be associated with greater susceptibility to tobacco product use among never-tobacco users and higher likelihood of ever having tried tobacco, past 30-day use of tobacco, after accounting for sociodemographic and behavioral risk factors for tobacco use and exposure to marketing in traditional venues.

Methods

Data

Data are from wave 1 of the Population Assessment of Tobacco and Health (PATH) Study conducted from September 12, 2013 to December 15, 2014 [15]. The PATH Study is a nationally representative, longitudinal cohort study of 45,971 adults and youths in the United States, aged 12 years and older. The National Institutes of Health, through the National Institute on Drug Abuse, is partnering with the Food and Drug Administration's Center for Tobacco Products to conduct the PATH Study under a contract with Westat. The PATH Study used Audio Computer-Assisted Self-Interviews available in English and Spanish to collect information on tobacco use patterns and associated health behaviors. This analysis draws from the 13,651 youth interviews (all participants were aged 12–17 years). Parent interviews ($n = 13,589$) were conducted

with one parent of nearly every youth participant. Recruitment employed address-based, area probability sampling, using an in-person household screener to select youths and adults. Adult tobacco users, young adults aged 18–24 years and African-Americans were oversampled relative to population proportions. The weighting procedures adjusted for oversampling and nonresponse; combined with the use of a probability sample, the weighted data allow the estimates produced by the PATH Study to be representative of the noninstitutionalized, civilian U.S. population. The weighted response rate for the household screener was 54.0%. Among households that were screened, the overall weighted response rate was 78.4% for the youth interview. Further details regarding the PATH Study design and methods are published by Hyland et al. [16] and on the PATH Study's Web site [17]. Westat's Institutional Review Board approved the study design and protocol and the Office of Management and Budget approved the data collection.

Missing data on age, sex, race, and Hispanic ethnicity were logically assigned from household screener data, as described in the PATH Study Restricted-Use Files User Guide [17].

Outcomes

Three tobacco-related outcomes were examined: (1) susceptibility to tobacco use among never-tobacco users; (2) ever having tried any tobacco product among all respondents; and (3) past 30-day tobacco use among ever-tobacco users. Products of interest included cigarettes, electronic cigarettes (e-cigarettes), cigars (traditional, cigarillos, and filtered), pipes, hookah (water pipe), snus pouches, other smokeless tobacco, dissolvable tobacco, bidis, and kreteks. First, never-tobacco users were considered susceptible to tobacco use if they responded “definitely yes,” “probably yes,” or “probably no” to one of the following questions for one or more tobacco products: (1) “If one of your friends offered you a (cigarette, e-cigarette, etc.), would you try it?” (2) “Do you think you will smoke a (cigarette, e-cigarette, etc.) sometime in the next year?” and (3) “Have you ever been curious about smoking/using a (cigarette, e-cigarette, etc.)?” [18,19]. Second, respondents were considered to have ever tried tobacco if they responded affirmatively to queries on ever use of one or more tobacco products (e.g., “Have you ever tried cigarette smoking, even one or two puffs?”). Finally, respondents were considered to be past 30-day tobacco users if they responded “earlier today,” “not today but sometime during the past 7 days,” or “not during the past 7 days but sometime during the past 30 days” to use of one or more tobacco products within the past 30 days (e.g., “When was the last time you smoked a cigarette, even one or two puffs?”).

Online engagement and covariates

The primary variable of interest was the level of online engagement with tobacco marketing, which equaled the sum of affirmative answers to 10 items that assessed online engagement (Table 2 and Appendix Table 1; e.g., “In the past 6 months, have you ever signed up for email alerts about tobacco products, read articles online about tobacco products, or watched a video online about tobacco products?”). The level of online engagement was categorized into sum scores: 0 items, 1 item, and 2 or more items. Online engagement scores of 2 or higher were collapsed because

only .8% of respondents reported engagement with three or more items.

Receptivity to tobacco marketing was also assessed through traditional media channels. Commercial vendors collected a pool of ad images during the year before the wave 1 PATH Study from television, magazine, and newspaper ads, as well as mailer campaigns. Each respondent was shown 20 randomly selected images of tobacco ads from a pool of 689 images (or 459 images if respondent interviewed after January 2014), stratified by four product types: cigarettes, e-cigarettes, cigars, and smokeless tobacco. Respondents were asked if they recalled seeing each tobacco ad and if so, whether they liked it. They were also asked if they had a favorite tobacco ad. Following the approach of Pierce et al. [20], who operationally defined receptivity as first remembering and then demonstrating an affective response to marketing, receptivity to tobacco marketing was categorized into four categories according to the level of response: none (saw 0 ads and liked 0 ads and had 0 favorite ads), low (saw ≥ 1 ad and liked 0 ads and had 0 favorite ads), moderate (saw ≥ 1 ad and either liked ≥ 1 ad or had ≥ 1 favorite ads, but not both), and high (saw ≥ 1 ad and liked ≥ 1 ad and had ≥ 1 favorite ads).

Other covariates included age, sex, race/ethnicity, and parental education level. Mental health status was assessed by internalizing and externalizing problems based on the Global Appraisal of Individual Needs-Short Screener [21]. The level of internalizing problems was categorized based on the sum score of 4 items: 0–1 items (low), 2–3 items (moderate), and 4 items (high). Similarly, the level of externalizing problems was categorized based on the sum score of 5 items: 0–1 (low), 2–3 items (moderate), and 4–5 items (high). Sensation seeking was assessed as the mean of three items modified from the Brief Sensation Seeking Scale measured on a five-point Likert scale (e.g., “I like to do frightening things”) and then categorized into terciles [22,23]. See Appendix Table 2 for a list of survey items for the level of internalizing problems, externalizing problems, and sensation seeking.

Respondents' overall use of the Internet and social networking behavior including frequency of Internet use, frequency of social networking account use, and whether respondents used a smart phone were also assessed. Additional covariates included parent report of youths' school performance during interview with parent; youths' weekly income from a job, family, or allowance; and any reported exposure to smoking in the youths' home, in a car, at school, or outdoors. Finally, other substance use was assessed including past 30-day binge alcohol drinking (≥ 5 alcoholic drinks in a day for males and ≥ 4 alcoholic drinks in a day for females), past-year marijuana use, and past-year nonprescription drug use (e.g., cocaine and unprescribed methylphenidate [Ritalin]). The level of other substance use was categorized into 0, 1, and 2 or more other substances.

Analyses

Throughout the analyses, the balanced repeated replication weights were utilized with Fay's correction (shrinkage factor set at .3). First, the prevalence of forms of engagement with online tobacco marketing was estimated. Confidence intervals were reported using the incomplete beta function [24]. Second, the weighted prevalence of each of the tobacco-related outcomes by the level of online engagement to tobacco marketing was assessed by Pearson's chi-squared test statistic with second-order Rao-Scott corrections [25].

Third, a multivariable weighted logistic regression model was fit among the $N = 10,246$ respondents who never used tobacco with susceptibility to tobacco as the dependent variable and level of online engagement as the primary variable of interest, while controlling for other covariates (described previously). Next, similarly specified multivariable weighted logistic regression models were fit for the following outcomes: (1) having ever tried tobacco (among $N = 13,115$ respondents with known tobacco use status) and (2) past 30-day tobacco use (among $N = 2,869$ ever users). For the regression models, multiple imputation was performed to account for missing data in the 10 individual items comprising the level of online engagement and other covariates (e.g., parental education). The multiple imputation method utilized assumed that missing data were missing at random [26]. The percentage of missing data for the 10 individual items comprising the level of online engagement and other covariates ranged from .0% to 4.0%; overall 1,508 records (11.5%) contained missing information on at least one of these variables. Five multiply imputed data sets were generated, the weighted logistic regression models described previously were fit, and the parameter estimates accounting for imputation uncertainty were combined.

Results

Study population

Sociodemographic characteristics of the PATH Study youth sample are described in Table 1. The sample was nearly equally split among 12- to 14-year-olds and 15- to 17-year-olds (51.3% vs. 48.7%, respectively). Respondents were 47.5% non-Hispanic white, 28.4% Hispanic, 13.2% non-Hispanic black, and 51.2% male. A majority of respondents accessed the Internet several times a day (61.2%), used their social networking account at least daily (32.7% several times a day and 27.3% once per day), and used a smart phone (69.6%).

Prevalence of engagement with online tobacco marketing

Among U.S. youth, 88.2% had not engaged with any form of online tobacco marketing, 8.9% had engaged with one form, and 2.9% had engaged 2 or more forms (Table 2). Common forms of online engagement included signing up for email alerts about tobacco products in the past 6 months (4.6%), using a smart phone to scan a quick response code for a tobacco product (2.9%), visiting at least one tobacco Web site (2.3%), receiving a discount coupon for any tobacco product online (2.2%), and liking or following a tobacco brand on a social networking site (1.5%). Although the total percent of youth engaged in online tobacco marketing was relatively small, it represents approximately 2.9 million U.S. youth who reported some interaction with online tobacco marketing.

Prevalence of tobacco use and its association with online engagement

Among U.S. youth, 43.8% of never-tobacco users were susceptible to at least one tobacco product use. In addition, 21.8% of all youth had ever tried a tobacco product and 42.5% of ever-tobacco users were past 30-day tobacco product users (Table 3). More than one in every two respondents who had ever

Table 1
Characteristics of wave 1 PATH Study youth sample, overall and by tobacco outcome

	N	Unweighted prev., %	Weighted prev., %	Susceptible to any tobacco use among never-tobacco users ^b , weighted prev., % (95% CI)	Ever tried tobacco among all respondents ^c , weighted prev., % (95% CI)	Past 30-day tobacco use among ever-tobacco users ^d , weighted prev., % (95% CI)
Total	13,651	100	100	43.8 (42.8–44.8)	21.8 (21.1–22.6)	42.5 (40.6–44.5)
Age group (y)						
12–14	6,998	51.3	50.4	38.4 (37.1–39.7)	10.7 (9.9–11.5)	28.7 (25.1–32.3)
15–17	6,653	48.7	49.6	51.1 (49.5–52.6)	32.8 (31.6–34.0)	46.8 (44.5–49.0)
Sex						
Female	6,657	48.8	48.7	44.1 (42.7–45.6)	20.3 (19.2–21.3)	40.5 (37.6–43.4)
Male	6,994	51.2	51.3	43.5 (42.1–44.9)	23.3 (22.2–24.4)	44.3 (41.6–47.0)
Race/ethnicity						
Non-Hispanic white	6,478	47.5	53.5	41.6 (40.2–43.0)	23.4 (22.3–24.5)	45.5 (42.8–48.2)
Hispanic	3,880	28.4	22.0	48.4 (45.7–51.1)	18.8 (16.8–20.8)	42.1 (36.0–48.2)
Non-Hispanic black	1,801	13.2	13.4	46.4 (32.9–59.9)	21.5 (11.1–32.0)	53.6 (25.8–81.4)
Multiple races	767	5.6	4.2	37.4 (32.1–42.7)	8.2 (5.4–11.0)	35.4 (18.3–52.5)
Asian/Pacific Islander	394	2.9	4.6	50.6 (46.2–55.1)	30.5 (27.0–34.0)	37.6 (30.8–44.3)
American Indian or Alaska Native	70	1.9	0.4	41.1 (34.3–47.9)	15.2 (10.3–20.0)	40.2 (21.9–58.4)
Parental education						
At least some college	8,148	60.1	63.9	44.3 (43.0–45.6)	19.8 (18.9–20.8)	42.2 (39.5–44.8)
High school graduate	2,570	19.0	18.1	42.2 (39.9–44.6)	25.7 (23.9–27.5)	44.7 (40.5–48.9)
Less than high school	2,834	20.9	18.0	43.5 (41.3–45.7)	24.8 (23.1–26.6)	41.5 (37.3–45.6)
Weekly income						
None	4,432	32.9	33.3	38.2 (36.6–39.9)	15.2 (14.0–16.3)	33.3 (29.3–37.2)
\$1–\$20	6,196	46.0	45.3	45.0 (43.6–46.5)	18.5 (17.5–19.6)	42.0 (38.8–45.1)
\$21–\$50	1,406	10.4	10.5	54.0 (50.7–57.4)	33.8 (31.2–36.5)	43.9 (39.0–48.9)
\$51+	1,429	10.6	10.9	51.1 (47.5–54.7)	43.9 (41.1–46.6)	52.1 (47.8–56.4)
School performance						
Mostly A's	3,358	24.9	26.7	37.2 (35.4–39.0)	10.7 (9.6–11.8)	33.1 (27.8–38.4)
A's and B's	4,639	34.4	34.1	44.2 (42.6–45.9)	19.0 (17.7–20.2)	38.0 (34.4–41.6)
Mostly B's	1,184	8.8	8.8	46.3 (42.8–49.7)	23.0 (20.4–25.6)	42.6 (35.9–49.3)
B's and C's	2,591	19.2	18.4	49.4 (47.0–51.8)	29.6 (27.7–31.5)	43.8 (39.9–47.8)
Mostly C's to Mostly F's	1,719	12.7	12.0	50.5 (47.3–53.7)	41.0 (38.5–43.5)	52.3 (48.1–56.4)
Internet access						
Several times/day	8,325	61.2	62.2	48.8 (47.5–50.1)	23.9 (22.9–24.9)	40.9 (38.5–43.3)
Once/day	2,005	14.7	15.0	35.1 (32.6–37.5)	17.1 (15.4–18.9)	40.3 (34.6–46.1)
3–5 days/week	1,308	9.6	9.3	40.3 (37.2–43.4)	21.3 (18.8–23.7)	49.4 (42.8–55.9)
1–2 days/week	551	4.1	3.9	30.8 (26.5–35.2)	13.0 (10.1–16.0)	41.4 (29.3–53.5)
Less than once/week	1,415	10.4	9.6	36.5 (33.6–39.5)	19.4 (17.1–21.7)	51.5 (44.4–58.5)
Social networking account use						
Several times a day	4,452	32.7	33.1	53.5 (51.7–55.4)	30.3 (28.8–31.7)	46.0 (43.1–48.9)
Daily	3,725	27.3	27.3	46.5 (44.6–48.4)	21.9 (20.5–23.3)	40.0 (36.4–43.7)
Weekly	1,593	11.7	11.7	43.6 (40.8–46.4)	18.0 (16.0–20.0)	39.4 (33.2–45.6)
Monthly or less often	1,143	8.4	8.4	36.4 (33.2–39.7)	13.9 (11.7–16.1)	28.7 (20.9–36.4)
No social networking account	2,709	19.9	19.6	30.6 (28.6–32.5)	12.8 (11.4–14.1)	43.4 (37.4–49.5)
Use smart phone						
Yes	9,470	69.6	69.8	48.0 (46.7–49.2)	25.0 (24.1–25.9)	43.0 (40.8–45.2)
No	4,145	30.4	30.2	35.5 (33.8–37.2)	14.3 (13.1–15.4)	40.6 (36.1–45.1)
Sensation seeking ^a						
Low	4,563	33.5	33.3	25.5 (24.1–26.9)	11.9 (10.9–12.9)	35.7 (31.1–40.2)
Moderate	5,228	38.3	38.4	48.0 (46.4–49.6)	18.6 (17.5–19.7)	38.0 (34.6–41.4)
High	3,845	28.2	28.2	66.7 (64.7–68.7)	37.5 (35.9–39.2)	47.8 (45.0–50.7)
Internalizing problems						
Low	6,379	47.9	48.1	32.8 (31.5–34.2)	16.0 (15.1–17.0)	40.9 (37.5–44.3)
Moderate	3,890	29.2	29.0	51.2 (49.3–53.0)	21.3 (19.9–22.6)	40.9 (37.2–44.5)
High	3,043	22.9	22.9	62.5 (60.2–64.7)	34.4 (32.6–36.2)	44.9 (41.6–48.1)

Table 1
Continued

	N	Unweighted prev., %	Weighted prev., %	Susceptible to any tobacco use among never-tobacco users ^b , weighted prev., % (95% CI)	Ever tried tobacco among all respondents ^c , % (95% CI)	Past 30-day tobacco use among ever-tobacco users ^d , weighted prev., % (95% CI)
Externalizing problems						
Low	6,602	50.0	49.7	32.5 (31.2–33.8)	15.4 (14.4–16.3)	40.8 (37.5–44.2)
Moderate	5,351	40.5	41.0	55.2 (53.6–56.9)	24.9 (23.6–26.1)	40.6 (37.7–43.5)
High	1,245	9.4	9.3	67.9 (64.2–71.5)	43.3 (40.4–46.3)	50.4 (45.8–55.0)
Exposure to smoking						
No	7,841	59.1	59.6	38.6 (37.4–39.8)	12.0 (11.2–12.8)	27.6 (24.4–30.8)
Yes	5,420	40.9	40.4	55.2 (53.4–56.9)	36.1 (34.7–37.5)	49.5 (47.1–51.9)
Other substance use ^e						
0	11,891	89.2	89.2	42.6 (41.6–43.6)	13.9 (13.2–14.6)	28.7 (26.3–31.2)
1	1,194	9.0	8.9	84.2 (79.5–89.0)	81.2 (78.8–83.6)	54.6 (51.2–58.0)
2 or more	248	1.9	1.9	96.3 (79.0–99.5)	93.6 (90.5–96.7)	79.0 (73.5–84.5)

Tobacco products included cigarettes, electronic cigarettes (e-cigarettes), cigars (traditional, cigarillos, and filtered), pipes, hookah (water pipe), snus pouches, other smokeless tobacco, dissolvable tobacco, bidis, and kreteks.

CI = confidence interval; PATH = Population Assessment of Tobacco and Health; Prev. = prevalence.

^a Terciles of mean sensation-seeking score not evenly distributed because of heaping in the score.

^b N = 10,246.

^c N = 13,115.

^d N = 2,869.

^e Other substance use includes past 30-day binge alcohol drinking, past-year marijuana use, and past-year nonprescription drug use.

Table 2

Prevalence of engagement to online tobacco marketing

Form of engagement ^a	Count	Wgt. Prev. % (95% CI)
Signed up for email alerts about tobacco products, past 6 months	605	4.6 (4.2–5.0)
Used a smart phone to scan a QR code for a tobacco product	395	2.9 (2.6–3.2)
Visited at least one tobacco brand Web site	326	2.3 (2.1–2.5)
Received a discount coupon for any tobacco product online	321	2.2 (2.1–2.4)
Liked or followed at least one tobacco brand on social networking site	218	1.5 (1.3–1.7)
Played online game related to a tobacco brand ^b	161	1.1 (.9–1.4)
Sent link about a tobacco brand on social networking site	126	.8 (.7–1.0)
Received information from tobacco companies online	110	.8 (.6–.9)
Scanned a QR code for a tobacco product that took respondent to a tobacco company Web site	46	.3 (.2–.5)
Registered on at least one tobacco brand Web site	38	.2 (.2–.3)
Online engagement score 0	12,024	88.2 (87.5–88.8)
Online engagement score 1	1,218	8.9 (8.3–9.6)
Online engagement score 2 or more	409	2.9 (2.5–3.3)

CI = confidence interval; QR = quick response; Wgt. Prev = weighted prevalence.

^a See Appendix Table 1 for exact wording of survey questions.

^b Brands include Marlboro, Newport, Camel, American Spirit, and Copenhagen.

tried any tobacco product had tried multiple (≥ 2) tobacco products (56.4% = 12.3%/21.8%).

Online engagement was associated with each of the tobacco outcomes. Among never-tobacco users, the prevalence of susceptibility to any tobacco product was higher across increasing levels of online engagement: 41.7%, 60.7%, and 79.5% for scores of 0, 1, and 2 or more, respectively. The prevalence of ever having tried tobacco and past 30-day tobacco use also was higher across increasing levels of online engagement; this association held for each class of tobacco product. For example, the prevalence of ever having tried e-cigarettes among all respondents increased from 9.7% to 18.3%–30.3% as the score increased from 0 to 1 to 2 or more. The prevalence of past 30-day e-cigarette use among ever-tobacco users was approximately equal for online engagement scores 0 and 1 (14.5% and 14.3%, respectively) and increased to 21.3% for a score of 2 or more.

Multivariable analyses

Adjusting for sociodemographic and behavioral characteristics, higher levels of online engagement were associated with higher odds of susceptibility to tobacco use and ever having tried tobacco (Table 4). The odds of susceptibility to tobacco use were 1.48 times higher (95% confidence interval [CI], 1.24–1.76) for respondents with an online engagement score of 1 and 2.37 times higher (95% CI, 1.53–3.68) for respondents with a score of 2 or more, compared to respondents with a score of 0. The odds of ever having tried tobacco were 1.33 times higher (95% CI, 1.11–1.60) for respondents with an online engagement score of 1 and 1.54 times higher (95% CI, 1.16–2.03) for respondents with a score of 2 or more compared to respondents with a score of 0. No significant independent associations were observed between online engagement and past 30-day tobacco use.

In addition to the level of online engagement, higher levels of receptivity to traditional tobacco marketing channels were

Table 3Prevalence of susceptibility, ever having tried tobacco, and past 30-day tobacco use by level of engagement to online tobacco marketing^a (weighted percent and 95% confidence interval)

Outcome	Overall	Online engagement score 0	Online engagement score 1	Online engagement score 2 or more
Susceptible to use of any tobacco product among never-tobacco users ^b	43.8 (42.8–44.8)	41.7 (40.6–42.7)	60.7 (57.2–64.2)	79.5 (73.5–85.5)
Ever tried any tobacco product among all respondents ^c	21.8 (21.1–22.6)	19.7 (19.0–20.5)	31.8 (29.0–34.6)	54.1 (48.8–59.3)
Cigarette	13.9 (13.3–14.6)	12.5 (11.8–13.1)	19.9 (17.5–22.4)	39.2 (34.1–44.3)
E-cigarette	11.1 (10.5–11.7)	9.7 (9.1–10.3)	18.3 (16.0–20.6)	30.3 (25.5–35.1)
Cigar	7.7 (7.2–8.2)	6.7 (6.2–7.2)	11.6 (9.7–13.5)	26.0 (21.5–30.5)
Hookah	7.7 (7.3–8.2)	6.8 (6.3–7.3)	12.2 (10.3–14.2)	21.6 (17.3–26.0)
Smokeless	4.9 (4.5–5.3)	4.3 (3.9–4.7)	7.5 (5.9–9.1)	17.3 (13.3–21.3)
Multiple products	12.3 (11.7–12.9)	10.9 (10.3–11.5)	18.4 (16.1–20.8)	35.4 (30.3–40.4)
Past 30-day use of any tobacco product among ever-tobacco users ^d	42.5 (40.6–44.5)	40.9 (38.7–43.1)	43.4 (37.9–48.9)	58.6 (51.6–65.7)
Cigarette	21.9 (20.3–23.5)	20.5 (18.8–22.3)	23.1 (18.6–27.7)	35.4 (28.8–42.0)
E-cigarette	15.0 (13.6–16.4)	14.5 (13.0–16.1)	14.3 (10.5–18.1)	21.3 (15.6–27.0)
Cigar	12.2 (10.9–13.4)	11.3 (9.9–12.7)	12.0 (8.6–15.4)	22.1 (16.4–27.8)
Hookah	7.9 (6.9–8.9)	7.3 (6.2–8.4)	9.1 (6.1–12.2)	12.5 (7.9–17.0)
Smokeless	7.4 (6.3–8.4)	6.8 (5.6–7.9)	7.1 (4.3–9.9)	14.7 (9.6–19.8)
Multiple products	17.3 (15.7–18.8)	16.0 (14.4–17.7)	17.7 (13.5–22.0)	30.4 (23.7–37.1)

^a Five most prevalent tobacco products shown.^b N = 10,246.^c N = 13,115.^d N = 2,869.

independently associated with greater odds of susceptibility, ever having tried tobacco, and past 30-day tobacco use. For example, the odds of susceptibility increased from 1.35 times higher (95% CI, 1.22–1.49) for low marketing receptivity, 3.22 times higher (95% CI, 2.57–4.03) for moderate marketing receptivity, and 2.33 times higher (95% CI, 1.92–2.84) for high marketing receptivity, compared to respondents with no marketing receptivity. The odds of susceptibility were higher for adolescents with higher levels of sensation seeking, internalizing disorders, and externalizing disorders. For example, the odds of susceptibility increased from 1.36 times higher (95% CI, 1.20–1.53) for respondents with a moderate level of internalizing disorders and 1.53 times higher (95% CI, 1.33–1.75) for respondents with a high level of internalizing disorders compared to respondents with a low level of internalizing disorders. Finally, the odds of susceptibility, ever having tried tobacco, and past 30-day tobacco use were also higher for older adolescents, as well as adolescents exposed to smoking, performed at lower levels in school, and used other substances. For example, the odds of past 30-day tobacco use increased from 7.95 times higher (95% CI, 6.55–9.65) for use of one other substance to 23.32 times higher (95% CI, 15.94–34.14) for use of two or more other substances, compared to respondents with no other substance use.

Discussion

Three central findings are reported in this cross-sectional analysis of engagement with online tobacco marketing in a nationally representative sample of youth. First, 12%, or approximately 2.9 million youth, engaged with at least one form of online tobacco marketing. Second, higher levels of online engagement were associated with greater susceptibility to tobacco use among never-tobacco users and ever having tried tobacco. Third, higher levels of receptivity to tobacco marketing in traditional media venues were also associated with these tobacco-related outcomes, independent of online engagement.

Adolescents and young adults who are susceptible to tobacco use are, indeed, more likely to initiate use than their non-susceptible counterparts [18,19,27,28]. For example, a 6-year longitudinal study of 1,574 never cigarette-smoking adolescents (aged 12–15 years at baseline) found that the sensitivity and positive predictive value of the cigarette-specific susceptibility index equaled 78.9% and 19.0%, respectively, for smoking ≥ 100 cigarettes in respondents' lifetime [19]. The odds of hookah smoking initiation were 2.52 times higher (95% CI, 1.39–4.60) among college freshmen susceptible to hookah smoking compared with their nonsusceptible classmates in a 4-year longitudinal study [27]. Finally, the odds of e-cigarette use initiation were 4.27 times higher among middle and high school students susceptible to e-cigarette use compared to their nonsusceptible classmates in a 1-year longitudinal study [28].

Our finding of the strong association between online engagement and susceptibility links this activity to the earliest stages of tobacco product use and adds to a well-established body of research on the effect of traditional tobacco advertising and promotion [29–31]. Youth who have never used tobacco and who enter e-cigarette brand Web sites, for example, can see what others write about their experiences with products on message boards, as well as interact with the Web site through its games, videos, and contests. Social networking sites can influence youth to become part of online peer networks around specific tobacco products. This stimulation and opportunity to socialize can magnify the effectiveness of online tobacco marketing compared with traditional marketing in reaching susceptible new users, changing perceived norms, and altering risk perceptions associated with tobacco products [12]. In addition, youth who are susceptible to tobacco use may engage with online tobacco marketing to learn more about specific products, as well as seek pleasure and reassurance from tobacco advertising [32,33].

Our findings also strengthen long-standing concern about youth exposure to tobacco advertising on interactive and participatory Web sites that emphasize user-generated content [5,6,34–36]. For example, the proportion of middle and

Table 4
Multivariable logistic regression results

	Susceptible to any tobacco use among never-tobacco users		Ever tried tobacco among all respondents		Past 30-day tobacco use among ever-tobacco users	
	Adj. OR	95% CI	Adj. OR	95% CI	Adj. OR	95% CI
Tobacco marketing						
Online engagement score (ref: 0)						
1	1.48	(1.24–1.76)	1.33	(1.11–1.60)	1.04	(.79–1.37)
2 or more	2.37	(1.53–3.68)	1.54	(1.16–2.03)	1.30	(.94–1.80)
Marketing receptivity (ref: none)						
Low	1.35	(1.22–1.49)	.97	(.85–1.11)	.76	(.61–0.95)
Moderate	3.22	(2.57–4.03)	1.70	(1.35–2.13)	1.95	(1.45–2.62)
High	2.33	(1.92–2.84)	2.45	(2.07–2.89)	3.38	(2.70–4.22)
Internet use						
Internet access (ref: less than once/week)						
1–2 days/week	.71	(.54–0.93)	.56	(.38–0.83)	.46	(.26–0.80)
3–5 days/week	.91	(.73–1.13)	.78	(.60–1.02)	.71	(.49–1.04)
Once/day	.83	(.68–1.00)	.75	(.59–0.97)	.56	(.39–0.82)
Several times/day	.99	(.83–1.17)	.70	(.56–0.87)	.46	(.33–0.65)
Social networking account use (ref: no account)						
Monthly or less often	1.01	(.84–1.22)	1.05	(.80–1.38)	.74	(.49–1.12)
Weekly	1.23	(1.04–1.46)	1.10	(.88–1.39)	.99	(.70–1.40)
Daily	1.32	(1.14–1.53)	1.20	(.98–1.46)	1.06	(.79–1.43)
Several times a day	1.49	(1.28–1.73)	1.46	(1.19–1.78)	1.42	(1.05–1.91)
Use smart phone (ref: no)	.91	(.82–1.01)	.88	(.76–1.01)	.90	(.72–1.13)
Individual risk factors						
15–17 years old (ref: 12–14 years old)	1.26	(1.15–1.39)	2.18	(1.92–2.46)	2.56	(2.09–3.14)
Male (ref: female)	1.07	(.97–1.18)	1.17	(1.04–1.32)	1.21	(1.02–1.45)
Race/ethnicity (ref: non-Hispanic white)						
Non-Hispanic black	1.33	(1.15–1.54)	.58	(.48–0.71)	.64	(.49–0.84)
American Indian/Alaska Native	1.33	(.71–2.49)	.76	(.36–1.58)	1.17	(.39–3.50)
Asian/Pacific Islander	1.04	(.81–1.36)	.40	(.24–0.66)	.37	(.17–0.80)
Multiple races	1.28	(1.04–1.58)	1.16	(.91–1.49)	.74	(.53–1.03)
Hispanic	1.44	(1.28–1.62)	.84	(.73–0.97)	.66	(.53–0.82)
Sensation seeking (ref: low)						
Moderate	1.96	(1.76–2.18)	1.27	(1.09–1.47)	1.30	(1.03–1.63)
High	3.15	(2.76–3.59)	2.03	(1.73–2.38)	1.96	(1.54–2.49)
Internalizing problems (ref: low)						
Moderate	1.36	(1.20–1.53)	.91	(.78–1.07)	.85	(.67–1.08)
High	1.53	(1.33–1.75)	1.23	(1.04–1.46)	1.20	(.93–1.55)
Externalizing problems (ref: low)						
Moderate	1.34	(1.17–1.53)	1.05	(.88–1.24)	.74	(.57–0.96)
High	1.89	(1.64–2.17)	.95	(.78–1.14)	.59	(.44–0.78)
Weekly income (ref: none)						
\$1–\$20	1.06	(.96–1.18)	.94	(.81–1.08)	1.17	(.94–1.46)
\$21–\$50	1.40	(1.17–1.66)	1.70	(1.41–2.06)	1.63	(1.21–2.19)
\$51+	1.17	(.97–1.41)	1.97	(1.63–2.37)	2.08	(1.60–2.72)
School performance (ref: mostly A's)						
A's and B's	1.22	(1.08–1.37)	1.71	(1.44–2.03)	1.79	(1.36–2.37)
Mostly B's	1.31	(1.09–1.57)	1.95	(1.54–2.45)	2.15	(1.50–3.09)
B's and C's	1.39	(1.20–1.61)	2.48	(2.04–3.01)	2.28	(1.68–3.07)
Mostly C's to Mostly F's	1.52	(1.27–1.82)	3.76	(3.07–4.62)	3.87	(2.88–5.20)
Other substance use (ref: 0)						
1	3.42	(2.33–5.01)	12.70	(10.52–15.35)	7.95	(6.55–9.65)
2 or more	9.98	(1.19–84.00)	27.36	(16.02–46.73)	23.32	(15.94–34.14)
Other risk factors						
Parental education (ref: at least some college)						
High school graduate	.82	(.72–0.93)	1.19	(1.03–1.39)	1.11	(.89–1.39)
Less than high school	.89	(.78–1.01)	1.20	(1.03–1.40)	1.02	(.81–1.29)
Exposure to smoking (ref: no)	1.46	(1.32–1.61)	2.28	(2.02–2.57)	2.73	(2.24–3.33)

Each model simultaneously adjusted for all covariates listed in first column.

Adj = adjusted; CI = confidence interval; OR = odds ratio; Ref = reference.

high school students who reported exposure to pro-tobacco messages on the Internet increased from 22% in 2000 to 33% in 2004 [37]. Our study considers engagement with—rather than exposure to—online tobacco marketing and concludes approximately 2.9 million adolescents (12%) engaged with such marketing in 2013–2014. Our finding

represents a public health concern because experiment-based studies find online engagement increases advertising effectiveness [12]. Thus, close monitoring of online tobacco marketing and youth engagement trends over time is warranted because of its potential to influence pro-tobacco attitudes among youth.

An additional issue is the interplay between traditional and online marketing. Tobacco ad images in magazines, for example, now often refer viewers to online venues. Our findings extend and support earlier studies conducted before the Internet era that conclude receptivity to traditional tobacco marketing increased the risk of susceptibility to cigarette smoking [20,29,38]. Notably, online tobacco marketing seems to be capturing different populations of youth compared with traditional venues (as suggested by the relatively low correlation between the two exposures). Future research may seek to better understand how youth encounter online venues.

Several important limitations are noted. First, the temporal order of engagement with online tobacco marketing and tobacco use cannot be established given the cross-sectional nature of the study. Based on future waves of the PATH Study, the longitudinal association between online engagement among nontobacco using youth and their risk of tobacco use—accounting for known psychosocial and behavioral risk factors—can be better determined. Alternatively, youth who are already susceptible to tobacco use or used tobacco in the past 30 days may be more likely to subsequently engage with online marketing. Second, our analysis relies upon respondents' self-report of online engagement and tobacco use, both of which may be subject to recall bias. Third, the frequency and recency of engagement with online tobacco marketing cannot be determined. Fourth, although engagement among youth was studied, engagement among young adults may be equally important because the older group serves as aspirational role models to the younger group [39]. Fifth, online engagement may have been underestimated, as youth may receive information about and discuss tobacco products on social media platforms that were not studied (e.g., Snapchat and Instagram). Sixth, we assessed engagement with online tobacco marketing overall and not for specific tobacco products (e.g., e-cigarettes). Thus, we cannot ascertain, for example, if engagement with online e-cigarette marketing is cross-sectionally associated with susceptibility to e-cigarette use. Finally, the predictive validity of the susceptibility index found among younger adolescents may not extend to older adolescents.

In conclusion, a substantial number of youth engage with online tobacco marketing. Online engagement with tobacco marketing may represent an important risk factor for youth tobacco use that has important regulatory implications because youth who engage with online tobacco marketing may be more susceptible to tobacco use than unengaged youth.

Supplementary Data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jadohealth.2017.01.023>.

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