The Longitudinal Impact of Seeing and Posting Tobacco-related Social Media on Tobacco Use Behaviors Among Youth (Aged 12-17): Findings From the 2014-2016 Population Assessment of Tobacco and Health (PATH) Study

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ABSTRACT

INTRODUCTION: This study examined the impact of seeing and posting tobacco-related content on social media on tobacco use outcomes in youth.

METHODS: Longitudinal secondary analyses of youth in the nationally representative 2014-2015 Population Assessment of Tobacco and Health (PATH) study were conducted to examine the association between the interaction of (i) seeing and (ii) posting tobacco-related social media content with previous ever use of each tobacco product, and 3 outcomes in 2015-2016: past 30-day e-cigarette use, past 30-day combustible product use, and past 30-day dual use of e-cigarettes and at least one combustible product. Six weighted multiple logistic regression models (2 interaction exposures*3 outcomes) were used to assess these associations, while adjusting for covariates.

RESULTS: Among youth never users in 2014-2015, seeing tobacco-related social media content was significantly associated with past 30-day e-cigarette use (AOR 1.92; 95% CI= 1.36-2.71), and past 30-day dual use of e-cigarettes and at least one combustible product (AOR= 2.11; 95% CI= 1.08- 4.13) in 2015-2016. Among youth ever users in 2014-2015, posting tobacco-related content on social media was significantly associated with all 3 outcomes: past 30-day day e-cigarette use (AOR= 2.09;95%CI=1.23-3.55), past 30-day combustible product use (AOR=2.86; 95% CI=1.67-4.88), and past 30-day dual use of these products (AOR=3.02;95%CI=1.45-6.31), after adjusting for covariates.

CONCLUSIONS: Seeing and posting tobacco-related content on social media predicts tobacco use among youth, nationwide. Results suggest that interventions and policies prohibiting tobacco-related content on social media are needed to curb the impact of social media on youth tobacco-use.

KEYWORDS: e-cigarettes, combustible products, dual use, past 30-day use, adolescents

Introduction

Since the early 2000s, the landscape of tobacco marketing has shifted to embrace social media[1,2]. The tobacco industry has a strong online presence on Instagram, Facebook, Twitter, and YouTube, which is of particular concern given that social media platforms are heavily used by youth[1]. In 2018, 97% of USA.

youth ages 13-17 reported using at least one social media site, including YouTube, Instagram, Snapchat, Facebook, Twitter, Tumblr, or Reddit[3]. Research has shown that youth are exposed to and engage with industry-sponsored tobacco content on social media, including brand pages, with 12% of youth reporting that they had engaged with one or more forms of online tobacco marketing in the year 2013-2014[4]. Compared to youth who did not engage with any online tobacco marketing, those who did have increased initiation of tobacco products one year later[5].

In contrast to industry-sponsored tobacco content such as brand pages, social media also exposes youth users to organic, user-generated content such as images of people using tobacco products, positive posts about e-cigarette or combustible product use, posts arguing against regulation, and videos of people performing e-cigarette vape tricks[6,7]. Information-sharing regarding e-cigarettes and combustible products is common on social media and provides youth with easy ways to obtain new information on tobacco products[6,8]. Furthermore, research has found that pro-tobacco messages far outnumber negative tobacco messages and warnings about the potential harms associated with tobacco product use[9,10]. Important implications for health behavior arise from the interactive information-sharing that occurs on social media sites, as it is likely that exposure to tobacco-related content on social media is associated with normalization of tobacco product use among youth[11].

Research has demonstrated that youth exposure to and engagement with user-generated social media depicting tobacco is prevalent and associated with tobacco use[4,6,7,9,12-15] A 2016 USA. convenience sample of 1729 youth (15-17 years) found that among those who used e-cigarettes 74.0% reported watching vape tricks online[14]. In a cross-sectional 2014-2015 study, a representative sample of middle and high school students found that 52.5% of students reported exposure to tobacco-related social media in the past 30-days[6]. Students who had written, responded, or reblogged tobacco-related content on social media had increased odds of past 30-day combustible product use[6]. In addition, posting videos/pictures of tricks with tobacco or e-cigarette products on social media was significantly associated with both ever and past 30-day dual e-cigarette/combustible product use[6]. Recently, an analysis of data from the nationally representative, longitudinal PATH study following youth (12-17 years old) never users of any tobacco product in 2014-2015 (wave 2) found that seeing tobacco content on social media sites was associated with initiation of ever e-cigarette use one year later (OR= 2.09, 95% CI= 1.43-3.46, n= 304)[15].

The majority of previously cited studies are not nationally representative and therefore do not have national implications[6,7,9,10,12-14]. It is unknown if seeing or posting tobacco-related content on social media sites used by youth is associated with past 30-day: e-cigarette use, combustible product use, or dual use of e-cigarettes and combustible product use one year later in a nationally representative sample of USA. youth. For this reason, we examined the longitudinal association between:

(1) seeing and (2) posting tobacco-related content on social media and 3 outcomes: (i) past 30-day e-cigarette use, (ii) past 30-day combustible product use, and (iii) past 30-day dual use of e-cigarettes and at least one combustible product in 2015-2016 PATH youth, while controlling for the effect of previous ever tobacco product use.

Methods

Study Design and Participants

The PATH study generated a nationally representative sample of USA. youth (aged 12-17) starting in 2013-2014 (wave 1) with annual follow-up until 2016-2017, and its methodology has been described elsewhere with a summary provided here[4,5,16,17]. The weighted retention rate for youth from 2013-2015 (wave 1 to 2) was 88.4%. In addition, there were a total of 2091 11 year olds from PATH households in 2013-2014 were invited to participate in PATH 2014-2015 when they turned 12 and were eligible to participate. Therefore, a total of 12 172 youth completed PATH wave 2. IRB approval for this study was obtained from the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston (HSC-SPH-17-0368).

Exclusion Criteria

Among the 12 172 youth, only those with complete social media use data in wave 2 and wave 3 follow-up data were included in the analysis. A total of 4791 youth were excluded who did not participant in both waves or reported never going online, not having a social media account, never using their social media account, refused to answer the questions on social media use, or had missing data for race/ethnicity or sex. This resulted in 7381 youth participants representing 16,109 064 USA youth with complete data for exposures, outcomes, and covariates of interest, which represents 60.6% of the PATH wave 2 youth sample.

Exposures

Seeing and posting tobacco-related content on social media was asked among youth participants who reported having a social media account at wave 2. Seeing tobacco-related content on social media was assessed with the question: "In the past 12 months, have you seen content posted about tobacco products (including e-cigarettes) on social media sites?". Posting tobacco-related content on social media was assessed with the question: "In the past 12 months, have you posted content about tobacco products (including e-cigarettes) on any of your social media accounts?". Response options for both questions included "Yes" and "No".

Outcomes

Longitudinal secondary analyses examined 3 outcomes at wave 3: (i) past 30-day e-cigarette use, (ii) past 30-day combustible

use, and (iii) past 30-day dual use of e-cigarettes and at least one combustible product.

Past 30-day E-cigarette Use

Past 30-day e-cigarette use was asked among participants who reported ever use of e-cigarettes: "When was the last time you used an e-cigarette, even one or two times?". Response options were dichotomized to represent within the past 30-days as "yes/no". Participants who answered "don't know" or refused to answer were excluded (n=20).

Past 30-day Combustible Product Use

Past 30-day combustible product use was measured using the combination of separate questions that asked about the last use of combustible tobacco products, including cigarettes, traditional cigars, filtered cigars, cigarillos, and hookah. Past 30-day combustible product use was asked among participants who reported ever use of each tobacco product. Response options were dichotomized as "yes/no". Participants who answered "don't know" or refused to answer were excluded (n=47). Participants who did not report combustible tobacco product use within the past 30-days were categorized as non-past 30-day combustible product users. Users were identified as participants who had used any of the 5 combustible products in the past 30-days.

Past 30-day Dual Use of a Combustible Product and E-cigarettes

Dual product users were participants who were categorized as both past 30-day combustible product users and past 30-day e-cigarette users (ie, at least one combustible product and e-cigarettes in the past 30-days at wave 3).

Interaction Between Exposures and Previous Tobacco Use

To control for the effect of previous tobacco use, we evaluated the association of the interaction between each exposure and previous tobacco use at wave 2. Six interaction variables were created from exposures measured at wave 2 which occurred before outcomes at wave 3. The interaction terms were: (i) seeing tobacco-related content on social media and ever e-cigarette use, (ii) seeing tobacco-related content on social media and ever combustible product use, (iii) seeing tobacco-related content on social media and ever dual use of e-cigarettes and at least one combustible product, (iv) posting tobacco-related content on social media and ever e-cigarettes use, (v) posting tobacco-related content on social media and ever combustible products use, and (vi) posting tobacco-related content on social media and ever dual use of e-cigarettes and at least one combustible product. For each interaction, this resulted in 4 exposure categories (ie, seeing content (yes)/ever e-cigarette use, seeing content (yes)/never e-cigarette use, seeing

content (no)/ever e-cigarette use, seeing content (no)/never e-cigarette use). For (i-iii) the reference category was never seeing tobacco-related content on social media sites and never use of each tobacco product. For (iv-vi) the reference category was never posting tobacco-related content on social media sites and never use of each tobacco product.

Covariates

For comparison with previous literature, we adjusted for sex, race/ethnicity, age, frequency of social media use, household income, and parental level of education in analyses. Participant age is provided by PATH in their public files[18] in two age categories: 12 to 14 years old and 15 to 17 years old. Answers to a question about participant sex classified participants as either males or females, and this variable was imputed by PATH at wave 1 but not at wave 2. PATH used the following categories to measure participant race: White race alone, Black race alone, Asian race alone, and Other race (including multi-racial). Ethnicity categorized participants as either Hispanic or Non-Hispanic. Answers to race/ethnicity questions were combined to create race/ethnicity categories that are comparable to those in the Surgeon General's report[19,20]: Non-Hispanic White, Hispanic, Non-Hispanic Black, Non-Hispanic Other (Asian, multi-race, and other Non-Hispanic).

Household income and parental education were obtained from the parent interview. Response options were categorized to represent parents who had responded that their total household income was greater than $50,000, less than $50,000, and those who refused to answer the question. Response options for parental education included less than high school, GED, high school graduate, some college (no degree) or associate degree, Bachelor's degree, advanced degree, and refused to answer the question. Due to low sample size, the categories for GED and high school graduate were collapsed, as well as some college and associate degree.

Frequency of social media use was asked to youth participants: "About how often do you visit your social media accounts?". Response options included: "several times a day", "about once a day", "3-5 days a week", "1-2 days a week", "every few weeks", "less often", and "never". Responses "3-5 days a week" and "1-2 days a week" were collapsed into a single category, as well as, "every few weeks" and "less often", due to low sample size in these categories.

Statistical Analysis

We used the PATH public-use youth datasets (waves 2 and 3)[21] for all analyses, and PATH wave 3 longitudinal person-level sampling weights were used. In addition, balance repeated replicate (BRR) sampling weights were used with the Fay's correction method value of .3[16,21,22]. Weighted summary statistics were estimated for sociodemographic characteristics, outcomes, exposures and covariates. For the analyses, six

weighted multiple logistic regression models were generated to assess the interaction between the two social media exposures at wave 2 and the 3 tobacco use outcomes at wave 3. Crude analyses are reported as well as adjusted models, controlling for the effect of sex, race/ethnicity, age, household income, parent level of education, and frequency of social media use. Crude and adjusted odds ratios and 95% confidence intervals are reported.

Results

Youth who participated in both waves 2 and 3 and who used their social media accounts were 50.9% female, the majority identified as Non-Hispanic white (54.5%), and 55.7% were 15-17 years old. Most parents (81.9%) of youth reported graduating from high school and about half reported (48.5%) a household income of $50,000 or greater. The majority of participants, 64.6%, used their social media accounts several times a day. Overall, 45.7% reported seeing tobacco-related content on social media in the past 12 months, while 3.85% reported posting tobacco-related content on their social media in the past 12 months. The prevalence at wave 2 of ever e-cigarette use, ever combustible product use, and ever dual use of an e-cigarette and at least 1 combustible product was 12.4%, 12.6%, 7.0%, respectively (Table 1). In addition, the prevalence of the outcomes at wave 3 were: 5.2% reported past 30-day e-cigarette use, 5.1% of youth reported past 30-day combustible product use, and 2.0% reported past 30-day dual use of an e-cigarette and at least 1 combustible product.

Table 2 presents the crude and adjusted weighted logistic regression analyses of the six interactions considered. In the adjusted models, among youth never e-cigarette users, seeing tobacco-related content on social media was significantly associated with past 30-day e-cigarette use one year later (AOR=1.92;95%CI=1.36-2.71). Similarly, among youth never dual users of e-cigarettes and combustible products, seeing tobacco-related content on social media was significantly associated with past 30-day e-cigarette use one year later (AOR=2.11;95%CI=1.08-4.13). In addition, the interaction of posting tobacco-related content on social media while controlling for previous ever use of each tobacco product use was significantly associated with each of the 3 outcomes among previous tobacco users: past 30-day day e-cigarette use (AOR= 2.09;95%CI=1.23-3.55), past 30-day combustible product use (AOR=2.86; 95%CI=1.67-4.88), and past 30-day dual use of these products (AOR=3.02;95%CI=1.45-6.31), after adjusting for demographic factors and frequency of social media use.

Discussion

Almost half (45.7%) of PATH youth representing 7.3 million youth in the USA reported seeing tobacco-related content on social media in 2014-2015. Our results suggest that seeing tobacco-related content on social media in the past 12 months in 2014-2015 was significantly associated with past 30-day e-cigarette and past 30-day dual use in 2015-2016 among youth who were previously never users. In addition, posting tobacco-related

content on social media in the past 12 months in 2014-2015 was associated with past 30-day e-cigarette, combustible, and dual use in 2015-2016 among youth who had previously used each tobacco product. Our findings are consistent with prior analyses of PATH data from 2014-2015, which found that youth non-users of any tobacco product who saw tobacco-related content on social media had a higher risk for initiation of ever use of tobacco products one year later[15], but our findings extend this previous work by focusing on past 30-day use outcomes.

Social media is different from traditional media in several ways that may make social media a stronger channel for tobacco content. First, social media sites facilitate interaction among individuals in the form of comments and sharing, which can further increase the impact of the content when youth engage with it. Additionally, social media sites allow users to endorse content in the form of "likes", which provides youth with a quantitative assessment of the content. A study from 2014 found that youth were more likely to endorse photos of risky behaviors, including cigarette smoking, if those photos had received more likes from peers, indicating the importance of relying on feedback from others[23].

Implications

Several strategies should be considered to alleviate the impact that tobacco-related content on social media has on youth tobacco use. While some social media sites have chosen to self-regulate by prohibiting tobacco/e-cigarette advertisements, the tobacco industry has found ways to circumvent these prohibitions by using 'influencers' (ie, third party paid endorsers that shape youth attitudes and behaviors through social media content)[24,25]. Research has shown that the tobacco and vaping industries have used this strategy to reach younger audiences[12,26-29]. Any advertising and/or 'influencer' restrictions set forth would be subject to constraints from the USA First Amendment's free speech protections[30], but it would be effective and lawful for states to restrict online tobacco industry content on social media to only age-verified adults, as social media is a private industry[31]. To better inform tobacco regulations, future research should consider the distinction between industry-sponsored advertising on social media, including the use of paid influencers, vs user-generated content to determine which of these content types youth are most exposed to. Prior research has suggested that industry-sponsored social media posts may be identifiable by characteristics of the post (eg, the hashtag used)[32], and additional evidence that helps distinguish between undisclosed, sponsored social media content and organic, user-generated social media content may help enforce regulations designed to prevent the tobacco industry from targeting youth. Furthermore, tobacco/e-cigarette companies are still allowed to maintain brand-sponsored pages on many platforms, and previous research has shown that the "age-gating" requirement that excludes youth who are younger than 18 from accessing the content was absent on 78% of hookah, 62% of e-cigarette, and 21% of cigar brand-sponsored pages on Facebook[33]. These findings show that policies restricting youth access

Table 1. PATH[¥] wave 2 (2014-2015) youth (12-17 years old) who used their social media accounts and participated in wave 3 (2015-2016).

VARIABLES		N[a] =7381	WEIGHTED N[a] =6,109 064	WEIGHTED % (SE)
Sex	Male	3639	7 904 177	49.2 (.27)
Ethnicity	Non-Hispanic White	3545	8 739 632	54.5 (.35)
	Non-Hispanic Black	963	2 107 283	13.1 (.23)
	Hispanic	2112	3 595 224	22.4 (.30)
	Non-Hispanic Other[!]	729	1 601 524	10.0 (.24)
Age	12-14 years old	4139	8 970 887	55.7 (.39)
	15-17 years old	3242	7 138 177	44.3 (.39)
Household Income	< 50 000	3298	6 537 964	40.6 (.95)
	≥ 50 000	3270	7 809 142	48.5 (.92)
	Refused to answer	813	1 761 958	10.9 (.45)
Parents level of education	Less than High School	996	1 811 173	11.2 (.51)
	High School Graduate	1533	3 146 599	19.5 (.65)
	Associate Degree/Some College	2202	4 726 945	29.3 (.84)
	Bachelor's Degree	1356	3 310 801	20.6 (.85)
	Advanced Degree	770	2 003 804	12.4 (.69)
	Refused to answer	524	1 109 742	6.9 (.35)
How often do you visit social media accounts	Several times a day	4732	10,405 724	64.6 (.71)
	About once a day	1340	2 951 018	18.3 (.52)
	1-5 days a week	701	1 482 253	9.2 (.37)
	Less often	608	1 270 069	7.9 (.36)
Seen content posted about tobacco products on social media in the past 12 months at wave 2		3330	7 364 699	45.7 (.70)
Posted content about tobacco products on social media in the past 12 months at wave 2		284	619 558	3.9 (.28)
Previous e-cigarette use at wave 2		906	1 989 826	12.4 (.50)
Previous combustible use at wave 2		921	2 026 366	12.6 (.38)
Previous dual use of e-cigarettes and at least one combustible product at wave 2		507	1 123 077	7.0 (.34)
Outcomes at wave 3				
Past 30-day e-cigarette use		369	841 770	5.2 (.34)
Past 30-day combustible use		358	818 385	5.1 (.34)
Past 30-day dual use of e-cigarettes and at least one combustible product		138	324 876	2.2 (.22)

¥Population Assessment of Tobacco and Health (PATH) Study[United States] Public-Use Files (2019). Inter-University Consortium for Political and Social Research.
[a]n=sample size; N: estimated population
! Non Hispanic Other includes: Asian, multirace, etc.

to brand-sponsored content on social media are not effectively enforced[4,34], so future campaigns could also focus on strict management of these policies. In addition, as previous researchers have noted[7], an effective strategy would be to partner with social media sites and influencers to educate youth users who are engaging with tobacco-related content for prevention and intervention campaigns. Health-based messages warning about the risks of tobacco use could be targeted to those social media users and their networks.

Strengths and Limitations

The strengths of this study ensure its importance in tobacco literature. First, the PATH study is nationally representative of

Table 2. Crude and adjusted odds ratios of the interaction between exposures and previous tobacco use on tobacco use behaviors among PATH[¥] youth (12-17 years old).

OUTCOMES (N=7381; N=16,109 064)	PAST 30-DAY E-CIGARETTE USE AT WAVE 3	PAST 30-DAY COMBUSTIBLE PRODUCT USE AT WAVE 3	PAST 30-DAY DUAL USE AT WAVE 3
In past 12 months, seen content about tobacco products on social media sites at wave 2			
Previous tobacco use at wave 2	Crude Odds Ratio (95%CI)		
No	**2.23 (1.60, 3.11)**	**1.64 (1.11, 2.41)**	**2.66 (1.45, 4.88)**
Yes	**1.46 (1.06, 2.01)**	1.28 (.91, 1.80)	1.59 (.92, 2.75)
Previous tobacco use at wave 2	Adjusted OR[a] (95%CI)		
No	**1.92 (1.36, 2.71)**	1.47 (.96, 2.25)	**2.11 (1.08, 4.13)**
Yes	1.30 (.93, 1.83)	1.22 (.86, 1.74)	1.50 (.85, 2.67)
In past 12 months, posted content about tobacco products on any social media sites at wave			
Previous tobacco use at wave 2	Crude Odds Ratio (95%CI)		
No	2.17 (.91, 5.16)	2.09 (.77, 5.66)	**4.34 (1.74, 10.85)**
Yes	**2.07 (1.26, 3.40)**	**2.55 (1.58, 4.10)**	**2.63 (1.34, 5.15)**
Previous tobacco use at wave 2	Adjusted OR[a] (95%CI)		
No	1.84 (.76, 4.44)	1.82 (.68, 4.89)	**3.38 (1.31, 8.74)**
Yes	**2.09 (1.23, 3.55)**	**2.86 (1.67, 4.88)**	**3.02 (1.45, 6.31)**

¥Population Assessment of Tobacco and Health (PATH) Study [United States] Public-Use Files (2019). Inter-University Consortium for Political and Social Research.
aAOR = odds ratio adjusted by sex, race/ethnicity, age, frequency of social media use, income and parent level education.

youth, making the findings presented here generalizable to the U.S. population. This study is consistent with previous studies on the relationship between tobacco-related content on social media and tobacco use[6,15,35], which adds to the growing body of literature. In addition, we were able to analyze associations across various forms of tobacco use, namely, past 30-day e-cigarette use, past 30-day combustible product use, and past 30-day dual use of e-cigarettes and at least one combustible product, which has not been reported before in the literature with a USA representative sample of youth. Furthermore, we had the ability to measure tobacco-use outcomes longitudinally.

This study has several limitations. First, the social media constructs we used are subject to recall bias. Although we were able to explore the associations between seeing and posting tobacco-related content on later use of specific product(s), the exposure measures did not capture what kind of product(s) youth saw or posted on social media. Future research on tobacco-related social media should include measures that specify the types of tobacco products participants are exposed to, both to understand the current social media landscape and to better understand whether product initiation is associated with exposure to any tobacco product, or only those specifically encountered. A second limitation of our study is that it did not inquire about pro-tobacco vs anti-tobacco content on social media. A few studies have found that the majority of tobacco-

related content on social media is positive[9,13], and given that we found robust associations across different types of tobacco use, it is plausible that most of the content seen by participants in this study was pro-tobacco. Finally, these data are from 2014-2016, and as such, these results may not generalize to the current social media and tobacco landscape in the USA However, population-based studies will always have the limitation of using data from previous years, as data collection representative of the entire USA takes time. Several important changes have occurred since data collection in 2015-2016, including increased regulations on industry-sponsored content on social media and the introduction of JUUL to the market, which accounted for nearly 75% of the e-cigarette market share in the USA in 2018, and is widely used by youth[36]. Our findings can be compared with more recent data to determine if changes in the social media and tobacco market landscapes have resulted in a worse relationship between tobacco content on social media and past 30-day tobacco use outcomes.

Conclusion

In conclusion, the findings presented here show that seeing and posting tobacco-related content on social media predict subsequent past 30-day e-cigarette use, past 30-day combustible product use, and dual past 30-day use of e-cigarettes and at least one combustible product among youth, nationwide. Tobacco-

related content on social media has important implications for regulation, and we encourage state policy-makers to consider these findings when making decisions about the legality of tobacco-related content on underage social media accounts.

Author contributions
Concept and Design: Pérez, Bluestein, Hébert *Acquisition, analysis, or interpretation of data:* Pérez, Spells, Bluestein *Draft of manuscript:* Pérez, Spells, Bluestein, Harrell, Hébert *Critical revision of the manuscript for important intellectual content:* Pérez, Spells, Bluestein, Harrell, Hébert *Statistical analysis:* Spells, Bluestein *Obtained funding:* Pérez, Bluestein, Harrell *Administrative, technical, or material support:* Bluestein *Supervision:* Pérez, Hébert.

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