Associations between public e-cigarette use and tobacco-related social norms among youth

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ABSTRACT

Importance E-cigarette use in public places may renormalise tobacco use.

Objective To measure associations between e-cigarette use in public places and social norms among youth.

Design Cross-sectional survey.

Setting School-based.

Participants 24 353 never tobacco users in US 6th–12th grades who completed the 2016–2017 National Youth Tobacco Surveys.

Exposure Individuals were classified as exposed in public places within the past 30 days to: (1) neither e-cigarette secondhand aerosol (SHA) nor combustible tobacco secondhand smoke (SHS); (2) SHA only; (3) SHS only; and (4) both SHA and SHS.

Outcomes Outcomes were overestimation of peer e-cigarette use (a measure of descriptive norms), harm perception and susceptibility. Data were analysed using descriptive statistics and logistic regression ($p<0.05$).

Results Overall prevalence of SHS and SHA exposure in public places was 46.6% and 18.3%, respectively. SHA exposure in public places was associated with increased odds of overestimating peer e-cigarette use (adjusted OR (AOR): 1.83; 95% CI 1.29 to 2.58) and decreased odds of perceiving e-cigarettes as harmful (AOR: 0.63; 95% CI 0.51 to 0.79), compared with those exposed to neither emission. SHA exposure in public places was also associated with increased susceptibility to using e-cigarettes (AOR: 2.26; 95% CI 1.82 to 2.81) and cigarettes (AOR: 1.51; 95% CI 1.20 to 1.90). E-cigarette harm perception was lower among students in jurisdictions with no comprehensive clean indoor air laws (AOR: 0.79; 95% CI 0.71 to 0.88) or cigarette-only laws (AOR: 0.88; 95% CI 0.78 to 0.99) than in those prohibiting both cigarette and e-cigarette use in public places.

Conclusions Prohibiting both e-cigarette and cigarette use in public places could benefit public health.

INTRODUCTION

E-cigarette use in public places can expose bystanders to harmful and potentially harmful chemicals, complicate smoke-free policy enforcement and may renormalise tobacco use.[1] Currently, only nine US states and DC prohibit e-cigarette use in workplaces, restaurants and bars.[2] A 2014 study revealed that the majority (59.5%) of US adult current e-cigarette users had used an e-cigarette in a designated smoke-free public environment (eg, a restaurant or workplace); only 2.5% of these individuals reported receiving negative reactions from other people present, suggesting a degree of social acceptance or confusion about what tobacco products are covered under existing smoke-free laws.[3] During 2015, an estimated 24.2% (6.58 million) of US middle and high school students reported past 30-day exposure to secondhand aerosol (SHA) from an e-cigarette in a public place.[4] Moreover, even in places with specific prohibitions, use may continue to occur; 52.5% of US adult e-cigarette users reported recent e-cigarette use in an area in which it was prohibited during 2017, including restaurants, movie theatres and airports.[5]

The 2016 US Surgeon General's Report concluded that e-cigarette aerosol is not harmless.[1] Rather, according to the US National Academies of Science, Engineering, and Medicine's report on the public health consequences of e-cigarettes, there is conclusive evidence that besides nicotine, most e-cigarette products contain and emit numerous other substances that are potentially toxic.[6] However, the report acknowledged some gaps in knowledge regarding e-cigarettes; for example, it recommends that studies are needed on the association of secondhand and third-hand exposures with health outcomes in vulnerable populations.[6]

A consideration of the spectrum of such 'health outcomes,' however, could extend beyond pathology and disease.[7 8] The WHO broadly defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.[9] Examination of the health consequences of e-cigarettes, therefore, may include potential effects on the body (disease), and those on cognitive processes and the socioecological environment that influences risky behaviour.[1] Behavioural norms among adolescents may be influenced, in part, by youths' desire to fit in socially. The transition from entertaining protobacco opinions to actually experimenting with tobacco products may result from an interaction of individual factors (eg, curiosity), beliefs about product risks (eg, perceived harmfulness) and pressures introduced by the peer environment.[10]

Social norms comprise two component parts: perceived prevalence (ie, descriptive norm) and perceived acceptability (ie, injunctive norm).[11] Based on objectively measured group prevalence, certain tobacco use behaviours may not actually be common or acceptable, despite youths' contrary beliefs about the popularity of tobacco use in its various forms. This overestimation of peers' use strongly predicts youths' own susceptibility and/or tobacco use.[12] For both e-cigarettes and cigarettes, overestimation is strongly associated with curiosity, susceptibility, ever use and current use of the respective products.[12] Moreover, there is evidence

that overestimation of peers' e-cigarette use is also associated with cigarette smoking curiosity and susceptibility,[12] which are early markers of renormalisation and social acceptance. The degree of susceptibility may reflect an individual's assessment of risk versus reward, as defined in the social context, as well as perceived harm posed by various tobacco products.[13] At least in part, perceived harm is likely shaped by the presence or absence of policies designed to limit tobacco product exposure. Absent specific public health protections (or, otherwise, enforcement), the public may discount certain risks, especially if exposure in public areas is ubiquitous.

While several investigators have examined the relationship between e-cigarette use in general and certain aspects of social norms,[12–15] no study has specifically examined the role of e-cigarette use in public places, and its potential effect on renormalisation of tobacco use behaviour. We therefore analysed data from the 2016–2017 National Youth Tobacco Survey (NYTS) to investigate associations between e-cigarette use in public places and social norms, including overestimation of peer use, harm perception, curiosity and susceptibility. We also tested the hypothesis that exposure to e-cigarette use in public places would have a cross-over effect, extending beyond e-cigarette-specific social norms, to those for conventional cigarettes. Arguably, seeing people use e-cigarettes in public places, particularly where combustible tobacco smoking is prohibited, could erode firmly established social norms that disapprove of smoking in public places. To reduce the likelihood of alternative explanations, we restricted analyses to youth who had never used any tobacco products in their lifetime, including cigarettes, pipes, waterpipes, smokeless tobacco products, cigars, bidis and e-cigarettes. Youth with a history of tobacco product use may have a higher likelihood of being exposed to e-cigarette aerosol than non-users (eg, selecting friends and environments where exposure to SHA is more likely); they may also have an altered perception of the harmfulness of tobacco products.[1 4] In addition, several of the outcome variables assessed (eg, curiosity and susceptibility) inherently assume a tobacco-naïve denominator, thereby warranting an exclusion of ever and former users.

METHODS

Sample

NYTS is an annual, nationally representative school-based survey of US students in grades 6–12.[16] Sampling was done at three stages: county (primary sampling unit (PSU)), school and class. To increase sample size for statistical reliability, we combined data from the 2016 and 2017 NYTS cycles (pooled n=24 353 never tobacco users). NYTS response rates were 71.6% and 68.1% in 2016 and 2017, respectively.

Exposure to secondhand smoke and e-cigarette aerosol

Self-reported exposures to e-cigarette SHA and combustible tobacco secondhand smoke (SHS) in a public place were used as indicators for exposure to e-cigarette use or tobacco smoking within a public place in the past 30 days, respectively. Students were asked two separate questions to assess the respective exposures, 'During the past 30 days, on how many days did you breathe [the vapor from someone who was using an electronic cigarette or e-cigarette/the smoke from someone who was smoking tobacco products] in an indoor or outdoor public place?' For both questions, exposure was dichotomised as '0' for 0 days and '1' for 1–30 days.

These two exposures are likely correlated and potentially confound the relationship of interest between public SHA exposure and accuracy of descriptive norms. Therefore, we created mutually exclusive categories to ensure well-defined exposures within multivariable analyses. Individuals were classified as being exposed in public places to: (1) neither SHA nor SHS; (2) SHA only; (3) SHS only; and (4) both SHA and SHS.

The constructs above used 'smell' (vs 'see') to capture public exposure to SHA and SHS. While it is possible to witness public use of tobacco products without being close enough to experience breathing the aerosol or smoke, relying on visual detection at a distance for exposures may increase the likelihood of misreporting (eg, from poor visibility). Use of 'smell' may reduce false positives as the distance from which emissions can be detected through olfaction likely guarantees they can also be seen.

Outcome variables

For each of e-cigarettes and cigarettes, four outcomes were measured: accuracy of descriptive norms (ie, overestimation of peer use), harm perception, curiosity and susceptibility. Overestimation of peer use for e-cigarettes was based on 2016 data only; all other outcomes were based on pooled 2016–2017 data (annual samples shown in online supplementary table).

Descriptive norms

Students who reported perceived prevalence among peers in their grade level greater than the actual prevalence among that grade level within the same geographic area were classified as overestimating peers' tobacco product use. Perceived prevalence was determined by asking students: 'Out of every 10 students in your grade at school, how many do you think use [cigarettes/e-cigarettes]?' Student responses (range 0–10) were transformed to a percentage by multiplying by 10. For example, a response of '3' became 30%. Actual prevalence was computed as the percentage of students reporting past 30-day tobacco use within the same grade and PSU (county indicator) as the respondent to account for variability in tobacco use across grade levels and geographic regions. These 'actual use' percentages were rounded to the nearest 10% (eg, prevalence of '23' became 20%) to ensure that both perceived and actual prevalence were being measured on the same scale. We computed overestimation of peer use of tobacco products on both the absolute (perceived prevalence minus actual prevalence, dichotomised as overestimating vs not overestimating peer use) and relative scales (perceived prevalence divided by actual prevalence, analysed as a numeric variable).

In NYTS, all individuals sampled from the same county (or subcounty) have the same PSU identifier (masked to protect confidentiality). Some PSUs may not directly correspond to actual counties since smaller counties could be combined into one larger PSU and large counties (certainty PSUs) may be divided into smaller PSUs. The practical impact of these PSU-county differences on our analyses is negligible, however, given rounding. In total, there were 164 PSUs included in our analyses (82 within each survey year).

Harm perception, curiosity and susceptibility

Harm perception was assessed for e-cigarettes and cigarettes separately, 'How much do you think people harm themselves when they [use e-cigarettes/smoke cigarettes] some days but not every day?' Perceived harm was dichotomised for each product as low harm ('No harm', 'Little harm') or high harm ('Some harm', 'A lot of harm').

Curiosity, which measures interest without an intention to use, was assessed for the two products separately as: 'Have you ever been curious about [using an e-cigarette/smoking a cigarette]?'

Table 1 Characteristics and prevalence of SHA and SHS exposure among never tobacco users, National Youth Tobacco Survey, 2016–2017

		n	Proportion (%)	Exposure to SHS in a public place* % (95% CI)	Exposure to SHA in a public place* % (95% CI)
Overall	–	24 353	100	46.6 (45.8 to 47.4)	18.3 (17.6 to 18.9)
Sex	Male	11 718	49.1	38.9 (37.7 to 40.0)	14.8 (14.0 to 15.6)
	Female	12 519	50.9	54.0 (52.8 to 55.1)	21.6 (20.6 to 22.5)
Race/ethnicity†	White	10 328	53.5	50.7 (49.5 to 51.9)	20.2 (19.2 to 21.1)
	Black	3784	12.3	35.7 (33.7 to 37.8)	11.4 (10.1 to 12.8)
	Hispanic	6103	23.3	44.3 (42.7 to 45.9)	18.9 (17.5 to 20.2)
	Other	3110	11	48.3 (45.9 to 50.7)	17.3 (15.5 to 19.1)
School level	Middle school	13 001	52.9	44.3 (43.2 to 45.5)	16.1 (15.2 to 16.9)
	High school	11 296	47.1	49.1 (47.9 to 50.2)	20.7 (19.8 to 21.6)
Household member tobacco use‡	None	16 780	71.9	41.5 (40.5 to 42.4)	16.6 (15.9 to 17.3)
	E-cigarette use (regardless of use of non-e-cigarette tobacco product)	894	4	61.0 (56.9 to 65.2)	56.8 (52.7 to 61.0)
	Non-e-cigarette tobacco product use only	5622	24.1	60.8 (59.1 to 62.5)	17.2 (16.0 to 18.5)
SHS exposure in a private space§	No	19 203	82	40.3 (39.4 to 41.2)	16.5 (15.9 to 17.2)
	Home only	1545	6.2	66.3 (63.1 to 69.4)	20.3 (17.7 to 22.9)
	Car only	1012	4.1	75.5 (72.1 to 78.9)	29.7 (26.0 to 33.3)
	Both home and car	1821	7.7	83.0 (80.7 to 85.3)	29.5 (26.7 to 32.2)
Comprehensive indoor air laws	Covering both cigarettes and e-cigarettes	4396	22.6	48.9 (47.0 to 50.7)	21.2 (19.7 to 22.7)
	Covering cigarettes only	7456	30.7	48.5 (47.0 to 50.0)	17.3 (16.2 to 18.4)
	None	12 501	46.7	44.2 (43.1 to 45.3)	17.5 (16.6 to 18.3)

The analytical sample was restricted to 24 353 youth who had never used any tobacco products in their lifetime (including cigarettes, pipes, waterpipes, smokeless tobacco products (snus, dissolvable tobacco products, snuff and chewing tobacco), cigars, bidis and e-cigarettes). Differences statistically significant within all subgroups assessed at $P<0.05$ using χ^2 tests.

*Exposure to SHS and SHA in a public place was assessed by asking, 'During the past 30 days, on how many days did you breathe [the smoke from someone who was smoking tobacco products/the vapor from someone who was using an electronic cigarette or e-cigarette] in an indoor or outdoor public place?' Exposure was dichotomised as '0' for 0 days and '1' for 1–30 days.

†All racial/ethnic groups are non-Hispanic unless otherwise specified. 'Other' racial/ethnic persons include American Indians/Alaska Natives; Asians; Native Hawaiians/Other Pacific Islanders; and multiracial persons.

‡Household member tobacco use was assessed by asking, 'Does anyone who lives with you now smoke/use…?' Non-e-cigarette tobacco products include cigarettes, cigars, smokeless tobacco products, hookahs, pipes and bidis.

§Exposure to SHS in a private space was assessed by asking, 'During the past 7 days, on how many days [did someone smoke tobacco products in your home while you were there/did you ride in a vehicle when someone was smoking a tobacco product]?' Exposure was dichotomised as '0' for 0 days and '1' for 1–7 days.

E-cigarette, electronic cigarette; SHA, secondhand aerosol; SHS, secondhand smoke.

Categorical response options to each question were 'definitely yes'; 'probably yes'; 'definitely not'; and 'probably not'. Consistent with previous literature, either of the former two responses was classified as being highly curious.[17–19]

Susceptibility, which temporally succeeds curiosity, indicates an openness to future use. This construct was measured using three questions for each product: 'Do you think that you will try [an e-cigarette/a cigarette] soon?', 'Do you think you will [use an e-cigarette/smoke a cigarette] in the next year?' and 'If one of your best friends were to offer you [an e-cigarette/a cigarette], would you [use/smoke] it?' Categorical response options to all three questions were: 'Definitely yes'; 'Probably yes'; 'Probably not'; and 'Definitely not'. Participants who indicated any response other than 'Definitely not' to at least one of the three questions were classified as being susceptible to the specified product; those who answered 'definitely not' to all three questions were classified as not being susceptible.

Control variables

The following variables were controlled for within multivariable analyses: sex, race/ethnicity, school level, household member tobacco product use, past 7-day SHS exposure in private environments (home and car), e-cigarette advertisement exposure (retail stores, TV/movies, internet and newspaper/magazines), survey year and an ecological variable describing status of comprehensive indoor air laws within the student's state of residence (covers both cigarettes and e-cigarettes; covers cigarettes only; no comprehensive indoor air law).[17] Respondents' pro-e-cigarette advertisement exposure status on each of the four assessed media was dichotomised as: 1=exposed (responses of 'Sometimes', 'Most of the time' and 'Always') or 0=non-exposed ('Never', 'Rarely' or those who indicated not using the assessed medium); the total number of distinct media on which the respondent was exposed to advertising was then tallied (range 0–4). Status of state clean indoor air laws was assessed as a confounder because youth living in a jurisdiction with prohibitions on e-cigarette use in public areas may be less likely to be exposed to e-cigarette use in public places, or to have a pro-e-cigarette attitude.

Data analysis

All data were weighted to account for the complex survey design and to yield nationally representative estimates. We accounted for the clustering of observations within counties by using the PSU and strata variables present in the NYTS data set to correctly estimate variance. Descriptive and multivariable analyses were

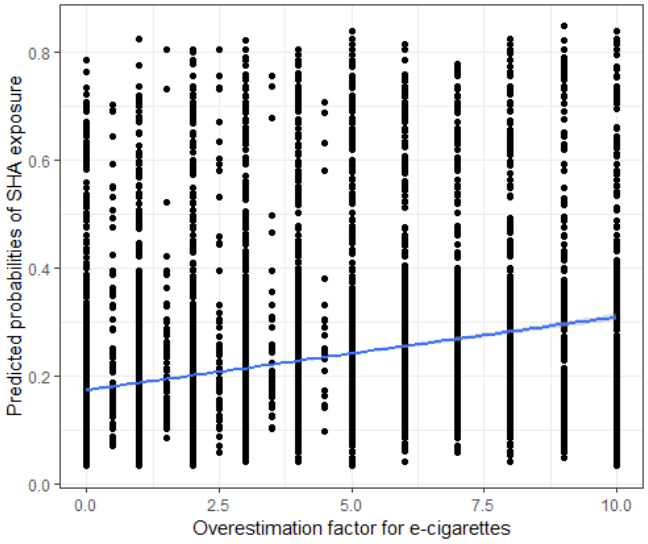

Figure 1 Correlation between predicted probabilities of e-cigarette secondhand aerosol (SHA) exposure in public places and overestimation factor for e-cigarette use among peers, National Youth Tobacco Survey, 2016. Predicted probabilities were computed conditional on sex, race/ethnicity, school level, household member tobacco product use, past 7-day secondhand smoke (SHS) exposure in private environments (home and car), e-cigarette advertisement exposure (retail stores, TV/movies, internet and newspaper/magazines), survey year and state-level comprehensive clean indoor air laws (covering both cigarettes and e-cigarettes; covering cigarettes only; none). Overestimation factor for e-cigarettes (numeric variable, not rounded) was computed as the ratio of perceived to actual prevalence of e-cigarettes within the student's grade level and specific to the county they lived in.

performed using R (V.3.5.1). Binary logistic regression analyses were conducted to measure associations between SHA/SHS exposure status in public places and each outcome variable, adjusting for the aforementioned confounders. Unless otherwise specified, all analyses used the dichotomised measure of overestimation of peer use.

RESULTS

Characteristics of never tobacco users are shown in table 1. Overall, 46.6% of never tobacco users reported public exposure to SHS, while 18.3% reported public exposure to SHA. Youth living with an e-cigarette user had significantly higher prevalence of public SHA exposure than those living with a user of a non-e-cigarette tobacco product (56.8% vs 17.2%, respectively), but did not differ significantly in their public SHS exposure.

There was a positive correlation between the predicted probability of SHA exposure and the overestimation factor for e-cigarettes on the relative scale (figure 1). Youth reporting public SHA exposure (regardless of their exposure to SHS) reported significantly higher prevalence of all of the following e-cigarette-related outcomes within unadjusted analyses, compared with those not reporting public SHA exposure: peer e-cigarette use overestimation (64.2% vs 46.7%), e-cigarette use curiosity (20.0% vs 10.1%) and e-cigarette use susceptibility (36.1% vs 21.2%). They also reported significantly higher prevalence of similar cigarette-related outcomes than those not reporting public SHA exposure (table 2).

Adjusted analyses revealed that SHA exposure in public places was significantly associated with higher odds of e-cigarette overestimation (adjusted OR (AOR)=1.83; 95% CI 1.29 to 2.58). SHA exposure was also associated with decreased odds of perceiving e-cigarettes as harmful (AOR=0.63; 95% CI 0.51 to 0.79), compared with those exposed to neither emission in public places (table 3). Each of SHA and SHS exposure in a public place was independently associated with increased curiosity and susceptibility to both conventional cigarettes and e-cigarettes (table 3). SHA exposure in public places was, however, a significantly stronger predictor than the corresponding SHS exposure for e-cigarette-related outcomes, including e-cigarette curiosity (AOR for SHA exposure: 2.64; 95% CI 2.03 to 3.44 vs AOR for SHS exposure: 1.62; 95% CI 1.42 to 1.84) as well as e-cigarette susceptibility (AOR for SHA exposure: 2.26; 95% CI 1.82 to 2.81 vs AOR for SHS exposure: 1.36; 95% CI 1.23 to 1.50). While SHA exposure in a public place also significantly predicted cigarette-related outcomes, the strength of association was generally smaller for these cigarette-related outcomes relative to those for e-cigarettes (table 3, figure 2). The odds of perceiving e-cigarettes as harmful were lower among students living in jurisdictions with no comprehensive clean indoor air laws (AOR=0.79; 95% CI 0.71 to 0.88) and those with laws that covered only cigarettes (AOR=0.88; 95% CI 0.78 to 0.99) compared with those living in jurisdictions with laws covering both cigarettes and e-cigarettes.

DISCUSSION

Approximately 18% of US 6th–12th graders who never used tobacco products reported public SHA exposure. Moreover, this exposure was independently associated with overestimation of peer use for both e-cigarettes and conventional cigarettes, although to a lesser extent for conventional cigarettes. Taken together with the findings of increased curiosity and susceptibility to e-cigarettes and cigarettes among those reporting SHA exposure in public, these findings suggest that seeing e-cigarette use in public areas may renormalise tobacco product use behaviours and promote tobacco product use among US youth. These findings underscore the importance of implementing and enforcing policies that prohibit both e-cigarette and cigarette use in indoor public places.

Youth who lived with a household member who used an e-cigarette reported a prevalence of public SHA exposure (56.8%) that was over threefold higher than that observed among youth with no tobacco user in their household (16.6%) and those with a household member who used any forms of tobacco other than e-cigarettes (17.2%). This could be attributable to household members' use of e-cigarettes around youth in areas outside the home. Furthermore, adult household members who use e-cigarettes may prefer frequenting restaurants or other public facilities that allow e-cigarette use, potentially exposing youth to SHA in these areas from individuals within or outside their immediate household. More so, constant exposure to SHA within private homes or cars could oversensitise youth to noticing an episode of e-cigarette use in public places, or of being permissive of someone using an e-cigarette around them in public places.

SHA exposure in a public place was associated with lower perceived risk for e-cigarettes, which suggests that e-cigarette use in places where cigarette smoking is prohibited could diminish perceptions of harm. Previous research has documented that one of the many reasons adolescents start e-cigarette use is to perform tricks with the aerosol,[14 18 19] suggesting that puffing e-cigarette aerosol may be perceived as a fun activity among some youth. Most of the 6th–12th graders in our study population were less than age 5 when e-cigarettes were first introduced on the

Table 2 Prevalence of outcome measures among never tobacco users, by SHA/SHS exposure status, National Youth Tobacco Survey, 2016–2017

	Electronic cigarette				Conventional cigarette			
	Overestimation of peer use* % (95% CI)	Harm perception† % (95% CI)	Curiosity‡ % (95% CI)	Susceptibility§ % (95% CI)	Overestimation of peer use* % (95% CI)	Harm perception† % (95% CI)	Curiosity‡ % (95% CI)	Susceptibility§ % (95% CI)
Overall	49.8 (48.7 to 50.9)	74.4 (73.7 to 75.1)	11.9 (11.4 to 12.4)	23.8 (23.1 to 24.5)	66.7 (65.6 to 67.7)	94.1 (93.8 to 94.5)	13.3 (12.8 to 13.9)	24.0 (23.3 to 24.6)
SHA exposure in a public place¶								
Unexposed	46.7 (45.4 to 47.9)	75.1 (74.3 to 75.8)	10.1 (9.6 to 10.7)	21.2 (20.5 to 22.0)	64.3 (63.1 to 65.5)	94.0 (93.5 to 94.4)	12.1 (11.5 to 12.7)	22.4 (21.6 to 23.1)
Exposed	64.2 (61.6 to 66.7)	71.5 (69.8 to 73.2)	20.0 (18.5 to 21.6)	36.1 (34.3 to 37.9)	77.6 (75.4 to 79.9)	95.5 (94.7 to 96.3)	19.0 (17.5 to 20.5)	31.1 (29.3 to 32.9)
SHS exposure in a public place¶								
Unexposed	45.5 (43.9 to 47.0)	75.2 (74.3 to 76.2)	8.8 (8.1 to 9.4)	19.6 (18.7 to 20.5)	61.4 (59.9 to 62.9)	93.2 (92.6 to 93.7)	10.4 (9.8 to 11.1)	21.5 (20.6 to 22.4)
Exposed	54.6 (52.9 to 56.2)	73.5 (72.4 to 74.6)	15.6 (14.8 to 16.5)	28.9 (27.8 to 30.0)	72.5 (71.0 to 74.0)	95.5 (95.0 to 96.0)	16.8 (15.9 to 17.7)	26.9 (25.8 to 27.9)

Analyses for overestimation of peer use for e-cigarettes were based on 2016 data only; all other outcomes were based on pooled 2016–2017 data. Differences statistically significant within all subgroups assessed (unexposed vs exposed) at $P<0.05$ using χ^2 tests. SHA and SHS exposures not mutually exclusive of each other.

*Binary variable. Individuals reporting perceived prevalence greater than the actual prevalence in their grade within their county (absolute differences) were classified as overestimating peer use of the specified product.

†Perceived harm was defined as a response of 'Some harm', or 'A lot of harm' to the question, 'How much do you think people harm themselves when they [smoke cigarettes/use e-cigarettes] some days but not every day?'.

‡Curiosity was assessed with the question: 'Have you ever been curious about [using an e-cigarette/smoking a cigarette]?' Categorical response options were 'definitely yes'; 'probably yes'; 'definitely not'; and 'probably not'. Either of the former two responses was classified as a positive indication of being highly curious.

§Susceptibility was defined as lack of a firm resolve not to use the specified tobacco product soon, in the next year, or if offered by a close friend.

¶Past 30-day exposure to SHS and SHA in a public place was assessed by asking, 'During the past 30 days, on how many days did you breathe [the smoke from someone who was smoking tobacco products/the vapor from someone who was using an electronic cigarette or e-cigarette] in an indoor or outdoor public place?' Exposure was dichotomised as '0' for 0 days and '1' for 1–30 days.

SHA, secondhand aerosol; SHS, secondhand smoke.

Table 3 Associations between SHA/SHS exposure and outcome variables among never tobacco users, National Youth Tobacco Survey, 2016–2017

		Electronic cigarette				Conventional cigarette			
		Overestimation of peer use† AOR (95% CI)	Harm perception‡ AOR (95% CI)	Curiosity§ AOR (95% CI)	Susceptibility¶ AOR (95% CI)	Overestimation of peer use † AOR (95% CI)	Harm perception‡ AOR (95% CI)	Curiosity§ AOR (95% CI)	Susceptibility¶ AOR (95% CI)
Exposure in a public place**	No exposure	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	SHA only	1.83 (1.29 to 2.58)*	0.63 (0.51 to 0.79)*	2.64 (2.03 to 3.44)*	2.26 (1.82 to 2.81)*	1.69 (1.18 to 2.42)*	1.57 (1.01 to 2.47)*	1.91 (1.45 to 2.52)*	1.51 (1.20 to 1.90)*
	SHS only	1.09 (0.96 to 1.22)	0.89 (0.81 to 0.98)*	1.62 (1.42 to 1.84)*	1.36 (1.23 to 1.50)*	1.28 (1.13 to 1.46)*	1.61 (1.34 to 1.93)*	1.54 (1.36 to 1.74)*	1.11 (1.01 to 1.22)*
	Both SHA and SHS	1.67 (1.43 to 1.94)*	0.85 (0.75 to 0.96)*	2.43 (2.09 to 2.82)*	2.09 (1.86 to 2.34)*	1.70 (1.43 to 2.03)*	1.52 (1.19 to 1.94)*	1.97 (1.70 to 2.28)*	1.51 (1.34 to 1.69)*
Sex	Male	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Female	1.34 (1.21 to 1.48)*	1.69 (1.56 to 1.83)*	1.05 (0.94 to 1.16)	0.99 (0.91 to 1.07)	1.47 (1.31 to 1.64)*	1.35 (1.16 to 1.57)*	1.15 (1.04 to 1.28)*	0.93 (0.86 to 1.01)
Race/ethnicity††	White	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Black	0.90 (0.77 to 1.04)	0.80 (0.71 to 0.90)*	1.29 (1.10 to 1.50)*	0.94 (0.83 to 1.07)	1.15 (0.98 to 1.35)	0.47 (0.39 to 0.58)*	1.23 (1.06 to 1.43)*	0.99 (0.87 to 1.12)
	Hispanic	1.41 (1.25 to 1.60)*	0.91 (0.82 to 1.00)	1.49 (1.32 to 1.69)*	1.44 (1.31 to 1.59)*	1.61 (1.40 to 1.85)*	0.56 (0.47 to 0.67)*	1.46 (1.29 to 1.65)*	1.72 (1.57 to 1.89)*
	Other	1.03 (0.88 to 1.20)	1.17 (1.03 to 1.34)*	1.27 (1.07 to 1.51)*	1.04 (0.91 to 1.19)	1.15 (0.97 to 1.37)	0.72 (0.56 to 0.92)*	1.42 (1.21 to 1.66)*	1.09 (0.96 to 1.25)
School level	Middle school	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	High school	4.68 (4.23 to 5.18)*	0.75 (0.69 to 0.81)	1.35 (1.21 to 1.49)*	1.26 (1.16 to 1.36)*	4.77 (4.26 to 5.34)*	0.92 (0.79 to 1.06)	1.31 (1.18 to 1.45)*	1.01 (0.93 to 1.09)
Household member tobacco use‡‡	None	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	E-cigarette use (regardless of use of non-e-cigarette tobacco product)	1.02 (0.76 to 1.36)	0.47 (0.38 to 0.57)*	1.42 (1.12 to 1.81)*	1.75 (1.43 to 2.13)*	0.84 (0.61 to 1.15)	0.83 (0.57 to 1.20)	0.85 (0.66 to 1.10)	1.33 (1.09 to 1.63)*
	Non-e-cigarette tobacco product use only	1.01 (0.88 to 1.16)	0.75 (0.67 to 0.83)*	1.24 (1.08 to 1.43)*	1.22 (1.09 to 1.36)*	1.10 (0.95 to 1.28)	0.86 (0.71 to 1.05)	1.04 (0.90 to 1.19)	1.20 (1.07 to 1.34)*
SHS exposure in a private space§§	None	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Home only	1.04 (0.83 to 1.29)	0.81 (0.68 to 0.95)*	1.17 (0.95 to 1.43)	1.21 (1.02 to 1.43)*	1.19 (0.93 to 1.51)	0.69 (0.51 to 0.95)*	1.32 (1.07 to 1.62)*	1.34 (1.14 to 1.59)*
	Car only	1.20 (0.93 to 1.55)	0.76 (0.63 to 0.91)*	1.22 (0.97 to 1.53)	1.38 (1.13 to 1.68)*	1.33 (0.98 to 1.80)	0.68 (0.47 to 0.98)*	1.29 (1.03 to 1.62)*	1.50 (1.24 to 1.82)*
	Both home and car	1.39 (1.10 to 1.76)*	0.76 (0.65 to 0.89)*	1.15 (0.93 to 1.43)	1.09 (0.92 to 1.30)	1.52 (1.18 to 1.97)*	0.57 (0.43 to 0.75)*	1.19 (0.95 to 1.47)	1.31 (1.10 to 1.55)*
E-cigarette advertisement exposure¶¶	0	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	1	1.38 (1.20 to 1.59)*	0.94 (0.84 to 1.04)	1.38 (1.19 to 1.60)*	1.28 (1.14 to 1.42)*	1.40 (1.21 to 1.62)*	1.16 (0.96 to 1.40)	1.12 (0.97 to 1.28)	1.14 (1.02 to 1.27)*
	2	1.80 (1.55 to 2.09)*	0.97 (0.86 to 1.09)	1.53 (1.30 to 1.80)*	1.52 (1.35 to 1.73)*	1.71 (1.46 to 2.01)*	1.27 (1.01 to 1.60)*	1.11 (0.95 to 1.30)	1.32 (1.17 to 1.49)*
	3	2.19 (1.86 to 2.59)*	1.20 (1.05 to 1.37)*	1.46 (1.23 to 1.74)*	1.52 (1.32 to 1.73)*	2.11 (1.76 to 2.53)*	1.46 (1.14 to 1.87)*	1.18 (1.00 to 1.39)	1.32 (1.16 to 1.51)*
	4	2.97 (2.45 to 3.62)*	1.40 (1.19 to 1.63)*	1.55 (1.29 to 1.87)*	1.34 (1.16 to 1.56)*	2.47 (1.97 to 3.08)*	1.74 (1.26 to 2.41)*	1.19 (1.00 to 1.43)	1.21 (1.04 to 1.40)*
Comprehensive indoor air laws	Covering both cigarettes and e-cigarettes	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Covering cigarettes only	0.68 (0.59 to 0.79)*	0.88 (0.78 to 0.99)*	1.01 (0.87 to 1.18)	1.01 (0.90 to 1.13)	1.17 (1.00 to 1.37)	1.16 (0.92 to 1.45)	0.95 (0.83 to 1.10)	1.00 (0.89 to 1.12)
	None	1.02 (0.90 to 1.16)	0.79 (0.71 to 0.88)*	1.04 (0.90 to 1.19)	1.04 (0.94 to 1.16)	1.48 (1.29 to 1.70)*	0.86 (0.71 to 1.04)	0.88 (0.77 to 1.01)	0.98 (0.88 to 1.09)
Survey year	2016	–	Ref	Ref	Ref	–	Ref	Ref	Ref
	2017	–	1.11 (1.03 to 1.21)*	1.01 (0.91 to 1.13)	0.99 (0.91 to 1.07)	–	1.19 (1.02 to 1.39)*	1.15 (1.04 to 1.27)*	0.98 (0.90 to 1.06)

Continued

Table 3 Continued

	Electronic cigarette				Conventional cigarette			
	Overestimation of peer use† AOR (95% CI)	Harm perception‡ AOR (95% CI)	Curiosity§ AOR (95% CI)	Susceptibility¶ AOR (95% CI)	Overestimation of peer use † AOR (95% CI)	Harm perception‡ AOR (95% CI)	Curiosity§ AOR (95% CI)	Susceptibility¶ AOR (95% CI)

Analyses for overestimation of peer use for e-cigarettes were based on 2016 data only; all other outcomes were based on pooled 2016–2017 data.
*P<.05.
†Binary variable. Individuals reporting perceived prevalence greater than the actual prevalence in their grade within their community (absolute differences) were classified as overestimating peer use of the specified product.
‡Perceived harm was defined as a response of 'Some harm', or 'A lot of harm' to the question, 'How much do you think people harm themselves when they [smoke cigarettes/use e-cigarettes] some days but not every day?'.
§Curiosity was assessed with the question: 'Have you ever been curious about [using an e-cigarette/smoking a cigarette]?' Categorical response options were 'definitely yes'; 'probably yes'; 'definitely not'; and 'probably not'. Either of the former two responses was classified as a positive indication of being highly curious.
¶Susceptibility was defined as lack of a firm resolve not to use the specified tobacco product soon, in the next year, or if offered by a close friend.
**Past 30-day exposure to SHS and SHA in a public place was assessed by asking, 'During the past 30 days, on how many days did you breathe [the smoke from someone who was smoking tobacco products/the vapor from someone who was using an electronic cigarette or e-cigarette] in an indoor or outdoor public place?' Exposure was dichotomised as '0' for 0 days and '1' for 1–30 days.
††Household member tobacco use was assessed by asking, 'Does anyone who lives with you now smoke/use…?' Non-e-cigarette tobacco products include cigarettes, cigars, smokeless tobacco products, hookahs, pipes and bidis.
‡‡Exposure to SHS in a private space was assessed by asking, 'During the past 7 days, on how many days [did someone smoke tobacco products in your home while you were there/did you ride in a vehicle when someone was smoking a tobacco product]?' Exposure was dichotomised as '0' for 0 days and '1' for 1–7 days.
§§Created by summing the media sources (internet, newspapers/magazines, retail stores and TV/movies) over which e-cigarette advertising exposure occurred (range: 0–4); respondents' exposure status was coded on each medium as either: 1=exposed (responses of 'Sometimes'/'Most of the time'/'Always') or 0=non-exposed ('Never'/'Rarely'; or those who indicated not using the assessed medium).
AOR, adjusted OR; E-cigarette, electronic cigarette; Ref, reference category; SHA, secondhand aerosol; SHS, secondhand smoke.

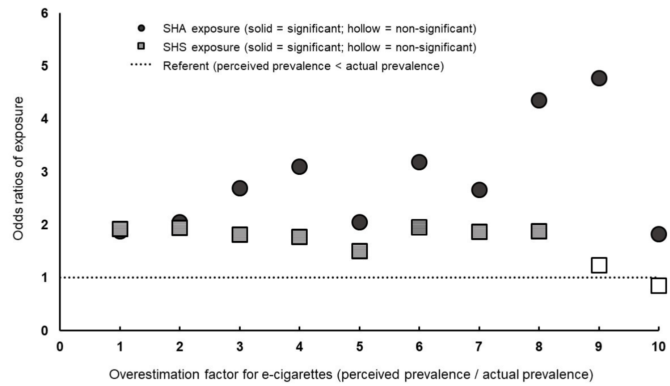

Figure 2 Exposure to secondhand aerosol (SHA) and secondhand smoke (SHS) modelled as a function of overestimation factor for e-cigarette use among peers, National Youth Tobacco Survey, 2016. ORs are crude (unadjusted). Statistical significance was set at p<0.05. Overestimation factor for e-cigarettes (rounded to the nearest integer) was computed as the ratio of perceived to actual prevalence of e-cigarettes within the student's grade level and specific to the county they lived in. For figure above, separate logistic regression models were fitted for SHA and SHS exposure in public places, respectively. The independent variable was overestimation factor for e-cigarettes; this was treated as a categorical variable with 11 levels (0–10). The referent category was 0 (individuals with perceived prevalence less than the actual prevalence within their grade).

US market; thus, they may perceive e-cigarettes as mainstream, especially since e-cigarettes have remained the most commonly used product among youth since 2014.[1 20] Prohibiting cigarette smoking, but not e-cigarette use, in public spaces potentially conveys the message that e-cigarette use is socially acceptable and/or safe. There is still confusion in the general public regarding whether e-cigarettes are tobacco products[13]; allowing e-cigarette use in public places where cigarettes are otherwise prohibited may further reinforce this confusion. Conversely, including e-cigarettes in smoke-free policies, as recommended by the US Surgeon General, would 'maintain current standards for clean indoor air, reduce the potential for renormalization of tobacco product use, and prevent involuntary exposure to nicotine and other aerosolised emissions from e-cigarettes.'[1]

Laws may formalise or catalyse societal disapproval of a behaviour. This is consistent with our observation that students who lived in jurisdictions with no prohibitions on e-cigarette use in public places were less likely to perceive e-cigarettes as being harmful. The widespread perception of smoking in public areas as a taboo among the majority of the US population has accelerated the adoption of comprehensive smoke-free laws across the country.[17 21] E-cigarettes, which are relatively newer products, may not have garnered social disapproval to the same extent; however, a 2017 survey of US adults indicated that 82.4% of adults strongly or somewhat opposed the use of electronic vapour products in indoor public places.[22] Implementing and enforcing laws that prohibit e-cigarette use in public places—along with other forms of tobacco use—may accelerate formation of norms that view e-cigarette use in public areas as unacceptable.

Youth exposed to both SHA and SHS had increased harm perception of cigarettes but reduced harm perception of e-cigarettes. E-cigarettes and their emissions contain a plethora of fruit, candy and several other flavours which might make SHA appear less harmful than SHS among those exposed to both emissions.[23] A recent survey of US adults likewise showed that a third of US adults did not know if SHA exposure posed any danger to

children; 5.3% thought there was no harm, 39.9% characterised the level of harm as 'little to some' and only 21.5% thought it posed a lot of harm[24]—suggesting gaps in knowledge at the population level. Interestingly, despite the conflicting perceptions of harm for e-cigarettes and cigarettes among students in our study, students exposed to both SHA and SHS still exhibited curiosity and susceptibility to using *both* cigarettes and e-cigarettes. This finding indicates the key role social norms play in experimentation of tobacco products among youth regardless of risk perception. Social media is replete with examples of youth engaging in various potentially life-threatening activities primarily to gain social recognition from peers.[25 26] Social norms-related interventions, restriction of youth-oriented advertising[27–29] and expansion of existing smoke-free laws to include e-cigarettes, in concert with other comprehensive tobacco prevention and control strategies, can help reduce the likelihood of tobacco experimentation among youth.

Some limitations exist to this study. First, the self-reported nature of NYTS may result in misreporting and potential misclassification of SHA and SHS, especially if youth saw a cigarette-like vaping device and misclassified them as cigarettes and vice versa. Second, while there might be a differential effect between public exposures from other youth versus from adults, this could not be assessed with NYTS data. Third, because of the cross-sectional nature of the survey, only associations could be examined. Fourth, these findings may not be generalised to populations not covered by NYTS, including home-schooled children or dropouts. Fifth, because PSUs are masked in NYTS, we were not able to assess for county-specific policies on e-cigarette use in public places; misclassification may have occurred if e-cigarettes are included in indoor air policies at the county, but not the state level. Finally, there may be residual confounding from the fact that in controlling for exposure to advertisements, data were available for e-cigarettes but not cigarettes; also, in controlling for exposure to tobacco-related emissions in indoor private areas, data were available for cigarettes but not e-cigarettes. Nonetheless, given the collinearity between cigarettes and e-cigarettes for the respective exposures,[4 30] it is likely that the magnitude of residual confounding bias is small.

CONCLUSIONS

Exposure to e-cigarette use in public spaces significantly predicted increased curiosity and susceptibility to both e-cigarettes and conventional cigarettes among US youth, and reinforced inaccurate, tobacco-related descriptive norms. Smoke-free policies that do not specifically include e-cigarettes may renormalise and promote tobacco product use among youth. Policies prohibiting both e-cigarette and cigarette use in public places could protect public health and reinforce tobacco-free norms.

What this paper adds

- Currently, only nine US states and DC prohibit e-cigarette use in workplaces, restaurants and bars. E-cigarette use in public places can potentially renormalise tobacco product use among youth.
- This study measured associations between e-cigarette use in public places and social norms among youth.
- Exposure to e-cigarette use in public places was associated with increased curiosity and susceptibility to both cigarettes and e-cigarettes, and also predicted overestimation of peer use of cigarette and e-cigarettes.
- Furthermore, youth exposed to e-cigarette use in public places had 37% lower odds of perceiving e-cigarette use as harmful; this relationship was statistically significant.
- Policies prohibiting both e-cigarette and cigarette use in public places could benefit public health.

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