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Discordance between perceived and actual tobacco product use prevalence among US youth: a comparative analysis of electronic and regular cigarettes

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ABSTRACT

Importance Two components of social norms—descriptive (estimated prevalence) and injunctive (perceived acceptability)—can influence youth tobacco use.

Objective To investigate electronic cigarettes (e-cigarette) and cigarette descriptive norms and measure the associations between overestimation of e-cigarette and cigarette prevalence and tobacco-related attitudes and behaviours.

Design Cross-sectional.

Setting School-based, using paper-and-pencil questionnaires.

Participants US 6th-12th graders participating in the 2015 (n=17 711) and 2016 (n=20 675) National Youth Tobacco Survey.

Exposure Students estimated the percent of their grade-mates who they thought used e-cigarettes and cigarettes; the discordance between perceived versus grade-specific actual prevalence was used to categorise students as overestimating (1) neither product, (2) e-cigarettes only, (3) cigarettes only or (4) both products.

Outcomes Product-specific outcomes were curiosity and susceptibility (never users), as well as ever and current use (all students). Descriptive and multivariable logistic regression analyses were performed. Statistical significance was at P<0.05. Data were weighted to be nationally representative.

Results More students overestimated cigarette (74.0%) than e-cigarette prevalence (61.0%; P<0.05). However, the associations between e-cigarette-only overestimation and e-cigarette curiosity (adjusted OR (AOR)=3.29), susceptibility (AOR=2.59), ever use (AOR=5.86) and current use (AOR=8.15) were each significantly larger than the corresponding associations between cigarette-only overestimation and cigarette curiosity (AOR=1.50), susceptibility (AOR=1.54), ever use (AOR=2.04) and current use (AOR=2.52). Despite significant declines in actual e-cigarette use prevalence within each high school grade level during 2015–2016, perceived prevalence increased (11th and 12th grades) or remained unchanged (9th and 10th grades).

Conclusions Four of five US students overestimated peer e-cigarette or cigarette use. Counter-tobacco mass media messages can help denormalise tobacco use.

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INTRODUCTION

During adolescence, youth are susceptible to the influence of social norms and are more likely to engage in certain behaviours deemed to be trendy or popular among their peers, including tobacco product use.[1–4] Two components of social norms—descriptive (estimated prevalence) and injunctive (perceived acceptability)—have the potential to influence youth tobacco use behaviour. For example, youth might experiment with electronic cigarettes (e-cigarettes) because they believe many of their peers use e-cigarettes (descriptive norms) or because e-cigarettes are judged by their close friends to be socially popular (injunctive norms).

The Theory of Reasoned Action/Theory of Planned Behavior and the Social Cognitive Theory argue that social norms, attitudes and beliefs influence intentions and behaviour.[5] These relationships are complex and reciprocal; for example, while prevailing social norms can influence individual-level attitudes and behaviour, a shift in societal norms can also begin with changes in individuals' attitudes and behaviour. Exposure to and perceptions about marketing are also important factors that can predict norms and attitudes, as well as behaviour. Several studies have highlighted social norms surrounding e-cigarette and regular cigarette use.[6–10] Kong *et al* identified curiosity as one of the top reasons for e-cigarette experimentation among US adolescents, together with peer influence and availability of appealing flavours.[6] Research shows that exposure to e-cigarette advertisement is associated with positive perceptions (eg, perceived social acceptability or reduced addictiveness), which, in turn, are associated with both intentions to use e-cigarettes and actual use.[9 10] Similarly, cigarette advertisements have been demonstrated to be associated with positive attitudes towards cigarette brands and brand loyalty among smokers.[11]

While several of the aforementioned studies have examined several aspects of social norms among youth,[2–4] to our knowledge, no study has measured the relationship between perceived norms and actual norms for both cigarettes and e-cigarettes and whether discrepant estimations are related to attitudes and behaviour. Thus, it is unknown to what extent youth accurately perceive the true prevalence of e-cigarette use among their peers, and the associations between overestimation of peer use and product curiosity, intention to use or actual use. More so, it is not known how e-cigarette-related descriptive norms have changed over time and how

they compare with those for regular cigarettes. To fill these gaps in knowledge, this study examined adolescents' perceived prevalence of e-cigarettes and cigarettes and investigated whether discordance in perceived versus actual prevalence is related to tobacco-related attitudes and behaviours. A better understanding of social norms in relation to these two products—the most commonly used tobacco products among US middle and high school students[12]—can help inform the content and delivery of public health messages aimed at recalibrating social norms among youth.

METHODS

Study design

This was a cross-sectional study; data were from the 2015 (n=17 711; response rate=63.4%) and 2016 (n=20 675; response rate=71.6%) National Youth Tobacco Survey (NYTS) of US students attending public and private schools in grades 6–12 in the 50 US states and D.C. A three-stage cluster sampling design was used to select a nationally representative sample of students who completed the surveys in a classroom setting.

Measures

Perceived peer use of e-cigarette and regular cigarette

Separate questions were asked for e-cigarette and regular cigarette as follows: 'Out of every 10 students in your grade at school, how many do you think [use e-cigarettes/smoke cigarettes]?' Response options ranged from 0 to 10. The e-cigarette question was asked in both 2015 and 2016 NYTS, while the cigarette question was asked only in 2016.

These questions were used to create two related, but distinct measures. First, we created a measure of *average* perceived prevalence, computed as grade-specific arithmetic means of the discrete responses students provided on how many students in their grade were thought to use the assessed product. For example, if two 8th grade students provided answers of 1 and 3 to the above question, the average perceived prevalence would be 2 out of 10 students (or 20%). Second, we created a measure of *discordance* between each individual student's perceived prevalence versus the objectively measured prevalence within that grade. This numeric variable was computed by taking the difference (δ) between perceived number of users out of 10 students (transformed to a percentage by multiplying by 10) and grade-specific actual prevalence (ie, number of students out of 100 that reported any use in the past 30 days). Considering that actual prevalence existed as integer multiples of 1% (0, 1, 2 … 100) and perceived prevalence existed only as integer multiples of 10% (0, 10, 20 … 100), estimates of actual use prevalence were first rounded to the nearest 10% before computing δ in order to minimise overstating the percentage of those who overestimated peer use prevalence. For example, among 8th graders, the objectively estimated prevalence (6.6%) when rounded becomes 10%; however, a respondent reporting a perceived prevalence of 10% (which is correct to within the respondent's ability to respond) would be considered overestimating in the absence of this rounding. All students were then dichotomised as overestimators (δ>0, exposed group) versus underestimators (δ≤0; unexposed group) for e-cigarettes and cigarettes separately. The term 'underestimators' was used for the latter group for ease of communication and because no single individual had a value of δ=0 prior to rounding (ie, where perceived prevalence exactly equalled actual prevalence).

Curiosity and susceptibility to using e-cigarettes and regular cigarettes

Curiosity and susceptibility are high-risk cognitions that are independent and strong predictors of future tobacco product experimentation and progression to regular use among never users.[13–16] Curiosity indicates interest, even in the absence of intentions to use; susceptibility measures openness to future use.[13–16] Consistent with previous research,[15] high curiosity (simply referred to as 'curiosity' subsequently) was defined as a response of 'definitely yes' or 'probably yes' (vs 'definitely not' or 'probably not') to the question, 'Have you ever been curious about [using an e-cigarette/smoking a cigarette]?'

Susceptibility was measured with a set of three questions: '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.[16]

Ever and current use of e-cigarettes and regular cigarettes

Ever and current use were measured as behavioural outcomes assessing experimentation and recent tobacco use. Ever use was assessed with the questions: 'Have you ever used an e-cigarette, even once or twice?' and 'Have you ever tried cigarette smoking, even one or two puffs?' Categorical response options were 'yes' and 'no'.

Current use was assessed with the questions: 'During the past 30 days, on how many days did you [smoke cigarettes/use e-cigarettes]?' Categorical response options were '0 days', '1 or 2 days', '3–5 days', '6–9 days', '10–19 days', '20–29 days' and 'all 30 days'. Any response option other than '0 day' was classified as being a current user.

Other tobacco product use

Ever (≥1 time in lifetime) and current (≥1 time in the past 30 days) use was further assessed for other non-cigarette combustible tobacco products (hookahs, bidis, roll-your-own tobacco, cigars, pipes), as well as smokeless tobacco products (chewing tobacco, snuff, dip, snus or dissolvable tobacco products). The number of distinct tobacco product types (including e-cigarettes and cigarettes) ever tried by respondents was categorised as 0, 1, 2 or 3+. Based on past 30-day tobacco use, respondents were further classified as current non-users of any tobacco product, combustible-only users, smokeless tobacco-only users, e-cigarette-only users and users of a combination of products.

Other independent variables

Other variables included sex, race/ethnicity, grade level, number and type of tobacco products used by household member(s) and the number of media (internet, newspapers/magazines, retail stores and TV/movies) in which the respondent was exposed to e-cigarette advertising (range 0–4). Respondents were classified on each medium as either: 1=exposed (exposure frequency of 'sometimes', 'most of the time' or 'always') or 0=non exposed ('never', 'rarely' or those who indicated not using the assessed medium).

ANALYSES

The 2015 and 2016 datasets were both used to analyse and compare direction of change for actual and perceived e-cigarette

prevalence separately by grade; within the same grade, results were averaged across all sampled schools under an assumption of equal variance. Changes between 2015 and 2016 were assessed with estimates of relative percentage change and tested statistically with χ^2 tests.

To determine whether the discordance between perceived and actual prevalence differed for cigarettes and e-cigarettes during 2016, grade-specific prevalence ratios (perceived over actual) were estimated and compared. A ratio of 1.0 indicates no discordance, and values further from 1 are indicative of greater discordance. Bootstrapped point estimates for ratios, along with their corresponding 95% CIs, were computed by sampling 1000 times from the data with replacement (ratios generated non-parametrically from bootstrapping may vary slightly from those computed directly from the raw data). Statistical significance was inferred based on the presence or absence of an overlap in the CIs of e-cigarette and regular cigarette. This is a conservative test as the absence of an overlap indicates statistical significance whereas the presence of one does not preclude significance.

We further computed the percentage of students who overestimated peer use of cigarettes and e-cigarettes within their grade level during 2016 (separate estimates were not computed for underestimators since both add up to 100%). Within-group differences were assessed with χ^2 tests. Multivariable logistic regression analyses were performed to measure the relationship between tobacco product overestimation and tobacco-related attitudes and behaviours. For the primary exposure, the binary variables measuring discordance between perceived prevalence and grade-specific actual prevalence for e-cigarette and regular cigarette were used to create a polytomous variable with four mutually exclusive categories, classifying students as overestimating (1) neither product (n=4043), (2) cigarettes only (n=3557), (3) e-cigarettes only (n=944) or (4) both products (n=10 915). Outcome variables (curiosity, susceptibility, ever use and current use) were assessed for e-cigarettes and cigarettes separately; a total of eight regression models were fitted. All regression models controlled for sex, grade level, race/ethnicity, use of other tobacco products (ie, other than the dependent variable), e-cigarette advertisement exposure and household member tobacco use. Results were deemed statistically significant at P<0.05. Data were weighted to yield nationally representative estimates. Analyses were performed with R V.3.2.4.

RESULTS

Differential change in actual versus perceived e-cigarette prevalence during 2015–2016

Between 2015 and 2016, actual e-cigarette use prevalence declined significantly among the following grade levels: 7th (4.9% to 3.6%); 9th (12.3% to 8.7%); 10th (15.3% to 12.0%); 11th (17.2% to 11.4%) and 12th (19.7% to 13.6%). Perceived prevalence of e-cigarette use declined in the 7th (21.7% to 19.1%) and 8th (26.3% to 23.7%) grades but increased in the 11th (36.9% to 39.7%) and 12th (37.3% to 39.8%) grades. All other changes were statistically non-significant (figure 1).

Differential magnitude in discordance between actual versus perceived prevalence: e-cigarettes and regular cigarettes during 2016

During 2016, the magnitude of discordance generally decreased with increasing grade level for both products (figure 2). Bootstrapped ratios of perceived to actual e-cigarette prevalence by

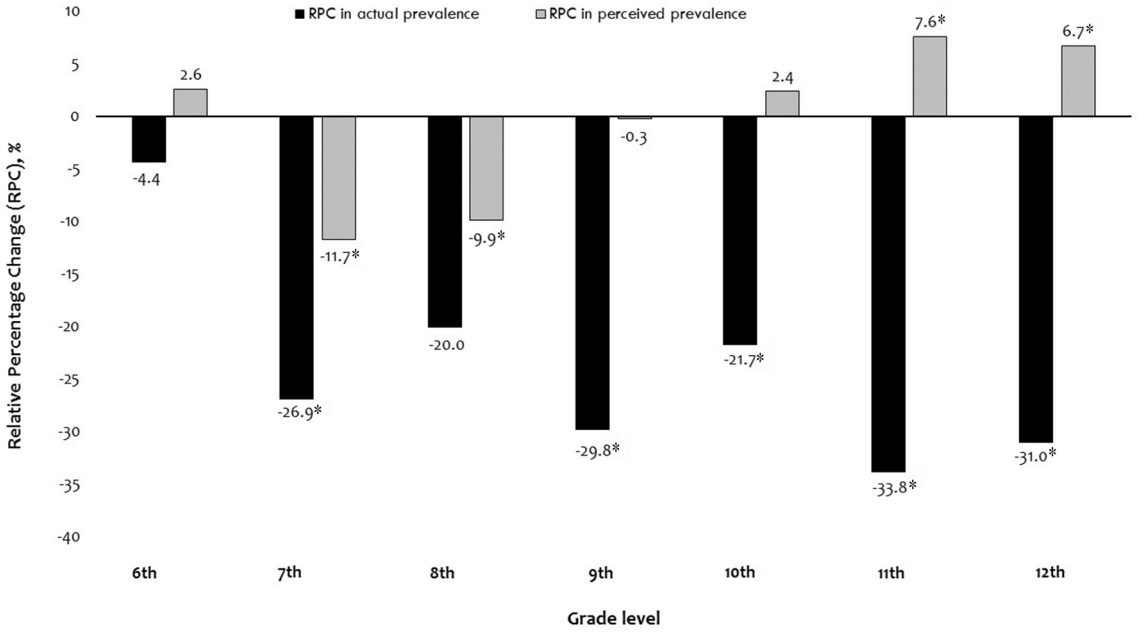

Figure 1 Relative percentage change (RPC) in actual† and perceived‡ electronic cigarette (e-cigarette) use prevalence, by grade level, National Youth Tobacco Survey (NYTS), 2015–2016. * Indicates a statistically significant change between 2015 and 2016 at P<0.05. During 2015–2016, actual e-cigarette prevalence declined (P<0.05) among: 7th (4.9% to 3.6%); 9th (12.3% to 8.7%); 10th (15.3% to 12.0%); 11th (17.2% to 11.4%) and 12th (19.7% to 13.6%) grades; no significant changes in actual prevalence were seen for the 6th (2.8% to 2.6%) and the 8th (8.2% to 6.6%) grades. Perceived e-cigarette prevalence declined in the 7th (21.7% to 19.1%) and 8th (26.3% to 23.7%) grades, but increased in the 11th (36.9% to 39.7%) and 12th (37.3% to 39.8%); no changes in average perceived prevalence were seen in the 6th (12.2% to 12.6%), 9th (35.2% to 35.1%) and 10th (37.9% to 38.8%) grades. †Defined as use of the assessed product on at least 1 day within the past 30 days (ie, dichotomised as 0=non-use within past 30 days; 1=use on ≥1 day). ‡Assessed by asking students how many students out of 10 in their grade they thought used the specified product; response options ranged from 0 to 10. The arithmetic means of the discrete responses produced the average perceived prevalence.

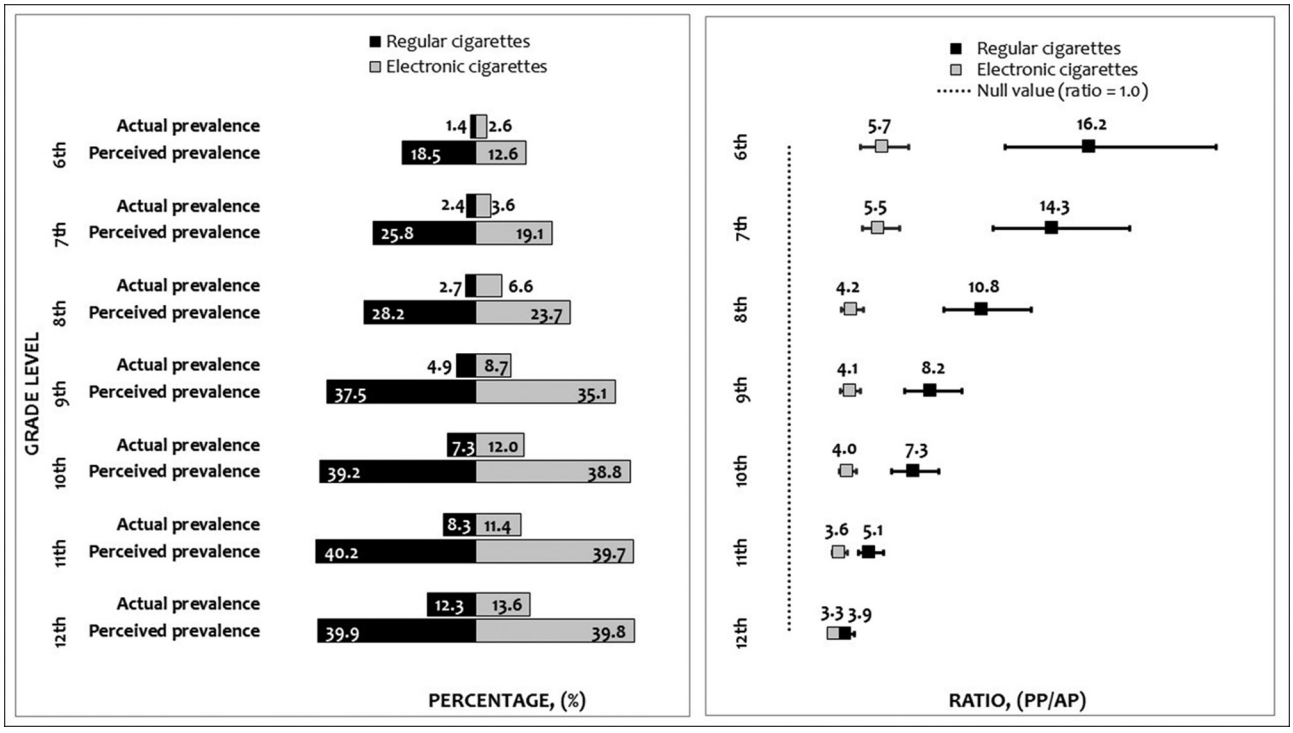

Figure 2 Percentages* and bootstrapped ratios with corresponding 95% CIs† of perceived prevalence (PP) versus actual prevalence (AP) for electronic (e-cigarette) and regular cigarette, by grade, National Youth Tobacco Survey. *Both AP and PP were computed from the raw data. AP was defined as the percentage who reported use of the assessed product on at least 1 day within the past 30 days (ie, dichotomised as 0=non-use within past 30 days; 1=use on≥1 day). PP was assessed by asking students how many students out of 10 in their grade they thought used the specified product; response options ranged from 0 to 10. The arithmetic means of the discrete responses produced the average PP. †The ratios of PP over AP served as a measure of discordance; a ratio of 1.0 indicates no discordance whereas values further from 1 are indicative of greater discordance. Both the presented point estimates for ratios and their corresponding CIs were generated using bootstrapping; 1000 permuted samples were taken from the original data with replacement. The bootstrapped point estimates for the ratios might therefore vary from those obtained directly from the raw data.

grade ranged from 3.3 (12th grade) to 5.7 (6th grade); corresponding ratios for regular cigarettes ranged from 3.9 (12th grade) to 16.2 (6th grade). Comparison of bootstrapped 95% CIs showed that with the exception of 12th grade, discordance was significantly higher for regular cigarettes than e-cigarettes in all other grades (figure 2).

More students overestimated cigarette prevalence (74.0%) than e-cigarette prevalence (61.0%; P<0.05) (table 1). Similar subgroup variations were observed for both e-cigarettes and regular cigarettes. Overestimation of e-cigarette prevalence was highest among females (64.1%), 12th graders (75.6%), Hispanics (65.4%), those who had ever used three or more tobacco products in their lifetime (86.6%), those who reported exclusive past 30-day use of e-cigarettes (93.3%), those whose household members used three or more tobacco products (79.9%), those whose household members exclusively used e-cigarettes (77.6%) and those exposed to e-cigarette advertisements on all four-media assessed (78.1%). Subgroup differences in overestimation of regular cigarette smoking are shown in table 1.

Association between perceived peer use and tobacco-related behaviours and attitudes: e-cigarettes versus regular cigarettes during 2016

In total, 14.6% of never e-cigarette users (n=15 801) and 16.9% of never cigarette smokers (n=16 376) reported being curious about e-cigarettes and cigarettes, respectively. Similarly, 28.4% of never e-cigarette users and 29.2% of never cigarette smokers reported susceptibility on at least one of the three composite items for the respective products. By specific construct, significantly more never e-cigarette than never cigarette smokers reported openness to trying if offered by a 'best friend' (23.1% vs 19.5%, e-cigarettes vs cigarettes, respectively) as well as a willingness to use in the next year (19.2% vs 15.4%, e-cigarettes vs cigarettes, respectively, supplementary figure). Overall, ever use prevalence was 23.1% for e-cigarettes and 20.0% for regular cigarettes; current use prevalence was 8.2% for e-cigarettes and 5.5% for regular cigarettes.

Some specificity was observed in the associations between single-product overestimation and behavioural study outcomes compared with those who overestimated neither product (figure 3). E-cigarette-only overestimation was significantly associated with all e-cigarette-related outcomes, as was the case for associations between cigarette-only overestimation and cigarette-related outcomes (table 2). Conversely, cigarette-only overestimation, while associated with e-cigarette curiosity (adjusted OR (AOR)=1.70) and susceptibility (AOR=1.49), was not significantly associated with e-cigarette ever and current use. Similarly, e-cigarette-only overestimation was associated with cigarette curiosity (AOR=1.50) and susceptibility (AOR=1.77) but not with ever or current cigarette smoking.

The strength of association between product overestimation and study outcomes was significantly larger for e-cigarettes than cigarettes for all outcomes (table 2; figure 3). Compared with those who overestimated neither product, e-cigarette-only overestimators had 3.29 higher odds of being curious about e-cigarettes (95% CI 2.41 to 4.48), whereas cigarette-only

Table 1 Percentage of students who overestimated* peer use of electronic cigarettes (e-cigarettes) and regular cigarettes within their grade, National Youth Tobacco Survey, 2016

	Distribution	E-cigarette		Regular cigarettes	
	% (N)	Percent of students who overestimated % (95% CI)	P values	Percent of students who overestimated % (95% CI)	P values
Overall		61.0 (60.1 to 61.8)		74.0 (73.2 to 74.8)	
Sex					
Male	50.6 (10 438)	57.9 (56.6 to 59.1)		69.1 (67.9 to 70.2)	
Female	49.4 (10 082)	64.1 (62.9 to 65.4)	<0.001	78.9 (77.9 to 79.9)	<0.001
Grade level					
6th	14.6 (3235)	39.2 (36.8 to 41.7)		54.5 (52.1 to 57.0)	
7th	14.8 (3249)	51.7 (49.4 to 54.0)		65.8 (63.6 to 68.0)	
8th	14.8 (3174)	46.7 (44.4 to 49.0)		74.1 (72.0 to 76.2)	
9th	15.3 (2741)	68.4 (66.3 to 70.5)		88.6 (87.1 to 90.0)	
10th	14.3 (2809)	73.1 (71.1 to 75.1)		77.4 (75.5 to 79.3)	
11th	13.3 (2674)	75.1 (73.1 to 77.0)		78.0 (76.1 to 80.0)	
12th	12.8 (2673)	75.6 (73.6 to 77.7)	<0.001	80.0 (78.1 to 81.9)	<0.001
Race/ethnicity†					
White	52.3 (8141)	61.6 (60.3 to 62.9)		74.0 (72.8 to 75.2)	
Black	12.3 (3050)	55.6 (53.4 to 57.9)		74.1 (72.0 to 76.1)	
Asian	3.9 (1036)	47.1 (43.2 to 50.9)		64.2 (60.5 to 67.9)	
Hispanic	25.4 (5793)	65.4 (63.8 to 67.0)		76.4 (74.9 to 77.8)	
Other	6.0 (1654)	63.7 (60.3 to 67.0)	<0.001	76.7 (73.8 to 79.6)	<0.001
Total number of tobacco products ever used by youth during lifetime					
0	68.2 (12 906)	51.7 (50.6 to 52.9)		68.8 (67.7 to 69.8)	
1	11.5 (2225)	73.5 (71.1 to 75.9)		78.9 (76.7 to 81.2)	
2	6.7 (1269)	77.4 (74.5 to 80.4)		86.5 (84.2 to 88.9)	
3+	13.6 (2395)	86.6 (84.8 to 88.4)	<0.001	89.2 (87.6 to 90.8)	<0.001
Type of tobacco product currently used by youth (past 30 days)‡					
None	86.8 (16 474)	56.9 (55.9 to 57.8)		71.8 (70.9 to 72.7)	
Combustible-only	4.1 (807)	75.1 (71.3 to 78.9)		86.9 (84.0 to 89.8)	
Smokeless tobacco only	0.8 (119)	66.1 (55.2 to 77.1)		82.7 (73.6 to 91.9)	
E-cigarettes-only	3.2 (558)	93.3 (90.6 to 95.9)		84.0 (80.3 to 87.7)	
Combination of products	5.2 (866)	91.4 (88.9 to 93.8)	<0.001	90.5 (87.9 to 93.0)	<0.001
Total number of tobacco products used by household member(s)					
0	64.9 (13 569)	57.2 (56.1 to 58.2)		70.4 (69.4 to 71.4)	
1	26.2 (5319)	64.9 (63.3 to 66.6)		78.4 (76.9 to 79.8)	
2	6.0 (1223)	73.7 (70.4 to 76.9)		85.4 (82.7 to 88.0)	
3+	2.9 (564)	79.9 (75.2 to 84.6)	<0.001	88.5 (85.0 to 92.1)	<0.001
Type of tobacco product used by household member(s)‡					
None	64.9 (13 569)	57.2 (56.1 to 58.2)		70.4 (69.4 to 71.4)	
Combustible-only	22.3 (4712)	64.0 (62.2 to 65.8)		79.1 (77.6 to 80.7)	
Smokeless tobacco only	3.7 (604)	66.4 (61.6 to 71.2)		77.3 (73.0 to 81.6)	
E-cigarettes-only	2.2 (436)	77.6 (72.4 to 82.8)		79.1 (73.8 to 84.4)	
Combination of products	6.9 (1354)	76.8 (73.8 to 79.8)	<0.001	86.6 (84.2 to 89.1)	<0.001
Number of e-cigarette advertisement exposure sources§					
0	21.4 (4189)	47.2 (45.3 to 49.1)		62.0 (60.1 to 63.9)	
1	28.1 (5424)	57.3 (55.6 to 59.0)		71.4 (69.9 to 73.0)	
2	21.3 (4203)	63.5 (61.6 to 65.4)		76.9 (75.3 to 78.6)	
3	16.9 (3241)	69.5 (67.5 to 71.6)		81.5 (79.8 to 83.3)	
4	12.3 (2312)	78.1 (75.9 to 80.2)	<0.001	86.5 (84.7 to 88.2)	<0.001

*Respondents were asked how many students in their grade they thought used e-cigarettes out of 10 (perceived prevalence). A 'difference score' (δ) was computed to measure the gap between perceived prevalence and grade-specific actual prevalence. Respondents were then dichotomised as either overestimating (δ>0) or not overestimating (δ≤0) peer e-cigarette use.

†Unless otherwise specified, all race/ethnicity groups are non-Hispanic. 'Other' category includes American Indians/Alaska natives; native Hawaiians/other Pacific Islander and multiracial persons.

‡Combustible tobacco products included cigarettes, hookahs, bidis, roll-your-own tobacco, cigars and pipes. Smokeless tobacco products included chewing tobacco, snuff, dip, snus and dissolvable tobacco products.

§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).

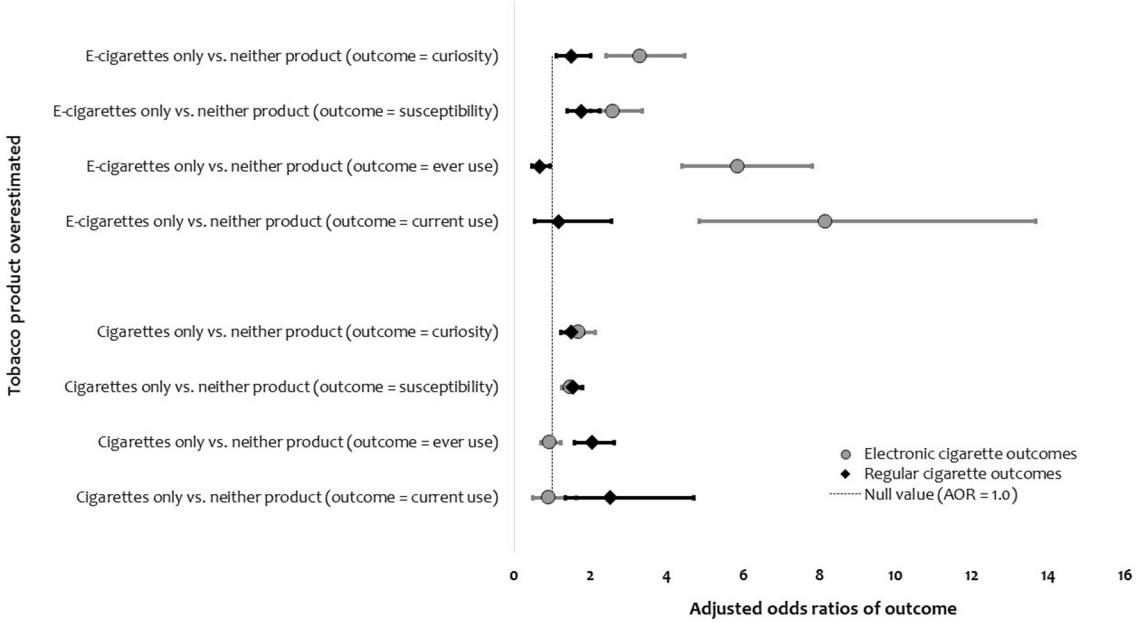

Figure 3 Adjusted ORs (AORs) of study outcomes* among electronic cigarette (e-cigarette)-only and regular cigarette-only overestimators compared with students who overestimated neither product's prevalence†, National Youth Tobacco Survey, 2016. *Outcome variables (curiosity, susceptibility, ever use and current use) were assessed for e-cigarettes and cigarettes separately, yielding a total of eight separate logistic regression models. All regression models controlled for sex, grade level, race/ethnicity, use of other tobacco products (ie, other than the dependent variable), e-cigarette advertisement exposure and household member tobacco use. Curiosity was defined as a response of 'definitely yes' or 'probably yes' (vs 'definitely not' or 'probably not') to the question 'Have you ever been curious about [using an e-cigarette/smoking a cigarette]?' Susceptibility was assessed by three questions: '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?' Susceptibility was defined as a response other than 'definitely no' to any of these questions. Ever use was defined as use of the assessed product on at least one time during the lifetime. Current use was defined as use of the assessed product on at least one time during the past 30 days.†Students reported the percent of their grade-mates they thought used electronic and regular cigarettes; the discordance between perceived versus grade-specific actual prevalence was used to categorise students as overestimating: (1) neither product (n=4043); (2) regular cigarettes only (n=3557); (3) e-cigarettes only (n=944) and (4) both products (n=10 915).

overestimators had 1.50 higher odds of being curious about cigarettes (95% CI 1.22 to 1.83). Similarly, e-cigarette-only overestimators had 2.59 higher odds of being susceptible to e-cigarettes (95% CI 2.01 to 3.35), whereas cigarette-only overestimators had 1.54 higher odds of being susceptible to cigarettes (95% CI 1.32 to 1.80). Consistent findings were observed for ever and current users; e-cigarette-only overestimators had 5.86 higher odds of ever using e-cigarettes (95% CI 4.41 to 7.80), whereas cigarette-only overestimators had 2.04 higher odds of ever smoking cigarettes (95% CI 1.59 to 2.62). Furthermore, e-cigarette-only overestimators had 8.15 higher odds of reporting current e-cigarette use (95% CI 4.86 to 13.65), whereas cigarette-only overestimators had 2.52 higher odds of being current cigarette smokers (95% CI 1.34 to 4.71).

DISCUSSION

The prevalence of overestimation was larger for cigarettes than e-cigarettes; however, the strengths of associations were stronger for e-cigarettes than cigarettes for all study outcomes, including curiosity, susceptibility, ever use and current use. Students may be more likely to overestimate regular cigarette prevalence because of cigarettes' longer existence on the US market,[17] higher use rates among adults[17 18] and possibly heavier marketing. In 2014 $8.5 billion was spent on cigarette advertising and promotion versus $115 million for e-cigarettes.[19 20] The descriptive norms paradox observed with e-cigarettes relative to cigarettes (smaller prevalence, yet stronger associations) suggest interactions between descriptive and injunctive norms in driving e-cigarette use behaviour. This perhaps is supported by the observation that a significantly greater proportion of never e-cigarette users were inclined to use an e-cigarette if offered by a 'best friend' than the corresponding proportion among never cigarette smokers. The combination of these dual factors—e-cigarette use deemed acceptable by close friends sharing similar values (injunctive norms) and the misperception that a large swath of peers uses e-cigarettes (descriptive norms)—may greatly amplify the likelihood of e-cigarette use. The pronounced role of peers in e-cigarette use behaviour suggests peer-led interventions to calibrate descriptive norms and positively influence injunctive norms might denormalise tobacco use and encourage quitting.[21]

Despite significant declines in actual e-cigarette prevalence within each high school grade level between 2015 and 2016, perceived e-cigarette use prevalence increased (11th and 12th grades) or remained unchanged (9th and 10th grades). These diametric trends might suggest that youth still continue to be exposed to pro-tobacco social influences which could perpetuate the impression that e-cigarette use is more common than it actually is. Biased estimates may result from using cognitive heuristics such as availability and representativeness.[22–24] The representativeness heuristic is closely tied to social norms[22]; the likelihood of overestimating the probability of e-cigarette

Table 2 Multivariable logistic regression analyses of the relationship between overestimation of peer tobacco product use and tobacco-related attitudes and behaviours, National Youth Tobacco Survey, 2016

Outcome variable	Exposure variable† (overestimation of peer cigarette or e-cigarette use)	Product assessed in outcome	
		E-cigarettes	Regular cigarettes
	Category	AOR (95% CI)	AOR (95% CI)
Curiosity‡	Neither product	1.00 (ref)	1.00 (ref)
	Cigarettes only	1.70 (1.37 to 2.13) *	**1.50 (1.22 to 1.83)***
	E-cigarettes only	**3.29 (2.41 to 4.48)***	1.50 (1.12 to 2.02)*
	Both products	2.66 (2.20 to 3.22)*	1.59 (1.34 to 1.89)*
Susceptibility§	Neither product	1.00 (ref)	1.00 (ref)
	Cigarettes only	1.49 (1.26 to 1.75)*	**1.54 (1.32 to 1.80)***
	E-cigarettes only	**2.59 (2.01 to 3.35)***	1.77 (1.39 to 2.24)*
	Both products	2.21 (1.93 to 2.54)*	1.91 (1.68 to 2.18)*
Ever use¶	Neither product	1.00 (ref)	1.00 (ref)
	Cigarettes only	0.94 (0.72 to 1.23)	**2.04 (1.59 to 2.62)***
	E-cigarettes only	**5.86 (4.41 to 7.80)***	1.18 (0.86 to 1.61)
	Both products	4.43 (3.56 to 5.52)*	2.63 (2.11 to 3.27)*
Current use**	Neither product	1.00 (ref)	1.00 (ref)
	Cigarettes only	0.90 (0.50 to 1.63)	**2.52 (1.34 to 4.71)***
	E-cigarettes only	**8.15 (4.86 to 13.65)***	1.18 (0.55 to 2.55)
	Both products	5.88 (3.78 to 9.14)*	2.80 (1.60 to 4.88)*

*Indicates results that were statistically significant at P< 0.05.
† Students reported the percent of their grade-mates they thought used e-cigarettes and regular cigarettes; the discordance between perceived versus grade-specific actual prevalence was used to categorise students as overestimating (1) neither product (n=4043); (2) regular cigarettes only (n=3557); (3) e-cigarettes only (n=944) and (4) both products (n=10 915).
‡Curiosity was defined as a response of 'definitely yes' or 'probably yes' (vs 'definitely not' or 'probably not') to the question 'Have you ever been curious about [using an e-cigarette/smoking a cigarette]?'.
§Susceptibility was assessed by three questions: '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?' Susceptibility was defined as a response other than 'definitely no' to any of these questions.
¶Use of the assessed product on at least one time during the lifetime.
**Use of the assessed product on at least one time during the past 30 days.
Eight separate regression models were fitted, corresponding to the four outcomes for each product. Each model adjusted for sex, school level, race/ethnicity, other tobacco use, number of sources of e-cigarettes advertisement exposure and tobacco user in household. **The bold estimates** indicate ORs measuring product-specific associations (ie, e-cigarette-only overestimation and e-cigarette-specific outcomes or cigarette-only overestimation and cigarette-specific outcomes).
AOR , adjusted OR; E-cigarette, electronic cigarette; Ref, referent category.

use among peers might increase, for example, if a student who is judged as being representative of that peer-group is known to use e-cigarettes. On the other hand, the availability heuristic involves making judgements about the likelihood of an event based on the ease of recall from prior conditioning.[22–24] Studies show that US youth have a high degree of exposure (70% in 2014) to e-cigarette advertising through a variety of media.[25]

For both regular and e-cigarettes, overestimation of peer use had a stronger association with behavioural outcomes than with cognitive outcomes; ORs generally increased along the continuum of product initiation and regular use (AORs for curiosity, susceptibility, ever use and current use, respectively, were 3.29, 2.59, 5.86 and 8.15 for e-cigarettes and 1.50, 1.54, 2.04 and 2.52 for regular cigarettes). Several other measured and unmeasured factors might contribute to increased curiosity and susceptibility among youth, including cultural factors, tobacco advertising and attractive tobacco product design features.[21] The stronger associations noted for behavioural outcomes could be partly attributable to reverse causation since ever or current users may conceivably be more likely to overestimate peer use because of higher tobacco product use among people within their immediate social circle (eg, family and friends). Nonetheless, the specificity between exposure and behavioural outcomes, the coherence observed with different outcomes and the strength of epidemiological associations, all suggest a possible role of overestimation of peer tobacco use on actual tobacco use behaviour. Future studies using a prospective design (stronger internal validity) will be important to test these relationships in a causal framework. Furthermore, as local and state policies and federal regulations[26] are implemented across the nation in relation to e-cigarettes and other tobacco products, research will be critical to evaluate the impact of these interventions on descriptive and injunctive norms among youth.

Our findings underscore the importance of youth-oriented preventive health messages to counteract pro-tobacco messages that potentially increase the attractiveness of tobacco products among youth.[27–29] For example, interventions that reduce youth exposure to pro-tobacco advertising can be coupled with targeted tobacco prevention messages that help shift social norms and denormalise tobacco product use among youth. Such messages could be delivered in a variety of youth-oriented settings, including media-based platforms, school, paediatric and family practices, recreational facilities, and other relevant settings. Other interventions include restricting tobacco industry–sponsored youth smoking prevention programmes which portray smoking as an adult choice, and, unlike public health messages, fail to highlight how tobacco advertising encourages smoking or the harmful consequences of smoking.[30] Well-designed, culturally sensitive and accessible antitobacco messages, when implemented in concert with other proven tobacco control and prevention strategies that are reflective of the diversity of the tobacco product landscape, including e-cigarettes, can help reduce tobacco product use among youth.[17]

There are at least four limitations to this study. First, the data were cross-sectional, and thus, temporality could not be assessed. Second, our measurement of the gap, δ, between grade-specific actual and perceived prevalence is bound by some uncertainty from sampling and non-sampling errors associated with measurement of the 'actual' prevalence. Furthermore, to harmonise the scale on which actual and perceived prevalence were measured when computing δ, we used rounded perceived prevalence and rounded actual prevalence; this reduced precision and might not have preserved the actual relationships. Third, certain random effects, for example, between-school variation in exposure to pro-tobacco social influences, could not be controlled. Finally, these findings may not be generalisable to school-aged youth not enrolled in traditional school (eg, dropouts, home-schooled).

CONCLUSION

More students overestimated cigarette than e-cigarette prevalence, yet stronger associations were observed for e-cigarette than cigarette overestimation for all product-specific outcomes assessed. Despite significant declines in actual e-cigarette prevalence within each high school grade level between 2015 and 2016, perceived e-cigarette use prevalence increased (11th and 12th grades) or remained unchanged (9th and 10th grades). Public health media campaigns can provide counter-tobacco messages to reverse the perception that e-cigarette or cigarette use is normal, ubiquitous or socially acceptable among youth. Such messages could help recalibrate descriptive social norms among youth and denormalise tobacco product use behaviour.

What this paper adds

- Two components of social norms—descriptive (estimated prevalence) and injunctive (perceived acceptability)—have the potential to influence youth tobacco use behaviour.
- This study performed a comparative analysis of descriptive social norms for electronic cigarettes (e-cigarettes) and regular cigarettes among US middle and high school students.
- More students overestimated cigarette prevalence (74.0%) than e-cigarette prevalence (61.0%; P<0.05). Yet, significantly stronger associations were observed for e-cigarette than cigarette overestimation for product-specific, tobacco-related cognitive and behavioural outcomes.
- Despite significant declines in actual e-cigarette prevalence within each high school grade level between 2015 and 2016, perceived e-cigarette use prevalence increased (11th and 12th grades) or remained unchanged (9th and 10th grades).
- Public health media campaigns can provide counter-tobacco messages to reverse the perception that e-cigarette or cigarette use is normal, ubiquitous or socially acceptable among youth.

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Discordance between perceived and actual tobacco product use prevalence among US youth: a comparative analysis of electronic and regular cigarettes

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Notes