

Psychosocial Factors Associated With Adolescent Electronic Cigarette and Cigarette Use

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abstract

BACKGROUND: Use of electronic cigarettes (e-cigarettes) among adolescents has increased since their introduction into the US market in 2007. Little is known about the role of e-cigarette psychosocial factors on risk of e-cigarette or cigarette use in adolescence.

METHODS: Information on e-cigarette and cigarette psychosocial factors (use and attitudes about use in the home and among friends) was collected from 11th- and 12th-grade participants in the Southern California Children's Health Study during the spring of 2014.

RESULTS: Of 2084 participants, 499 (24.0%) had used an e-cigarette, including 200 (9.6%) current users (past 30 days); 390 participants (18.7%) had smoked a combustible cigarette, and 119 (5.7%) were current cigarette smokers. Cigarette and e-cigarette use were correlated. Nevertheless, 40.5% ($n = 81$) of current e-cigarette users had never smoked a cigarette. Psychosocial factors (home use of each product, friends' use of and positive attitudes toward e-cigarettes and cigarettes) and participant perception of the harm of e-cigarettes were strongly positively associated both with e-cigarette and cigarette use. Most youth who reported e-cigarette use had friends who used e-cigarettes, and almost half of current users reported that they did not believe there were health risks associated with e-cigarette use.

CONCLUSIONS: Longitudinal studies of adolescents are needed to determine whether the strong association of e-cigarette psychosocial factors with both e-cigarette and cigarette use will lead to increased cigarette use or dual use of cigarettes and e-cigarettes, or whether e-cigarettes will serve as a gateway to cigarette use.



WHAT'S KNOWN ON THIS SUBJECT: Electronic cigarette (e-cigarette) use in adolescence is increasing. E-cigarette use has been associated with cigarette use, but there has been little study of other psychosocial risk factors for e-cigarette use and their relationship with cigarette use.

WHAT THIS STUDY ADDS: Approval and use of e-cigarettes and cigarettes among friends and family were strongly associated with cigarette and e-cigarette use in a cohort of adolescents in southern California.

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Dr Barrington-Trimis formulated the research question, completed the analyses, interpreted the results, and wrote and edited the manuscript; Drs Berhane, Huh, and Chou and Mr Urman, and Ms Wang contributed to formulating the research question, interpretation of the results, statistical analyses, and editing the manuscript; Mr Howland developed the questionnaire, collected data, and contributed to the draft of the manuscript; Drs Cruz, Unger, Leventhal, Gilreath, and Pentz contributed to formulating the research question, interpretation of results, and editing the manuscript; Dr McConnell designed the study, collected data, contributed to formulating the research question and interpretation of the results, and critically reviewed the manuscript, and all authors approved the final manuscript as submitted.

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Awareness and use of electronic cigarettes (e-cigarettes) have increased in adolescent and emerging adult populations since their introduction into the US market in 2007.¹ The National Youth Tobacco Survey (NYTS), a nationally representative cross-sectional survey of adolescents in the United States from the 6th through 12th grades, found an increase in current (past 30 day) e-cigarette use from 2011 to 2014 among high school students (1.5% in 2011, 2.8% in 2012, 4.5% in 2013, 13.4% in 2014).²⁻⁶ In 2014, both the NYTS and the Monitoring the Future Study found higher rates of current e-cigarette use than cigarette use.^{6,7} Although e-cigarette use has been strongly associated with cigarette use,^{5,8,9} to date the upward trend in e-cigarette use has not been accompanied by an increase in smoking; current (past 30 day) cigarette use among adolescents actually decreased from 2011 to 2014 (NYTS: 15.8% in 2011, 14.0% in 2012, 12.7% in 2013, 9.2% in 2014).^{3,4,6}

A better understanding of risk factors potentially common to cigarette and e-cigarette use may help predict future trends in cigarette and dual use and guide preventive interventions. For example, psychosocial characteristics, including parental and peer cigarette use and the perception of smoking as acceptable or normative among peers,¹⁰ are strong predictors of cigarette use in adolescence. However, such risk factors have not yet been studied for e-cigarette use. An adolescent social environment in which e-cigarettes are more widely accepted (as measured through home and peer use and acceptance of use) could potentially lead to increased use and a normalization of e-cigarette use, which may then be accompanied by a “renormalization” of linked attitudes toward cigarette use and subsequent increases in cigarette use or dual use in adolescent populations.¹¹⁻¹³

In this study, we examined the prevalence of e-cigarette and cigarette use in 2014 in 11th- and 12th-grade adolescents in southern California and evaluated psychosocial factors associated with cigarette and e-cigarette use. We hypothesized that (1) the prevalence of e-cigarette use in southern California adolescents would be higher than cigarette use, reflecting trends observed nationally in recent years; (2) a substantial proportion of adolescent e-cigarette users would have no history of cigarette use; and (3) psychosocial factors indicating a social environment favorable to e-cigarette or cigarette use (home use of e-cigarettes and cigarettes, greater number of friends using these products, and friends’ positive attitudes toward e-cigarette and cigarette use) and perceptions of e-cigarettes as harmless would be associated both with higher e-cigarette and cigarette use.

METHODS

Study Sample

We studied 2084 11th- and 12th-grade participants (mean \pm SD age: 17.3 \pm 0.6 years) in the Children’s Health Study (CHS), a cohort originally developed to study the health consequences of air pollution. This cohort has been followed yearly since enrollment in 2002–2003, when participants were in kindergarten or first grade, from entire classrooms in schools in 12 communities throughout southern California (see Supplemental Information).¹⁴ Data for this analysis were collected between January 2014 and June 2014 by self-administered questionnaire, completed by students supervised by study staff in their high schools.

Measures

Sociodemographic Characteristics

Gender, ethnicity (Hispanic white, non-Hispanic white, other), family income (<\$30 000/year, \$30 000–

\$74 000/year, \geq \$75 000/year), and parental education (<12th grade, high school diploma or GED [general educational development], some college, college degree, some graduate school or higher) were collected by self-administered questionnaires completed by parents of participants at study enrollment (in 2002–2003). The highest level of education attained by either parent was used in all analyses.

Current and Past Use of Tobacco and Alternative Nicotine Products

Questionnaires administered to students in 2014 assessed the use of tobacco and alternative tobacco products, including cigarette and e-cigarette use. Students were asked whether they had tried each type of product (“How old were you when you first tried these products?”) and the number of days each product was used in the past 30 days (“During the past 30 days, on how many days did you use these products?”) for e-cigarettes (“electronic or e-cigarette, even one or two puffs”) and cigarettes (“cigarette, even one or two puffs”). Participants who had “never tried” cigarettes or e-cigarettes (ie, not “even one or two puffs”) were classified as “never users.” Those who had used cigarettes or e-cigarettes but not in the past 30 days were classified as “past users.” Participants who had used a product on at least 1 of the past 30 days were classified as “current users” of that product. Participants missing data were excluded from analyses (see Supplemental Information).

Psychosocial Characteristics

Psychosocial factors were evaluated by using the following questions: (1) friends’ use (“How many of your 4 closest friends use these products?”: 0–4 friends); (2) friends’ attitudes (“How would your best friends act toward you if you used these products?”: very unfriendly, unfriendly, friendly, or very friendly),

and (3) home use (“Does anyone who lives with you now use these products?”: yes or no). We additionally assessed participants’ perceptions of the harm of each product (“Do you think using these products would be bad for your health?”: strongly agree, agree, disagree, or strongly disagree).

Statistical Analysis

Polytomous regression models were used to evaluate psychosocial factors as predictors of current or past tobacco product use with the use of 3 outcome categories: never users (reference group), past users, and current users. Separate models were used for each predictor due to collinearity between factors. Odds ratios (ORs) and 95% confidence intervals (CIs) were computed to estimate the risk of current or past use of each product relative to never use. Formal tests of heterogeneity were used to evaluate differences between risk factor ORs for current users and for past users. Trend analyses were completed for ordinal psychosocial factors by modeling each factor as a continuous predictor (0/1/2). Formal tests of interaction were used to evaluate whether effect estimates differed by demographic characteristics (ethnicity [Hispanic versus non-Hispanic], gender). All models were adjusted for sociodemographic variables (gender, ethnicity, family income, highest parental education, and community [as a fixed effect]) hypothesized a priori to be associated both with psychosocial factors and with cigarette and e-cigarette use. We additionally conducted sensitivity analyses including school as a fixed effect; patterns were similar to models adjusting for community. A level of significance of $\alpha \leq 0.05$ was used in all statistical analyses. Reported *P* values are 2-sided. Analyses were performed by using Stata version 13.1 (StataCorp, College Station, TX).

Ethics Statement

The study was approved by the University of Southern California Institutional Review Board. Written informed consent was obtained before data collection.

RESULTS

The sample included approximately equal numbers of male and female adolescents and a large percentage of Hispanic adolescents (51.7% Hispanic, 35.1% non-Hispanic white, 13.2% other; Table 1). Boys were twice as likely as girls to report current use of e-cigarettes after adjustment for remaining sociodemographic variables (OR: 1.76; 95% CI: 1.29–2.39). No other statistically significant associations between sociodemographic characteristics and e-cigarette or cigarette use were observed.

Twenty-four percent of adolescents ($n = 499$) reported any lifetime e-cigarette use; 9.6% ($n = 200$) were current users (past 30 days) and 14.4% ($n = 299$) were past users (Table 2). Notably, a lower proportion of adolescents ($n = 390$; 18.7%) had ever smoked a cigarette; 5.7% ($n = 119$) were current cigarette smokers and 13.0% ($n = 271$) were past cigarette smokers. Among e-cigarette users, 40.5% of current users and 44.2% of past users had never smoked a cigarette. Dual-current use (of cigarettes and e-cigarettes) was reported by 66 adolescents (3.2% of the total sample; 33.0% of current e-cigarette users). Current cigarette smoking was strongly associated with both current (OR: 62.9; 95% CI: 35.6–111) and past (OR: 17.1; 95% CI: 9.42–31.2) e-cigarette use after adjustment for sociodemographic variables.

E-cigarette use, especially current use, was strongly associated both with e-cigarette and cigarette psychosocial factors (home environment and friends’ use and attitudes toward e-cigarettes and

cigarettes; Table 3). For example, 34% of current e-cigarette users had another e-cigarette user at home, compared with only 7.3% of never users (OR: 6.80; 95% CI: 4.71–9.83); a cigarette smoker at home was also associated with higher odds of current e-cigarette use (OR: 2.79; 95% CI: 2.01–3.86). Among current e-cigarette users, 49.5% had 3 or 4 friends who used e-cigarettes, compared with only 3.4% of never users (adjusted OR: 10.4; 95% CI: 60.5–179), and 91.0% of current users indicated that they would receive a positive response to their use from their best friends (“friendly” or “very friendly”), whereas only 30.7% of never users predicted the same (“friendly” versus “unfriendly/very unfriendly”: adjusted OR: 18.6; 95% CI: 10.9–31.6; “very friendly” versus “unfriendly/very unfriendly”: adjusted OR: 37.0; 95% CI: 20.9–65.5). We observed trends of greater risk of current e-cigarette use both with greater number of friends using e-cigarettes and with a more favorable reaction to e-cigarettes by participants’ best friends ($P < .05$).

Most participants “strongly agreed” or “agreed” that both e-cigarettes (86.0%) and cigarettes (98.6%) are bad for health (Tables 3 and 4). However, the proportion of adolescents who disagreed that e-cigarettes were bad for their health varied greatly by e-cigarette use (nearly half of all current users, but only 7.5% of never users; OR: 23.5; 95% CI: 15.3–36.1; Table 3). Very few participants disagreed that cigarettes were bad for their health ($n = 30$; 1.4%; Table 4). Nearly all risk factors in Table 3 were more strongly associated with increased current e-cigarette use than with past use relative to never use.

Psychosocial factors indicating a positive e-cigarette social environment were more common than factors indicating a positive cigarette social environment (Tables 3 and 4). For example, 49.5% of

TABLE 1 Association Between Selected Demographic Characteristics and Past or Current E-cigarette and Cigarette Use: Southern California CHS

	Total, <i>N</i> (%)	Never Users, <i>n</i> (%)	Past Users, <i>n</i> (%)	Current Users, <i>n</i> (%)	OR (95% CI) ^a	
					Past Versus Never E-cigarette Users	Current Versus Never E-cigarette Users
E-cigarette use						
Total, <i>N</i> (%)	2084	1585 (76.0)	299 (14.4)	200 (9.6)		
Gender						
Female	1033 (49.6)	825 (52.0)	130 (43.5)	78 (39.0)	Ref	Ref
Male	1051 (50.4)	760 (48.0)	169 (56.5)	122 (61.0)	1.46 (1.13–1.89)	1.76 (1.29–2.39)
Race/ethnicity						
Hispanic white	1078 (51.7)	819 (51.7)	158 (52.8)	102 (51.0)	Ref	Ref
Non-Hispanic white	731 (35.1)	543 (34.3)	106 (35.5)	79 (39.5)	1.00 (0.72–1.40)	1.16 (0.80–1.69)
Other	275 (13.2)	223 (14.0)	35 (11.7)	19 (9.5)	0.98 (0.64–1.51)	0.60 (0.34–1.05)
Family income (2002–2003)						
<\$30 000	462 (22.2)	338 (21.3)	76 (25.4)	48 (24.0)	Ref	Ref
\$30 000–\$74 000	605 (29.0)	457 (28.8)	86 (28.8)	62 (31.0)	0.85 (0.57–1.26)	0.77 (0.49–1.22)
≥\$75 000	656 (31.5)	509 (32.1)	90 (30.1)	57 (28.5)	0.98 (0.63–1.52)	0.65 (0.38–1.09)
Missing	361 (17.3)	281 (17.7)	47 (15.7)	33 (16.5)	0.84 (0.53–1.34)	0.72 (0.41–1.25)
Education (highest parental; 2002–2003)						
<12th grade	386 (18.5)	296 (18.7)	59 (19.7)	31 (15.5)	Ref	Ref
12th grade	312 (15.0)	226 (14.3)	57 (19.1)	29 (14.5)	1.33 (0.86–2.05)	1.31 (0.75–2.31)
Some college	718 (34.5)	535 (33.7)	106 (35.4)	77 (38.5)	0.97 (0.62–1.49)	1.43 (0.84–2.43)
College degree	258 (12.4)	199 (12.6)	32 (10.7)	27 (13.5)	0.79 (0.45–1.40)	1.57 (0.80–3.05)
Some graduate school	247 (11.8)	203 (12.8)	25 (8.4)	19 (9.5)	0.60 (0.32–1.10)	1.08 (0.53–2.22)
Missing	163 (7.8)	126 (7.9)	20 (6.7)	17 (8.5)	0.83 (0.43–1.62)	1.62 (0.77–3.42)
Cigarette use						
Total, <i>N</i> (%)	2084	1694 (81.3)	271 (13.0)	119 (5.7)		
Gender						
Female	1033 (49.6)	851 (50.2)	126 (46.5)	56 (47.1)	Ref	Ref
Male	1051 (50.4)	843 (49.8)	145 (53.5)	63 (52.9)	1.17 (0.90–1.52)	1.18 (0.81–1.73)
Race/ethnicity						
Hispanic white	1078 (51.7)	859 (50.7)	156 (57.6)	63 (52.9)	Ref	Ref
Non-Hispanic white	731 (35.1)	604 (35.7)	81 (29.9)	46 (38.7)	0.89 (0.63–1.27)	0.99 (0.62–1.58)
Other	275 (13.2)	231 (13.6)	34 (12.6)	10 (8.4)	0.91 (0.59–1.40)	0.65 (0.32–1.33)
Family income (2002–2003)						
<\$30 000	462 (22.2)	353 (20.8)	78 (28.8)	31 (26.1)	Ref	Ref
\$30 000–\$74 000	605 (29.0)	493 (29.1)	69 (25.5)	43 (36.1)	0.75 (0.50–1.12)	0.86 (0.50–1.50)
≥\$75 000	656 (31.5)	554 (32.7)	70 (25.8)	32 (26.9)	0.87 (0.55–1.38)	0.65 (0.34–1.24)
Missing	361 (17.3)	294 (17.4)	54 (19.9)	13 (10.9)	0.80 (0.51–1.26)	0.44 (0.20–0.98)
Education (highest parental; 2002–2003)						
<12th grade	386 (18.5)	305 (18.0)	63 (23.3)	18 (15.1)	Ref	Ref
12th grade	312 (15.0)	244 (14.4)	49 (18.1)	19 (16.0)	1.08 (0.70–1.68)	1.47 (0.73–2.96)
Some college	718 (34.5)	580 (34.2)	86 (31.7)	52 (43.7)	0.78 (0.50–1.21)	1.55 (0.80–3.02)
College degree	258 (12.4)	221 (13.1)	25 (9.2)	12 (10.1)	0.61 (0.33–1.11)	1.09 (0.45–2.64)
Some graduate school	247 (11.8)	218 (12.9)	19 (7.0)	10 (8.4)	0.49 (0.26–0.93)	0.95 (0.38–2.41)
Missing	163 (7.8)	126 (7.4)	29 (10.7)	8 (6.7)	1.37 (0.75–2.50)	2.13 (0.76–5.95)

Ref, reference.

^a Adjusted for community and coadjusted for gender, ethnicity, income, and highest parental education, as appropriate.

current e-cigarette users had 3 or 4 best friends who also used e-cigarettes, but only 27.7% of cigarette users reported that 3 or 4 best friends smoked ($P_{\text{difference}} < .001$). Although 91.0% of e-cigarette users perceived that their friends would react positively to their e-cigarette use, a positive reaction to cigarette use was perceived by only 75.6% of cigarette users ($P_{\text{difference}} < .001$).

Notably, associations between e-cigarette psychosocial factors and cigarette use were as strong as those between cigarette psychosocial factors and cigarette use (with the exception of number of friends using e-cigarettes or cigarettes; Table 4). For example, e-cigarette use by other household members was associated with almost 4 times the odds of current cigarette use (OR: 3.71; 95% CI: 2.33–5.92), and adolescents

indicating “friendly” or “very friendly” reactions from friends to e-cigarette use were substantially more likely to currently use cigarettes (OR_{very friendly}: 13.3; 95% CI: 7.12–24.7).

Overall, product-specific psychosocial factors were stronger predictors of e-cigarette use than cigarette use (Tables 3 and 4). For example, a “very friendly” reaction to e-cigarette use

TABLE 2 Never, Current, and Past Use of E-cigarettes and Cigarettes Among Adolescents Enrolled in the Southern California CHS, 2014

	Total, <i>N</i> (%)	Never E-cigarette Users, <i>n</i> (%)	Past E-cigarette Users, <i>n</i> (%)	Current E-cigarette Users, <i>n</i> (%)	OR (95% CI) ^a	
					Past Versus Never E-cigarette Use	Current Versus Never E-cigarette Use
Total, <i>N</i> (%)	2084	1585 (76.0)	299 (14.4)	200 (9.6)		
Never cigarette users	1694 (81.3)	1481 (93.4)	132 (44.2)	81 (40.5)	Ref	Ref
Past cigarette users	271 (13.0)	84 (5.3)	134 (44.8)	53 (26.5)	19.3 (13.7–27.3)	12.4 (8.06–19.0)
Current cigarette users	119 (5.7)	20 (1.3)	33 (11.0)	66 (33.0)	17.1 (9.42–31.2)	62.9 (35.6–111)

Ref, reference.

^a Adjusted for community and coadjusted for gender, ethnicity, income, and highest parental education, as appropriate.

was associated with 37 times the odds of current e-cigarette use (95% CI: 20.9–65.5), whereas a “very friendly” reaction to cigarette use was associated with 9 times the odds of current cigarette use (95% CI: 5.29–16.7).

Ethnicity (Hispanic versus non-Hispanic) modified the association of most psychosocial factors and harm perception variables with e-cigarette and cigarette use (Supplemental Tables 5 and 6). Psychosocial factors were more strongly associated both with e-cigarette and cigarette use among non-Hispanic youth than among Hispanic youth. For example, 18.6% of Hispanic adolescents currently using e-cigarettes had no friends using e-cigarettes, compared with 79.1% of never users; among non-Hispanic adolescents, 4.7% of current e-cigarette users and 81.2% of never e-cigarette users had no friends using e-cigarettes (Supplemental Table 5). The association between the number of friends using cigarettes and current cigarette use was also stronger among non-Hispanic youth than among Hispanic youth. Although 17.5% of Hispanic current smokers and 78.8% of Hispanic nonsmokers had no friends who smoked, 8.3% of non-Hispanic current smokers and 82% of nonsmokers had no friends who smoked cigarettes (Supplemental Table 6).

DISCUSSION

We observed higher rates of e-cigarette use than cigarette use in

this sample of southern California adolescents. The prevalence of e-cigarette use was similar to the prevalence reported in regional studies in Connecticut⁹ and in Hawaii¹⁵ and to the prevalence of use in the 2014 Monitoring the Future Study⁷ and in the 2014 NYTS.⁶ Nearly one-fourth of adolescents in our study reported having ever used e-cigarettes, and almost 10% of adolescents reported current use, which is considerably higher than rates of smoking cigarettes (18.7% and 5.7%, respectively). If this trend is maintained over time, e-cigarettes are likely to become established as the dominant tobacco product and initial source of nicotine exposure in this age group.

Overall, students’ responses indicated a social environment more favorable to the use of e-cigarettes than to smoking cigarettes. Although 42.9% of adolescents predicted that their friends would react positively to their own e-cigarette use, only 31.4% of adolescents predicted a similar response to cigarette use ($P_{\text{difference}} < .001$). Furthermore, although 14.0% of all adolescents thought that e-cigarettes were not harmful (including nearly half of all current e-cigarette users), only 1.4% of adolescents thought the same about cigarettes ($P_{\text{difference}} < .001$). The less favorable social perception and perception of the health risk of cigarettes likely reflect both the known health hazards and success of the long public health struggle to denormalize smoking. However, both tobacco products shared common

social risk factors, and a favorable e-cigarette social environment was strongly associated both with e-cigarette use and with smoking. These results raise the possibility that the generally more favorable social perceptions of e-cigarettes could contribute to the “renormalization” of tobacco products generally.

Together, the higher prevalence of e-cigarette use (9.6% current use) relative to the rates of cigarette use (5.7% current use) and the large proportion of e-cigarette users who have never tried cigarettes (>40% of current and past users) suggest that e-cigarettes could lead to nicotine dependence in adolescents who would not otherwise have used tobacco products. In addition, a recent study found that adolescents using e-cigarettes were more susceptible to cigarette use than nonusers on the basis of responses to questions assessing the likelihood of initiation of smoking.¹⁶ Research is needed to determine whether use of e-cigarettes by nonsmoking adolescents could function as a gateway to combustible cigarette use, leading to increases in cigarette use, either by renormalizing smoking and the social acceptability of smoking or by reducing the perceived risks associated with initiation of use as a result of exposure to marketing of e-cigarettes as a cessation aid.^{12,17}

Tobacco control measures in California have been successful in reducing cigarette use by adolescents; in our study, cigarette use among southern California adolescents was low. The success of the California

TABLE 3 Association Between Selected Psychosocial Characteristics and Past or Current E-cigarette Use: Southern California CHS, 2014

	Total, <i>N</i> (%)	Never Users, <i>n</i> (%)	Past Users, <i>n</i> (%)	Current Users, <i>n</i> (%)	OR (95% CI) ^a	
					Past Versus Never E-cigarette Users	Current Versus Never E-cigarette Users
Total, <i>N</i> (%)		1585 (76.0)	299 (14.4)	200 (9.6)		
Anyone living at home use e-cigarettes?						
No	1829 (87.8)	1461 (92.2)	236 (78.9)	132 (66.0)	Ref	Ref
Yes	241 (11.6)	115 (7.3)	58 (19.4)	68 (34.0)	3.23 (2.25–4.63)	6.80 (4.71–9.83)**
Missing	14	9	5	0		
Anyone living at home use cigarettes?						
No	1638 (78.6)	1297 (81.8)	217 (72.6)	124 (62.0)	Ref	Ref
Yes	433 (20.8)	280 (17.7)	77 (25.8)	76 (38.0)	1.54 (1.14–2.09)	2.79 (2.01–3.86)**
Missing	13	8	5	0		
Number of friends who use e-cigarettes						
0	1410 (67.7)	1265 (79.8)	121 (40.5)	24 (12.0)	Ref	Ref
1 or 2	308 (14.8)	156 (9.8)	98 (32.8)	54 (27.0)	6.23 (4.50–8.63)	18.7 (11.1–31.4)***
3 or 4	205 (9.8)	54 (3.4)	52 (17.4)	99 (49.5)	9.21 (5.93–14.3)	104 (60.5–179)***
Missing	161	110	28	23		
Trend					3.72 (3.03–4.55)	11.2 (8.64–14.6)***
Number of friends who use cigarettes						
0	1513 (72.6)	1267 (79.9)	163 (54.5)	83 (41.5)	Ref	Ref
1 or 2	325 (15.6)	166 (10.5)	80 (26.8)	79 (39.5)	3.56 (2.58–4.93)	7.46 (5.21–10.7)***
3 or 4	85 (4.1)	31 (2.0)	32 (10.7)	22 (11.0)	6.87 (4.00–11.8)	11.2 (6.06–20.7)
Missing	161	121	24	16		
Trend					3.14 (2.49–3.95)	4.57 (3.54–5.89)*
Best friends' reactions to e-cigarette use						
Unfriendly ^b	1172 (56.2)	1087 (68.6)	68 (22.7)	17 (8.5)	Ref	Ref
Friendly	630 (30.2)	358 (22.6)	163 (54.5)	109 (54.5)	6.82 (4.97–9.36)	18.6 (10.9–31.6)**
Very friendly	265 (12.7)	128 (8.1)	64 (21.4)	73 (36.5)	7.39 (4.96–11.0)	37.0 (20.9–65.5)***
Missing	17	12	4	1		
Trend					3.18 (2.64–3.83)	5.67 (4.50–7.15)***
Best friends' reactions to cigarette use						
Unfriendly ^b	1415 (67.9)	1159 (73.1)	154 (51.5)	102 (51.0)	Ref	Ref
Friendly	487 (23.4)	306 (19.3)	109 (36.5)	72 (36.0)	2.54 (1.91–3.38)	2.51 (1.80–3.51)
Very friendly	167 (8.0)	109 (6.9)	33 (11.0)	25 (12.5)	2.07 (1.33–3.21)	2.40 (1.80–3.51)
Missing	15	11	3	1		
Trend					1.72 (1.43–2.07)	1.80 (1.45–2.23)
Are e-cigarettes bad for your health?						
Strongly agree	1324 (63.5)	1150 (72.6)	134 (44.8)	40 (20.0)	Ref	Ref
Agree	455 (21.8)	304 (19.2)	87 (29.1)	64 (32.0)	2.50 (1.84–3.40)	6.02 (3.95–9.18)***
Disagree ^c	291 (14.0)	119 (7.5)	76 (25.4)	96 (48.0)	5.43 (3.81–7.75)	23.5 (15.3–36.1)***
Missing	14	12	2	0		
Trend					2.37 (2.00–2.82)	4.83 (3.92–5.95)***
Are cigarettes bad for your health?						
Strongly agree	1784 (85.6)	1376 (86.8)	257 (86.0)	151 (75.5)	Ref	Ref
Agree	260 (12.5)	172 (10.9)	41 (13.7)	47 (23.5)	1.19 (0.82–1.74)	2.35 (1.62–3.43)*
Disagree ^c	30 (1.4)	28 (1.8)	0	2 (1.0)	—	—
Missing	14	9	1	0		

Ref, reference; —, analysis not possible due to small cell count.

^a Adjusted for community and coadjusted for gender, ethnicity, income, and highest parental education, as appropriate. *P* values for test of difference in effect estimates: **P* < .05, ***P* < .005, ****P* < .0005.

^b Very unfriendly or unfriendly.

^c Disagree or strongly disagree.

Tobacco Control Program, and other tobacco control programs nationally and worldwide, can be attributed in part to interventions targeted at psychosocial factors associated with increased initiation and use of tobacco products, including accessibility and availability of products, perceptions that tobacco

use is normative, and use of tobacco by family and peers (among other measures).¹⁰ The California Tobacco Control Program has focused on changing cigarette-related social norms by, for example, “creating a social milieu and legal climate in which tobacco becomes less desirable, less acceptable and less

accessible”^{18–20} and by limiting tobacco-promoting influences by reducing advertising promoting cigarettes and other tobacco products, countering the “glamorization of tobacco use,” exposing tobacco company practices and holding tobacco companies accountable, and reducing the

TABLE 4 Association Between Selected Psychosocial Characteristics and Past or Current Cigarette Use: Southern California CHS, 2014

	Total, <i>N</i> (%)	Never Users, <i>n</i> (%)	Past Users, <i>n</i> (%)	Current Users, <i>n</i> (%)	OR (95% CI) ^a	
					Past Versus Never Cigarette Users	Current Versus Never Cigarette Users
Total, <i>N</i> (%)		1585 (76.0)	299 (14.4)	200 (9.6)		
Anyone living at home use e-cigarettes?						
No	1829 (87.8)	1537 (90.7)	205 (75.7)	87 (73.1)	Ref	Ref
Yes	241 (11.6)	150 (8.9)	60 (22.1)	31 (26.1)	3.25 (2.29–4.62)	3.71 (2.33–5.92)
Missing	14	7	6	1		
Anyone living at home use cigarettes?						
No	1638 (78.6)	1392 (82.2)	179 (66.1)	67 (56.3)	Ref	Ref
Yes	433 (20.8)	295 (17.4)	86 (31.7)	52 (43.7)	2.16 (1.61–2.90)	3.48 (2.34–5.17)*
Missing	13	7	6	0		
Number of friends who use e-cigarettes						
0	1410 (67.7)	1251 (73.9)	124 (45.8)	35 (29.4)	Ref	Ref
1 or 2	308 (14.8)	207 (12.2)	61 (22.5)	40 (33.6)	3.02 (2.12–4.29)	6.55 (4.01–10.7)*
3 or 4	205 (9.8)	110 (6.5)	63 (23.3)	32 (26.9)	5.68 (3.90–8.27)	9.77 (5.73–16.6)*
Missing	161	126	23	12		
Trend					2.50 (2.08–3.00)	3.28 (2.56–4.20)
Number of friends who use cigarettes						
0	1513 (72.6)	1356 (80.1)	140 (51.7)	17 (14.3)	Ref	Ref
1 or 2	325 (15.6)	182 (10.7)	88 (32.5)	55 (46.2)	4.82 (3.50–6.64)	25.5 (14.3–45.4)***
3 or 4	85 (4.1)	31 (1.8)	21 (7.8)	33 (27.7)	6.51 (3.58–11.9)	86.2 (42.1–176)***
Missing	161	125	22	14		
Trend					3.58 (2.81–4.56)	11.2 (8.03–15.6)***
Best friends' reactions to e-cigarette use						
Unfriendly ^b	1172 (56.2)	1071 (63.2)	85 (31.4)	16 (13.5)	Ref	Ref
Friendly	630 (30.2)	432 (25.5)	135 (49.8)	63 (52.9)	3.94 (2.91–5.34)	9.06 (5.13–16.0)*
Very friendly	265 (12.7)	180 (10.6)	48 (17.7)	37 (31.1)	3.30 (2.21–4.92)	13.3 (7.12–24.7)***
Missing	17	11	3	3		
Trend					2.07 (1.73–2.47)	3.50 (2.69–4.56)***
Best friends' reactions to cigarette use						
Unfriendly ^b	1415 (67.9)	1253 (74.0)	134 (49.5)	28 (23.5)	Ref	Ref
Friendly	487 (23.4)	307 (18.1)	117 (43.2)	63 (52.9)	3.61 (2.71–4.82)	8.89 (5.55–14.2)**
Very friendly	167 (8.0)	122 (7.2)	18 (6.6)	27 (22.7)	1.29 (0.75–2.20)	9.41 (5.29–16.7)***
Missing	15	12	2	1		
Trend					1.73 (1.42–2.10)	3.55 (2.75–4.59)***
Are e-cigarettes bad for your health?						
Strongly agree	1324 (63.5)	1157 (68.3)	125 (46.1)	42 (35.3)	Ref	Ref
Agree	455 (21.8)	338 (20.0)	80 (29.5)	37 (31.1)	2.17 (1.59–2.97)	2.97 (1.86–4.72)
Disagree ^c	291 (14.0)	187 (11.0)	64 (23.6)	40 (33.6)	3.12 (2.20–4.44)	5.60 (3.47–9.02)*
Missing	14	12	2	0		
Trend					1.82 (1.54–2.16)	2.41 (1.91–3.04)*
Are cigarettes bad for your health?						
Strongly agree	1784 (85.6)	1481 (87.4)	226 (83.4)	77 (64.7)	Ref	Ref
Agree	260 (12.5)	179 (10.6)	41 (15.1)	40 (33.6)	1.30 (0.90–1.90)	3.98 (2.60–6.10)***
Disagree ^c	30 (1.4)	26 (1.5)	2 (0.7)	2 (1.7)	—	—
Missing	14	12	2	0		

Ref, reference; —, analysis not possible due to small cell count.

^a Adjusted for community and coadjusted for gender, ethnicity, income, and highest parental education, as appropriate. *P* values for test of difference in effect estimates: **P* < .05, ***P* < .005, ****P* < .0005.

^b Very unfriendly or unfriendly.

^c Disagree or strongly disagree.

availability of tobacco, including youth access.¹⁸ Similar efforts to counteract the normalization of e-cigarette use in adolescent populations (eg, prohibiting sales of e-cigarettes to minors) have very recently been adapted by the California Department of Public

Health, including an educational campaign entitled “Wake Up” to warn the public about the dangers of e-cigarettes (<http://cdph.ca.gov/pages/presskits.aspx>). Although long-term health hazards of e-cigarettes will not be apparent for several decades, emerging literature suggests potential

adverse health effects.^{21–31} Research continuing to investigate the health impact of e-cigarettes in adolescent populations is needed.

Our results suggest that the influence of psychosocial factors on tobacco product use (e-cigarettes and cigarettes) was stronger among

non-Hispanic white youth than among Hispanic youth for both products. Although there has been little study of ethnic differences in effects of e-cigarette psychosocial effects on either e-cigarette or cigarette use, studies of smoking psychosocial environment have found greater odds of smoking among white adolescents, relative to Hispanic adolescents, associated with peer use of cigarettes^{32,33} and peer approval of cigarettes.³⁴ Other studies have found similar effects for cigarette peer use and approval across ethnic groups,³⁵⁻³⁷ although the majority of studies have not examined vulnerability by ethnicity. Our findings of stronger e-cigarette psychosocial effects on cigarette use among non-Hispanic white adolescents, together with consistent previous findings of ethnic differences in the association between cigarette psychosocial factors and cigarette use, suggest that non-Hispanic white adolescents may be more generally susceptible to tobacco product peer influence.

Our study is subject to some limitations. Because the data were cross-sectional, the direction of associations between psychosocial factors and tobacco product use was not clear. In addition, cigarette and e-cigarette psychosocial variables were strongly correlated and models including both e-cigarette and cigarette social environment variables showed considerable multicollinearity, so each e-cigarette and cigarette psychosocial factor was examined in a separate model. As a sensitivity analysis, we ran additional models to evaluate the joint effects of dichotomized cigarette and e-cigarette psychosocial variables (eg, modeling the effects of home use

of e-cigarettes alone, cigarettes alone, or home use of both products; modeling the effects of having only friends who use e-cigarettes, having only friends who use cigarettes, or having friends who use both products). In models evaluating joint effects of psychosocial variables on e-cigarette use, adolescents who had friends who used both e-cigarettes and cigarettes were most likely to use e-cigarettes; effect estimates suggested an additive effect (data not shown). In models evaluating the joint effects of psychosocial factors on cigarette use, dual home use and dual friends' use of cigarettes and e-cigarettes were associated with greater odds of cigarette use than e-cigarette or cigarette use alone (data not shown). For example, adolescents with some friends who used cigarettes were 27.1 times as likely to be a current smoker (95% CI: 12.6-58.1), whereas adolescents with some friends who used cigarettes and some friends who used e-cigarettes were 47.5 times as likely to report current use of cigarettes (95% CI: 24.6-91.7; $P_{\text{heterogeneity}} = .065$; data not shown). Finally, the e-cigarette market has seen rapid proliferation over the past several years, with the emergence of numerous new and evolving products. Because these products were so new at the time of survey development, we were unable to collect data on the use of different types of electronic cigarettes (eg, disposable versus rechargeable, devices containing prefilled versus refillable cartridges) or on dose of e-cigarette use (including nicotine concentration). Future longitudinal studies of the role of the social environment on e-cigarette or cigarette use should evaluate the directional associations

of variables within these complex relationships.

CONCLUSIONS

Psychosocial variables indicating a favorable e-cigarette social environment were associated with cigarette use, as well as with e-cigarette use, in this population of southern California adolescents. This finding is a cause for concern because e-cigarettes were the dominant tobacco product used, and a substantial proportion of e-cigarette users had no history of cigarette use. The health hazards of e-cigarettes are not yet well studied, although the adverse health effects of nicotine, including neonatal, neurodevelopmental, and carcinogenic effects, are well established³¹, and several studies have identified additional potential hazards of e-cigarette aerosols.²¹⁻²⁴ Longitudinal studies of adolescents are needed to investigate chronic health effects of e-cigarettes and to determine whether e-cigarette use will lead to renormalization of cigarette use and dual use of cigarettes and e-cigarettes, or whether e-cigarette use will result in further reductions in cigarette use.

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ABBREVIATIONS

CHS: Children's Health Study
CI: confidence interval
e-cigarette: electronic cigarette
NYTS: National Youth Tobacco Survey
OR: odds ratio

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REFERENCES

- Grana R, Benowitz N, Glantz SA. E-cigarettes: a scientific review. *Circulation*. 2014;129(19):1972–1986
- Wang B, King BA, Corey CG, Arrazola RA, Johnson SE. Awareness and use of non-conventional tobacco products among U.S. students, 2012. *Am J Prev Med*. 2014;47(2 suppl 1):S36–S52
- Centers for Disease Control and Prevention. Notes from the field: electronic cigarette use among middle and high school students—United States, 2011–2012. *MMWR Morb Mortal Wkly Rep*. 2013;62(35):729–730
- Arrazola RA, Neff LJ, Kennedy SM, Holder-Hayes E, Jones CD; Centers for Disease Control and Prevention. Tobacco use among middle and high school students—United States, 2013. *MMWR Morb Mortal Wkly Rep*. 2014;63(45):1021–1026
- Dutra LM, Glantz SA. Electronic cigarettes and conventional cigarette use among U.S. adolescents: a cross-sectional study. *JAMA Pediatr*. 2014;168(7):610–617
- Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students—United States, 2011–2014. *MMWR Morb Mortal Wkly Rep*. 2015;64(14):381–385
- Miech R, Johnston L, O'Malley P, Bachman J, Schulenberg J. *E-Cigarettes Surpass Tobacco Cigarettes Among Teens*. Ann Arbor, MI: University of Michigan News Service; 2014
- Camenga DR, Delmerico J, Kong G, et al. Trends in use of electronic nicotine delivery systems by adolescents. *Addict Behav*. 2014;39(1):338–340
- Krishnan-Sarin S, Morean ME, Camenga DR, Cavallo DA, Kong G. E-cigarette use among high school and middle school adolescents in Connecticut. *Nicotine Tob Res*. 2015;17(7):810–818
- US Department of Health and Human Services. Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, Office on Smoking and Health; 2012
- Stanwick R. E-cigarettes: are we renormalizing public smoking? Reversing five decades of tobacco control and revitalizing nicotine dependency in children and youth in Canada. *Paediatr Child Health (Oxford)*. 2015;20(2):101–105
- Kandel D, Kandel E. The Gateway Hypothesis of substance abuse: developmental, biological and societal perspectives. *Acta Paediatr*. 2015;104(2):130–137
- Bell K, Keane H. All gates lead to smoking: the 'gateway theory', e-cigarettes and the remaking of nicotine. *Soc Sci Med*. 2014;119:45–52
- McConnell R, Berhane K, Yao L, et al. Traffic, susceptibility, and childhood asthma. *Environ Health Perspect*. 2006;114(5):766–772
- Wills TA, Knight R, Williams RJ, Pagano I, Sargent JD. Risk factors for exclusive e-cigarette use and dual e-cigarette use and tobacco use in adolescents. *Pediatrics*. 2015;135(1):e43–e51
- Bunnell RE, Agaku IT, Arrazola RA, et al. Intentions to smoke cigarettes among never-smoking US middle and high school electronic cigarette users: National Youth Tobacco Survey, 2011–2013. *Nicotine Tob Res*. 2015;17(2):228–235
- Pentz MA, Shin H, Riggs N, Unger JB, Collison KL, Chou CP. Parent, peer, and executive function relationships to early adolescent e-cigarette use: a substance use pathway? *Addict Behav*. 2015;42:73–78
- A Model for Change: the California Experience in Tobacco Control*. California Department of Health Services, Tobacco Control Section; 1998.
- Lightwood J, Glantz SA. The effect of the California Tobacco Control Program on smoking prevalence, cigarette consumption, and healthcare costs: 1989–2008. *PLoS ONE*. 2013;8(2):e47145
- Lightwood JM, Dinno A, Glantz SA. Effect of the California Tobacco Control Program on personal health care expenditures. *PLoS Med*. 2008;5(8):e178
- Bahl V, Lin S, Xu N, Davis B, Wang YH, Talbot P. Comparison of electronic cigarette refill fluid cytotoxicity using embryonic and adult models. *Reprod Toxicol*. 2012;34(4):529–537
- Behar RZ, Davis B, Wang Y, Bahl V, Lin S, Talbot P. Identification of toxicants in cinnamon-flavored electronic cigarette refill fluids. *Toxicol In Vitro*. 2014;28(2):198–208
- Cervellati F, Muresan XM, Sticozzi C, et al. Comparative effects between electronic and cigarette smoke in human keratinocytes and epithelial lung cells. *Toxicol In Vitro*. 2014;28(5):999–1005
- Barrington-Trimis JL, Samet JM, McConnell R. Flavorings in electronic cigarettes: an unrecognized respiratory health hazard? *JAMA*. 2014;312(23):2493–2494
- Romagna G, Alliffranchini E, Bocchietto E, Todeschi S, Esposito M, Farsalinos KE. Cytotoxicity evaluation of electronic cigarette vapor extract on cultured mammalian fibroblasts (ClearStream-LIFE): comparison with tobacco cigarette smoke extract. *Inhal Toxicol*. 2013;25(6):354–361
- McAuley TR, Hopke PK, Zhao J, Babaian S. Comparison of the effects of e-cigarette vapor and cigarette smoke on indoor air quality. *Inhal Toxicol*. 2012;24(12):850–857
- Goniewicz ML, Knysak J, Gawron M, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control*. 2014;23(2):133–139
- Jensen RP, Luo W, Pankow JF, Strongin RM, Peyton DH. Hidden formaldehyde in e-cigarette aerosols. *N Engl J Med*. 2015;372(4):392–394
- Balhas Z, Salman R, Talih S, Karaoghlanian N, Shihadeh A. Toxicant emissions from electronic cigarette "direct drip atomizers". Paper presented at: Society for Research on Nicotine and Tobacco; 2015; Philadelphia, PA
- Spindle TR, Pettaway KN, Breland AB, Eissenberg T, Karaoghlanian N, Shihadeh A. Does electronic cigarette liquid nicotine concentration and user experience influence puff topography? Poster presented at: Society for Research on Nicotine and Tobacco; 2015; Philadelphia, PA
- US Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress. A Report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for

- Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014
32. Gritz ER, Prokhorov AV, Hudmon KS, et al. Predictors of susceptibility to smoking and ever smoking: a longitudinal study in a triethnic sample of adolescents. *Nicotine Tob Res.* 2003;5(4):493–506
 33. Landrine H, Richardson JL, Klonoff EA, Flay B. Cultural diversity in the predictors of adolescent cigarette smoking: the relative influence of peers. *J Behav Med.* 1994;17(3):331–346
 34. Siddiqui O, Mott J, Anderson T, Flay B. The application of Poisson random-effects regression models to the analyses of adolescents' current level of smoking. *Prev Med.* 1999;29(2):92–101
 35. Griesler PC, Kandel DB. Ethnic differences in correlates of adolescent cigarette smoking. *J Adolesc Health.* 1998;23(3):167–180
 36. Griesler PC, Kandel DB, Davies M. Ethnic differences in predictors of initiation and persistence of adolescent cigarette smoking in the National Longitudinal Survey of Youth. *Nicotine Tob Res.* 2002; 4(1):79–93
 37. Hu MC, Davies M, Kandel DB. Epidemiology and correlates of daily smoking and nicotine dependence among young adults in the United States. *Am J Public Health.* 2006;96(2):299–308

SQUEEZING RESIDENTS: *I have four children. Three either are in or have graduated from college. Two are thinking about graduate school. The costs of higher education remain staggering to me and have made me quite cost conscious. My children and I have had to balance the benefits of in-state tuition at our state university versus the potential educational benefits of private colleges and universities. While colleges and universities do have to pay attention to their bottom line, in their attempt to maximize their bottom line, a new and worrisome trend has emerged. As reported in The New York Times (The Upshot: May 18, 2015), many public universities are limiting the number of students paying in-state tuition rates. The result is that more students attending large academic public universities are out-of-state and therefore pay higher tuition. The Carnegie Foundation classifies approximately 150 public universities as national leaders in conducting research; these schools tend to have selective admissions criteria. Approximately 500 public universities are categorized as regional because they conduct less research; these tend to have less selective admissions criteria. Both the national and regional universities enroll the same numbers of students. Over the past decade, however, the percentage of in-state matriculants at national and regional universities has dramatically diverged. Between 2000 and 2012, the percentage of in-state matriculants at regional universities held steady at approximately 90%. However, in national universities, the percentage has dropped from 80%. For example, at one large well-known university, less than half the incoming class is from that state. The university has accomplished this by admitting more students – meaning that the same number of students residing in that state is enrolling as before, but more students from other states are being added to the class. Other national universities have taken a different approach. Many have specifically limited the number of in-state matriculants or even reduced the number of in-state applicants they will accept. Others have tightened eligibility for in-state tuition. While higher education financing and recruitment is complicated and tied to prestige, merit scholarships, and other issues, the bottom line is that too many national public universities seem to have forgotten why they were chartered. The goal is to provide educational opportunities for all students, not just those with the most resources.*

Noted by WVR, MD