Risk Factors for Exclusive E-Cigarette Use and Dual E-Cigarette Use and Tobacco Use in Adolescents

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abstract

OBJECTIVE: To describe electronic cigarette (e-cigarette) use and cigarette use among adolescents and determine whether established risk factors for smoking discriminate user categories.

METHODS: School-based survey of 1941 high school students (mean age 14.6 years) in Hawaii; data collected in 2013. The survey assessed e-cigarette use and cigarette use, alcohol and marijuana use, and psychosocial risk and protective variables (eg, parental support, academic involvement, smoking expectancies, peer smoking, sensation seeking). Analysis of variance and multinomial regression examined variation in risk and protective variables across the following categories of ever-use: e-cigarette only, cigarette only, dual use (use of both products), and nonuser (never used either product).

RESULTS: Prevalence for the categories was 17% (e-cigarettes only), 12% (dual use), 3% (cigarettes only), and 68% (nonusers). Dual users and cigarette-only users were highest on risk status (elevated on risk factors and lower on protective factors) compared with other groups. E-cigarette only users were higher on risk status than nonusers but lower than dual users. E-cigarette only users and dual users more often perceived e-cigarettes as healthier than cigarettes compared with nonusers.

CONCLUSIONS: This study reports a US adolescent sample with one of the largest prevalence rates of e-cigarette only use in the existing literature. Dual use also had a substantial prevalence. The fact that e-cigarette only users were intermediate in risk status between nonusers and dual users raises the possibility that e-cigarettes are recruiting medium-risk adolescents, who otherwise would be less susceptible to tobacco product use.

WHAT'S KNOWN ON THIS SUBJECT: There is a debate about whether e-cigarettes will benefit public health. However, there is little knowledge about how e-cigarette users and dual users (those using both e-cigarettes and tobacco cigarettes) differ from other adolescents on a range of variables.

WHAT THIS STUDY ADDS: Teenagers who only used e-cigarettes were intermediate in levels of risk and protective factors between nonusers and those who used both cigarettes and e-cigarettes. This raises a question about whether e-cigarettes recruit low-risk youth to tobacco product use.

Electronic cigarettes (e-cigarettes) are an emerging phenomenon, with current data showing projected sales of $11.7 billion in the United States for 2013.[1,2] Studies of general population samples of US and UK adults show rates of ever-use were <1% in 2009, 2% to 3% in 2010, and 6% to 7% in 2011, so prevalence is at least doubling every year.[3–6] Data from national samples of US adolescents indicate that ever-use prevalence rates among high school students are also increasing steadily every year[7–9]; for example, data from the National Youth Tobacco Survey showed rates of ever-use were 4.7% in 2011 and 10.0% in 2012.[9]

E-cigarette use may have particular implications for younger adolescents, whose attitudes and behavior around smoking tobacco cigarettes (hereafter, cigarettes) are still being formed.[2] Some current commentary on e-cigarettes, focused mostly on adults, suggests that e-cigarettes may help people quit smoking while acknowledging that nicotine addiction is still probably maintained.[10,11] Others have noted that because there are currently no legal restrictions on this product, adults can be observed using e-cigarettes in settings where cigarettes are banned.[12] Furthermore, aggressive marketing campaigns for e-cigarettes are being conducted on prime-time television, on the Internet, at shopping malls, and at other venues readily accessible to adolescents.[13–16] Such considerations have led to concerns that e-cigarettes may lead to a renormalization of cigarette smoking, with this being a particular concern for younger populations, who show a high degree of awareness of e-cigarettes.[2,17] However, at present there is little empirical evidence on this issue. Studies of US adolescents have found that current e-cigarette users are more likely to smoke cigarettes[8,9] but there are few published data on psychosocial variables that distinguish e-cigarette users and dual users (ie, people who use both e-cigarettes and cigarettes) from nonusers (people who do not use either product).

There are 2 contrasting theoretical models about e-cigarette use among adolescents. One model suggests that youth who try e-cigarettes have more conventional and health-oriented values.[18] Their choice of e-cigarettes would be motivated more by health concerns, so they would not find cigarettes or other substances (eg, marijuana) attractive and would not score high on known risk factors for adolescent substance use.[19] An alternative model suggests that e-cigarettes may appeal to youth for reasons similar to those noted for alcohol or marijuana: They provide a means of rebelling against conventional values[20] and engaging in behaviors that provide pleasant physical sensations and increase positive mood.[21] This conceptualization suggests that youth who use e-cigarettes will also use tobacco and alcohol and will score high on substance use risk factors. Although both formulations are plausible, there is little empirical evidence to support or reject either theory at this time.

To test these competing models, we administered survey items on e-cigarette use to a diverse sample of adolescents in Hawaii in 2013. Previous research has demonstrated that typical risk factors (eg, sensation seeking, peer use) and protective factors (eg, parental support, academic involvement) predict substance use among adolescents in Hawaii, as they do elsewhere.[22] In addition to data on e-cigarette use, we obtained data on a range of risk and protective factors, variables that have been linked to a higher or lower likelihood of substance use.[19] In this article we report data on the prevalence of e-cigarette and cigarette use and conduct analyses to determine variables that discriminate e-cigarette users and dual users from nonusers, with the analyses controlling for demographics.

METHODS

Participants and Procedure

Participants

Participants were 1941 students (76% response rate) in 3 public and 2 private high schools on Oahu, Hawaii; 57% were ninth graders and 43% were 10th graders. The sample was 53% female, and mean age was 14.6 years (SD = 0.7). Regarding race and ethnicity, 21% of participants were Asian American (Chinese, Japanese, or Korean), 17% Caucasian, 32% Filipino, 20% Native Hawaiian or other Pacific Islander (Samoan or Tongan), and 10% other ethnicity (mostly African American or Hispanic). Regarding family structure, 16% of the participants were living with a single parent, 13% were in a stepparent family, 60% were with 2 biological parents, and 11% were in an extended family. The mean for father's education on a 6-point scale was 4.1 years (SD = 1.2) and for mother's education was 4.3 years (SD = 1.1), representing 1 year of education beyond high school on average.

Procedure

For recruiting schools, we first identified 5 high schools that were typical of the Hawaii educational system (in terms of size, student demographics, and parental education). Approval from the district superintendent and the principals of the 5 schools (100% of those approached) was then obtained. Parental consent and adolescent assent were required for participation. A survey taking approximately 40 minutes was administered to assenting students in classrooms by trained research staff. Students were instructed that data were completely confidential, and they should not write their names on the survey. The research procedure was reviewed and approved by the institutional review boards of the University of Hawaii and the Hawaii State Department of Education.

Measures

The measures had been validated in several populations,[22,23] but scale structure was verified with factor analysis and internal consistency analysis. Variables were scored such that a higher score reflects more of the attribute in the variable label.

Demographics

The student was asked to indicate his or her gender and write in his or her age in years. An item on family structure asked, "What adults do you live with right now?" Nine response alternatives were provided (mother, father, stepmother, stepfather, aunt, uncle, grandmother, grandfather, guardian), and the student was told to check ≥1 as appropriate. For ethnicity, the student was given 14 ethnic options and asked, "What would you say you are? (Check one or more)." Response options were Native American or Alaskan Native, black (African American), Chinese, Hispanic (Latino), Native Hawaiian, Filipino, Japanese/Okinawan, Korean, Micronesian (Chuuk, Guam, Palau, Pohnpei, Yap), Samoan, Southeast Asian (Cambodian, Lao, Thai, Vietnamese), Tongan, white (Caucasian), or Other. Participants who checked >1 were asked, "If you had to choose only one, what would you say?" with an open-end response. Items for parental education asked, "What is the highest level of education your father/mother has completed?" There were 6 fixed responses, with anchor points *grade school* and *post-college.*

Outcome Variables

An initial item asked, "Have you ever heard of or seen an electronic cigarette (e-cigarette, Volcano) before?" (1 = *No,* 2 = *Yes*). The first item on e-cigarette use had the stem, "Which of the following is most true for you about smoking electronic cigarettes? (Check one)" (0–6 scale with anchor points 'Never did this'

and 'Usually smoke e-cigarettes every day'). A second item asked, "Was there a time in the past month when you smoked an e-cigarette? (check one)" (0–3 scale with anchor points 'No' and 'Three or more times'). An item on cigarette smoking was introduced with the stem, "Which of the following is most true for you about smoking cigarettes?" (0–6 scale with anchor points 'I have never smoked a cigarette' and 'I smoke cigarettes every day'). We determined outcome categories by cross-classifying the sample on ever-use of e-cigarettes and ever-use of cigarettes, which produced 4 usage groups: e-cigarette use only, cigarette use only, dual use (used both products), and nonuser (never used either product).

Predictor Variables

Psychosocial variables tested for discriminating e-cigarette use and cigarette use are summarized in Table 1. Several measures were derived from social-cognitive theory, which posits that involvement in smoking is influenced by cognitive perceptions of substance use and substance users and by perceptions of competence and self-efficacy.[24–26] Validated measures were included on smoking expectancies, perceptions of peer smokers, academic and social competence, and self-control.[22,23,26,27] Several measures were derived from problem behavior theory, which posits that adolescent substance use derives from rebellion against conventional values, tendency toward acting-out behavior, and affiliation with deviance-prone peers.[20,28,29] Measures were included on rebelliousness and sensation seeking, impulsiveness and emotional dysregulation, and affiliation with peers who smoke.[22,23,30–33] An item on perceived health effects of e-cigarettes asked, "Do you think smoking electronic cigarettes is healthier than regular cigarettes?"

(1 = No, 2 = Yes). Items on alcohol and marijuana use had a stem similar to the cigarette item and responses on similar 0 to 6 scales. An item on heavy drinking asked, "Was there a time in the past month when you had 3 or more drinks of alcohol (beer, wine, or liquor) at one sitting, that is, in about 2 hours" (0–3 scale with anchor points 'Never' and 'Three or more times').

Data Analysis

We report the prevalence of e-cigarette use and other substance use. A one-way analysis of variance (ANOVA) then tested the overall variation in study variables across the 4 cross-classified usage groups. To examine 3 specific contrasts (e-cigarette only compared with each of the other 3 categories), we fit a multinomial logistic regression (generalized logit model with polytomous nominal response variable) specifying usage group as the criterion. The analytic model entered a given predictor variable and controlled for gender, grade, parental education, family structure (3 binary indices, which contrasted single, blended, and extended structures with intact family as the reference group), and ethnicity (4 binary indices, which contrasted Caucasian, Filipino, Native Hawaiian, and other ethnicity with Asian American as the reference group). The analysis was done in SAS Proc Surveylogistic (SAS Institute, Inc, Cary, NC), with school included as a clustering variable. This multivariate model tests prediction of usage group membership, controlling for any correlations of the predictor with the full range of demographic variables and adjusting standard errors for within-school correlations of values.

RESULTS

Prevalence Rates

Results showed 96% of the participants were aware

TABLE 1 Psychosocial Variables Tested as Correlates of E-Cigarette Use in a Sample of High School Students in Hawaii

Variable (Items)	α	Sample Item	Correlation of Scale With		
			Smoking Frequency	Alcohol Frequency	Marijuana Frequency
Social-cognitive risk factors					
Smoker prototypes (4)[a]	.80	The type of person your age who smokes is [popular].	.18	.14	.16
Smoking expectancies (5)[b]	.95	Smoking helps you feel more [self-confident].	.39	.31	.32
Behavioral dysregulation (15)[b]	.84	I often do things without stopping to think.	.18	.23	.19
Emotional dysregulation (14)[b]	.87	My moods change a lot from day to day.	.20	.24	.19
Peer smoking (1)[c]	na	Do any of your friends smoke cigarettes?	.38	.38	.37
Social-cognitive protective factors					
Parental support (5)[b]	.94	When I feel bad about something, my parent will listen.	−.18	−.19	−.14
Parental monitoring (5)[b]	.75	My parent asks me what I do with my friends.	−.18	−.21	−.18
Academic competence (5)[b]	.79	I like school because I do well in class.	−.21	−.22	−.18
Grades past year (1)[d]	na	Overall, what were your grades like the past year?	−.22	−.14	−.22
Behavioral self-control (18)[b]	.89	I like to plan things ahead of time.	−.21	−.26	−.22
Emotional self-control (13)[b]	.90	When I'm upset, I can stop myself from losing my temper.	−.14	−.19	−.16
Social competence (5)[b]	.80	I find it easy to make friends with other teenagers.	.01#	.03#	.04#
Problem behavior risk factors					
Parent–adolescent conflict (3)[b]	.83	I have a lot of arguments with my parent.	.17	.18	.17
Sensation seeking (5)[b]	.75	I like to do things that are a little frightening.	.29	.35	.28
Rebelliousness (4)[b]	.85	I like to break the rules.	.36	.42	.40

na, not applicable. N for correlations = ~1910. Correlations are significant at $P < .001$ unless otherwise noted. #, indicates not significant.

[a] Response = 1–5 adjective scale (*Not at all–Very*).

[b] Response = 1–5 Likert scale (*Not at all true–Very true*).

[c] Response = 0–4 count scale (*None of my friends–4 or more of my friends*).

[d] Response = 1–5 categorical scale (1 = *mostly F* to 5 = *mostly A*).

of e-cigarettes and 67% considered them to be healthier than cigarettes. Prevalence data (Table 2) showed that 29% of the sample had ever used e-cigarettes, with 18% having used them in the past month.

The prevalence of ever-use was 15% for cigarettes, 47% for alcohol, and 18% for marijuana. These rates are generally comparable to data from national samples of high school students,[34] except rates of regular cigarette smoking tend to be lower in Hawaii, a difference that is attributed to high taxation and strict sales enforcement.[35] The psychosocial risk and protective variables assessed in the study were correlated significantly ($P < .001$) with participants' cigarette, alcohol, and marijuana use in 14 of 15 tests (Table 1), a result consistent with a number of other studies of adolescent substance use.[19,22,23]

Cross-tabulation showed a substantial prevalence of both single and dual e-cigarette use: 17% for e-cigarettes only, 12% for dual use, 3% for cigarettes only, and 68% for nonuser. Regarding demographic variables (Table 3), 10th grade participants were overrepresented in the dual-use group. Cell χ^2s

TABLE 2 Prevalence Rates (n and %) for E-Cigarettes and Other Substance Use

Frequency	Frequency of E-Cigarette Use		Past-Month E-Cigarette Use		
Never	1376	71%	None	1594	82%
1–2 times	164	9%	Once	124	7%
3–4 times	221	11%	Twice	59	3%
Yearly	40	2%	≥3 times	157	8%
Monthly	58	3%			
Weekly	45	2%			
Daily	33	2%			

Frequency	Frequency of Cigarette Use		Frequency of Alcohol Use		Frequency of Marijuana Use		Past-Month Heavy Drinking		
Never	1652	85%	1026	53%	1591	82%	None	1709	88%
1–2 times	121	6%	403	21%	99	5%	Once	121	6%
3–4 times	74	4%	236	12%	73	4%	Twice	41	2%
Yearly	29	2%	166	9%	60	3%	≥3 times	66	4%
Monthly	29	2%	72	4%	45	2%			
Weekly	15	<1%	25	1%	37	2%			
Daily	16	<1%	7	<1%	28	2%			

N for rates = ~1930.

indicated that participants from intact families were overrepresented in the nonuser group and underrepresented in the e-cigarette only and dual-use groups. In contrast, participants from single-parent and blended families were overrepresented in the cigarette-only and dual-use groups. For ethnicity, Asian Americans were overrepresented in the nonuser group and underrepresented in the e-cigarette only and dual-use groups, whereas Filipinos were overrepresented in the e-cigarette only group. Native Hawaiians were overrepresented in the e-cigarette only and dual-use groups. Participants from lower-education families were overrepresented in the e-cigarette only and dual-use groups.

Comparison of Single- and Dual-Use Groups

Means for the study variables for the 4 usage groups are presented in Table 4. ANOVAs (Table 4, left)

showed that almost all study variables varied significantly across the 4 usage groups. Multinomial regression analyses (shown in Table 4, right) indicated a number of significant contrasts, with patterning generally consistent across variables. The pattern was such that in almost all contrasts the e-cigarette only group scored higher on risk factors and lower on protective factors (ie, risk status) compared with the nonuser group. In almost all contrasts the dual-use group was significantly higher on risk factors compared with the e-cigarette only group.

The e-cigarette only group was higher on risk status compared with nonusers, but in almost all contrasts it was significantly lower than the dual-use group. Thus it represented an intermediate risk status.

With respect to specific protective factors, the e-cigarette only group scored significantly lower than the nonuser group on parental support

and monitoring, academic involvement and grades, and behavioral and emotional self-control. The dual-use group scored lower than the e-cigarette only group on 5 of these same variables. The cigarette-only group differed from the e-cigarette only group in only 2 contrasts, being lower on parental support and monitoring. The 1 null result in this domain was for social competence, where there was no significant overall difference across the usage groups.

An analogous pattern (with opposite direction) was found for specific risk factors. In almost all tests the dual-use group was significantly higher than the e-cigarette only group on social-cognitive risk factors and problem behavior risk factors, the exception being perceiving e-cigarettes as healthier, where they were tied (mean of 1.8 for both groups). The cigarette-only group did not differ in most tests from the e-cigarette only group, the exceptions being higher scores on smoking expectancies and emotional dysregulation. The e-cigarette only group was significantly elevated on risk factors compared with the nonuser group in all contrasts tested, but they were significantly lower than the dual-use group in most contrasts.

Large differences were found for collateral substance use. The dual-use group showed significantly more alcohol and marijuana use than the e-cigarette only group. The e-cigarette only group was higher on alcohol and marijuana use than nonusers, again occupying an intermediate status.

These analyses were repeated with more stringent definitions for classifying the usage groups, with a higher score on the e-cigarette and cigarette scales for defining a user. We did so to ensure that the findings did not apply only to people who had tried cigarettes or e-cigarettes only once. Although the numbers were smaller, the results from these

TABLE 3 Prevalence of E-Cigarette Ever-Use (n and Row %) by Usage Groups, With Cell χ^2 Tests

Demographic Subgroup (n)	Usage Group (Marginal Row %)			
	Nonuser	E-Cigarette Only	Cigarette Only	Dual Use
	(68%)	(17%)	(3%)	(12%)
Gender				
Female (1029)	719 (70%)	162 (16%)	37 (4%)	111 (11%)
Male (894)	595 (67%)	167 (19%)	16 (2%)	116 (13%)
Grade				
9th grade (1104)	773 (69%)	203 (19%)	31 (3%)	97 (9%)**
10th grade (825)	544 (65%)	128 (16%)	23 (3%)	130 (16%)***
Family structure				
Single parent (313)	177 (56%)**	69 (22%)*	15 (5%)*	52 (17%)**
Blended family (247)	134 (54%)**	40 (16%)	14 (6%)**	59 (24%)***
Intact family (1146)	868 (76%)**	165 (14%)*	22 (2%)	91 (8%)***
Extended family (218)	134 (61%)	56 (26%)**	2 (1%)	26 (12%)
Ethnicity				
Asian American (380)	328 (86%)***	23 (6%)***	5 (1%)	24 (6%)**
Caucasian (316)	232 (73%)	45 (14%)	12 (4%)	27 (9%)
Filipino (595)	385 (65%)	135 (23%)***	12 (2%)	63 (11%)
Native Hawaiian (378)	206 (54%)***	82 (22%)*	13 (3%)	77 (20%)***
Parental education				
Lower education (528)	320 (61%)*	115 (22%)**	9 (2%)	84 (16%)***
Higher education (954)[a]	708 (74%)	139 (15%)	26 (3%)	81 (8%)**

Asterisks indicate cell departure from expectation, based on cell χ^2 with 1 degree of freedom. *Indicates cell χ^2 significant at $P < .05$; **$P < .01$; ***$P < .001$. Overall χ^2 tests are as follows: for gender, χ^2 (3) = 10.8, $P = .01$; for grade, χ^2 (3) = 22.9, $P < .001$; for family structure, χ^2 (9) = 112.0, $P < .001$; for ethnicity, χ^2 (9) = 118.3, $P < .001$; for parental education, χ^2 (3) = 38.2, $P < .001$.

[a] Coding is as follows: lower = up to high school graduate, higher = some college or more.

TABLE 4 Mean (SE) for Variables by Usage Groups, With F for ANOVA and Ps for 3 Contrasts From Multinomial Regression

Variable	Usage Group				F	Contrast (P)		
	1. Nonuser	2. E-Cigarettes Only	3. Cigarettes Only	4. Dual Use		1 vs 2	2 vs 3	2 vs 4
Social-cognitive protective factors								
Parental support	25.9 (0.20)	23.3 (0.40)	20.0 (0.97)	21.8 (0.48)	36.5	.001	.01	.03
Parental monitoring	21.2 (0.10)	20.0 (0.20)	18.7 (0.50)	19.0 (0.24)	33.0	.001	.04	.01
Academic involvement	18.3 (0.11)	16.6 (0.22)	15.5 (0.53)	15.5 (0.26)	46.7	.001	ns	.002
Grades past year	4.3 (0.02)	3.9 (0.05)	3.8 (0.11)	3.5 (0.06)	65.1	.001	ns	.001
Behavioral self-control	65.4 (0.32)	61.2 (0.65)	57.9 (1.58)	57.0 (0.77)	43.2	.001	ns	.001
Emotional self-control	44.3 (0.28)	40.4 (0.57)	35.9 (1.42)	38.9 (0.68)	33.9	.001	ns	ns
Social competence	9.4 (0.08)	9.7 (0.16)	8.7 (0.39)	9.7 (0.19)	2.5#	ns	ns	ns
Social-cognitive risk factors								
Smoker prototype	8.9 (0.10)	9.4 (0.20)	10.1 (0.50)	10.5 (0.24)	13.3	.02	ns	.01
Smoking expectancies	8.8 (0.16)	10.1 (0.31)	13.3 (0.79)	14.3 (0.38)	68.6	.001	.002	.001
Behavioral dysregulation	38.9 (0.27)	43.6 (0.54)	42.6 (1.33)	45.7 (0.64)	45.3	.001	ns	.02
Emotional dysregulation	21.7 (0.22)	24.7 (0.45)	27.4 (1.11)	26.7 (0.54)	37.0	.001	.03	.01
Peer smoking	0.8 (0.04)	1.5 (0.08)	1.9 (0.19)	2.8 (0.09)	135.6	.001	ns	.001
E-cigarettes healthier	1.6 (0.01)	1.8 (0.03)	1.7 (0.06)	1.8 (0.03)	30.3	.001	ns	ns
Problem behavior risk factors								
Parent–adolescent conflict	7.6 (0.09)	8.7 (0.18)	9.4 (0.46)	9.5 (0.22)	29.2	.001	ns	.02
Sensation seeking	13.4 (0.12)	15.8 (0.24)	16.8 (0.58)	17.8 (0.29)	89.6	.001	ns	.001
Rebelliousness	6.3 (0.09)	8.4 (0.18)	9.5 (0.46)	10.9 (0.22)	152.7	.001	ns	.001
Collateral substance use								
Alcohol use	0.5 (0.03)	1.5 (0.06)	1.9 (0.14)	2.5 (0.07)	296.4	.001	ns	.001
Marijuana use	0.1 (0.03)	0.6 (0.05)	1.1 (0.13)	2.6 (0.06)	474.4	.001	ns	.001
Heavy drinking	0.1 (0.02)	0.3 (0.03)	0.4 (0.08)	0.9 (0.04)	138.2	.001	ns	.001

ns, nonsignificant. Usage group sizes are as follows: Nonuser group = 1319 cases; e-cigarette only group = 331 cases; cigarette-only group = 54 cases; and dual-use group = 228 cases. F for ANOVA has approximately 3/1910 degrees of freedom. Fs are significant at $P < .001$ unless otherwise noted; # indicates not significant. Regressions include control for gender, grade, family structure, ethnicity, and parental education and adjustment for any within-school clustering. For contrasts, 0.001 indicates effect is significant at $P < .001$; otherwise, exact probability indicates significance level of result.

analyses are quite similar to those reported here.

DISCUSSION

The aim of this research was to determine the prevalence of e-cigarette use in middle adolescence and test how e-cigarette users differed on a range of variables. We found there was an appreciable prevalence of e-cigarette use in this population, and the prevalence was higher than data previously reported from studies conducted in 2011 and 2012.[7–9] In addition, we found a substantial prevalence of dual use, and there was little cigarette-only use. The current study has limitations in being cross-sectional and being conducted in one geographic area. However, our findings on the association of e-cigarette use with current smoking status are consistent with those of other studies on adolescent e-cigarette use,[7–9] and our results on demographics are consistent with these and other

studies on the relation of demographic variables to adolescent substance use.[35–37]

Contrasting Models of E-Cigarette Use

Our introduction outlined a conceptual model in which e-cigarette use in adolescence is motivated more by curiosity and conventional exploration, contrasted with a model suggesting that e-cigarettes appeal to youth who are inclined to engage in problem behavior and affiliate with substance-using peers. Some support for both models can be found in our data. People who used only e-cigarettes did not score high on variables such as rebelliousness, sensation seeking, and peer smoker affiliations compared with dual users; in this respect, they are characterized as less deviance prone, and this finding supports the first model. Consistent with the second model, dual users were found to be higher on risk factors and lower on protective

factors than the other groups. This pattern was observed across a range of variables, including some that were substance-specific (eg, smoking expectancies, perceptions of smokers) and some that were more general (eg, academic involvement, behavioral dysregulation). Thus the dual users clearly represent people who are prone to problem behavior. In contrast, people who used only e-cigarettes differed on most variables from nonusers but were at significantly lower risk in many respects than the dual users; thus, they represent a group that is intermediate on risk status.

The prevalence of e-cigarette use in this population was substantially higher than rates reported previously from studies conducted in 2011 to 2012.[7–9] A possible reason for the higher rate is that cigarettes are highly taxed in Hawaii, so alternatives may be more attractive economically, and vendors provide flavors that are popular with local adolescents (eg,

mango, pineapple), making e-cigarettes attractive from a taste standpoint. It is worth noting that adolescents in Hawaii are exposed to aggressive marketing for e-cigarettes in several venues popular with adolescents, including radio and shopping malls but also on television and in movie theaters. Anecdotal reports from school administrators suggest that some parents perceive e-cigarettes as desirable and buy them for adolescents. (Administrators see this when they take e-cigarettes away from students and parents then complain and demand them back.) These conditions, and the lack of any previous restrictions on use of e-cigarettes, apparently combine to produce a high level of awareness of e-cigarettes (96% in the present sample) with perceptions and expectancies that are favorable to smoking in part of the adolescent population.[1,2,12,17]

The group of people who used only cigarettes was small. The cigarette-only users generally did not differ significantly from people who used only e-cigarettes, an exception being their expectancies about the subjective effects of smoking. It is possible that these particular people are more sensitive to the effects of nicotine, reflected in their high score on smoking expectancies, and perhaps they are less socially integrated in peer groups, reflected in their lower scores on social competence and peer smoker affiliations. In addition, it appears they had less perception of e-cigarettes as a healthier alternative to cigarettes (a variable that distinguished them from the dual users). Because of the smaller group

size, conclusions about the size and nature of this group must be replicated in other samples.

Questions for Future Research

This study showed that e-cigarette users were somewhat elevated on risk status and that dual users scored particularly high. The present results raise several important questions that must be addressed in future research. First is whether the high prevalence of dual use in the present sample derives from a renormalization of smoking.[1] Additional research is needed to study geographic areas with particularly high or low rates of e-cigarette use and dual use and test alternative explanations for these differences. Attention should be given to the prominence of e-cigarette advertising, the perceived attractiveness of e-cigarettes because of price, policy, or flavoring considerations, and differences in attitudes about cigarettes and e-cigarettes (eg, perceptions of users, expectancies about use, and perceived desirability from a health standpoint). Another significant question is how e-cigarette use is related to cigarette smoking. The fact that e-cigarette only users were at low risk on most study variables but had favorable smoking expectancies and perceptions of adolescent smokers suggests that they may be vulnerable to cigarette smoking. Whether this occurs because they have used e-cigarettes is not known, and this question is best resolved by longitudinal studies that examine initial e-cigarette use in relation to subsequent smoking-related attitudes and cigarette smoking behavior. This is a particular concern for young people because of

the greater sensitivity of the developing adolescent brain to the effects of nicotine.[38–40]

An issue posed by observations about the dual-user group is whether e-cigarettes are being used to help them quit smoking.[10,11] The fact that adolescents in the dual-use group had high rates of other substance use (eg, alcohol and marijuana) and problem behavior variables (eg, sensation seeking and rebelliousness) suggests that they may have difficulty quitting the use of cigarettes and other substances. In addition, the existing literature on e-cigarettes does not show that e-cigarette use does much to help established smokers quit.[2] This is ultimately an empirical question, and longitudinal studies are needed to test whether e-cigarette use helps promote smoking cessation or, instead, operates to maintain involvement in multiple types of substance use. The present results raise a question about whether low-risk youth are being recruited to cigarette smoking by being exposed to e-cigarettes and acquiring perceptions and attitudes favorable to smoking. These issues must be considered in the ongoing debate about formulation of policies to regulate e-cigarettes.[10,12,41–44]

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