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Frequency of E-cigarette Use, Health Status, and Risk and Protective Health Behaviors in Adolescents

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Abstract

Objectives—E-cigarettes (ECs) are increasingly popular among adolescents, who perceive them as “safer” than cigarettes. Although research has examined risk factors for adolescent EC use, little is known about how EC use correlates with health status and protective health behaviors.

Methods—2,488 adolescents (mean age=17.31, $SD=0.67$; 46% male) completed a survey on EC and cigarette use, physical and mental health, physical activity, diet, sleep, and alcohol and other drug (AOD) use. Logistic regression compared EC-only users to dual EC/cigarette users, cigarette-only users, and non-users on these health factors. Among EC-only users, separate ordinary least squares regression models assessed the effects of health status/behavior variables on frequency of past-year EC use, controlling for demographics and smokeless tobacco use.

Results—User groups were similar on physical health and engagement in protective health behaviors (physical activity, sleep duration/quality, healthy diet), but EC-only users reported fewer mental health symptoms and less AOD use than dual or cigarette-only users. Among EC-only users, AOD use (all $p < .0001$) predicted more frequent EC use; healthy diet predicted less frequent use ($p < .01$).

Conclusions—EC-only use is associated with lower engagement in risky behaviors, but not better health status or higher engagement in protective health behaviors, compared to cigarette smoking. Dual EC/cigarette users may represent a particularly high risk group due to their greater AOD use and cigarette consumption. Among “intermediate risk” EC-only users, AOD use and unhealthy diet correlated with heavier use, and may be important targets for preventing escalation to more harmful tobacco use.

Introduction

E-cigarettes (ECs) have witnessed an explosion in popularity over the past several years (King et al., 2015). Individuals use these devices to aerosolize “e-liquids,” which are typically glycerin or propylene glycol solutions containing nicotine, flavoring compounds,

and various other constituents (Grana et al., 2014). While not harm-free (e.g., users are at risk for exposure to various toxins [Farsalinos et al., 2015; Goniewicz et al., 2014], and nicotine dependence [Foulds et al., 2015]), ECs yield significantly *lower* concentrations of carcinogens and other toxins than combustible cigarettes (hereafter, cigarettes) (Hajek et al., 2014), and are marketed as less harmful alternatives to cigarettes (Paek et al., 2014). This reduced-harm designation may account for much of their popularity among adult smokers, who commonly report using ECs as “healthier” substitutes for cigarettes (e.g., to help cut down on smoking; Chapman & Wu, 2014).

However, health officials have voiced concerns that EC use among adolescents may promote nicotine dependence, and perhaps result in more dangerous forms of tobacco use, calling into question their popular designation as a “lower risk” product (Rigotti, 2015). Recent longitudinal studies suggest that adolescents who use ECs are more likely to progress to using cigarettes in the future (Leventhal et al., 2015; Primack et al., 2015; Wills et al., 2016). This is particularly concerning given the increasingly widespread use of ECs observed in nationally representative surveys of youth. For example, data from the CDC National Youth Tobacco Survey (NYTS), a nationally representative school-based survey of U.S. middle and high school students (grades 6–12), showed that current EC use (past 30-day use) among high school students rose from 1.5% to 16.0% in the period during which EC survey data was collected (2011 and 2015; Singh et al., 2016). The rates of EC use in 2015 (16.0%) represented an estimate of approximately 2.4 million high school student users in the United States, a figure that far outnumbered the estimated number of cigarette users by about 1 million. Similarly, data from the 2015 Monitoring the Future (MTF) survey, a nationally representative school-based survey that gathers data from 8th, 10th, and 12th grade students in classrooms annually, showed that up to 16% of 12th graders report past-month EC use, which again exceeds rates for cigarettes (11%) (Johnston et al., 2016). In addition, concurrent or “dual” use of ECs and cigarettes is also common among adolescents in the NYTS; in 2012, 49.8% of middle school and high school youth who reported past 30 day use of ECs reported past 30 day use of cigarettes (Dutra & Glantz, 2014).

Consistent with this, an emerging literature suggests that EC and cigarette use are predicted by similar demographic and psychosocial risk factors, including: male gender (Anand et al., 2015; Barrington-Trimis et al., 2015; Hamilton et al., 2014; Kinnunen et al., 2014; Krishnan-Sarin et al., 2014); lower socioeconomic status (Kinnunen et al., 2014; Wills et al., 2015); peer and family tobacco use (Barrington-Trimis, et al., 2015; Pentz, et al., 2015; Wills, et al., 2015); positive smoking expectancies (Anand et al., 2015; Barrington-Trimis et al., 2015; Wills et al., 2015); and personality and psychological factors (e.g., sensation-seeking [Hampson et al., 2015; Wills et al., 2015]; executive functioning deficits [Pentz et al., 2015]; emotional dysregulation [Wills et al., 2015]). In addition, studies have found that adolescent EC users, like cigarette smokers, are more likely to engage in risky health behaviors like alcohol and other drug (AOD) use (Kristjansson & Sigfusdottir, 2015; Pentz et al., 2015; Suris et al., 2015; Wills et al., 2015).

Yet, ECs are explicitly distinguished from cigarettes in that they are marketed (Paek et al., 2014) and perceived (Ambrose et al., 2014; Amrock et al., 2015; Barrington-Trimis, et al., 2015) as healthier alternatives to smoking. This distinction may influence patterns of EC

versus cigarette use among adolescents. For example, teens who use ECs are more likely than cigarette smokers to view ECs as less risky to health than cigarettes (Barrington-Trimis et al., 2015), suggesting that some adolescents may use ECs instead of cigarettes because they perceive them to be a “healthier.” In a recent study of high school youth in Hawaii, which included a large sample of EC-only users (n=331), Wills et al. (2015) compared EC-only users, cigarette-only users, dual users, and non-users on a range of behavioral and psychosocial risk and protective variables (including parental support, academic involvement, and sensation seeking). This study found that EC-only users showed an “intermediate risk” profile, such that EC-only users were less likely to engage in other risk behaviors like AOD use compared to their cigarette smoking peers, but showed higher ratings on risk factors and lower ratings on protective factors compared to non-users (Wills et al., 2015). Another study by Leventhal et al. (2016) similarly showed evidence of EC-only users as an “intermediate risk” group. EC-only users appeared to be less healthy than non-users, but healthier than both cigarette smokers (on psychological outcomes such as depression, generalized anxiety, panic, social phobia, and obsessive-compulsive disorder) and dual users (on externalizing outcomes such as mania and AOD abuse). However, it is unclear whether adolescent EC-only users are “healthier” in terms of their health status and participation in protective health behaviors.

To our knowledge, no studies have examined differences in physical health status or “protective” health behaviors (e.g., healthy diet, physical activity, adequate sleep) across EC and cigarette users. This information has important implications for conceptualizing EC use—versus cigarette smoking—as a correlate of overall health, and could identify potential lifestyle factors that might protect against more dangerous forms of nicotine use among youth. Furthermore, most studies that report an association between EC use and risky health behaviors have focused on associations with the likelihood of *any* (yes/no) EC use (e.g., Kristjansson & Sigfusdottir, 2015; Suris et al., 2015; although see Wills et al., 2015). It is unclear how health factors, including physical and mental health status, protective health practices, and risky health behaviors relate to *frequency of EC consumption* among adolescents who use ECs exclusively. Thus, this study contributes new information to this burgeoning literature and may yield important insights into potential variability among adolescent EC users with respect to health status and health behaviors.

Using data from a large, ethnically diverse California cohort, and one of the largest samples of EC-only users studied to date, the current study expands the knowledge base on EC use and health among young people by examining how the health profiles of youth that report EC use compare to those of youth who (a) use cigarettes only, (b) use both cigarettes and ECs (dual users), or (c) use neither type of product. Specifically, we compare these groups on both protective health behaviors (physical activity, limited sedentary behavior, sleep duration and quality, limited consumption of unhealthy foods/beverages) and subjective physical health. Further, we significantly extend the existing literature by investigating, among EC-only users, how their frequency of use is associated with these indicators of health status and health-related behaviors.

METHODS

Procedure

The parent study began in 2008 with two cohorts of youth in 6th and 7th grade at Wave 1. The current study is based on Wave 7 data. Participants were part of an evaluation of an AOD use prevention program, CHOICE, conducted in 16 middle schools in the greater Los Angeles area (see (D'Amico et al., 2012) for details). The CHOICE program was completed by Wave 2. As youth graduated from middle school to high school between Waves 5 and 6, they transitioned to over 200 high schools nationally and internationally. We fielded the full sample at every wave so that all participants had an opportunity to participate in each individual survey; the majority of youth (77%) completed 4 or more waves of the study (D'Amico et al., in press). The cohort was re-contacted and re-consented to complete a web-based survey (Wave 6) between May 2013 and April 2014 when participants were in 9th–11th grades. Of the 4,366 youth who were eligible (i.e., in 6th–7th grade at Wave 1, could be located, were re-consented), 2,653 (61%) completed the Wave 6 survey. At Wave 7 (one year later), we retained 80% of the same individuals who participated in Wave 6 (N=2,044), and enrolled an additional 444 youth who were part of the original cohort but did not participate in Wave 6. Drop-out across Waves 1–7 was not associated with demographics or risk behaviors (e.g., AOD use). Moreover, rates of AOD use in the sample are consistent with national norms. For example, MTF (Johnston et al., 2016) reports rates of past month marijuana (8th grade = 6.5%, 10th grade = 15%) and alcohol (8th grade = 9.7%, 10th grade = 22%) use that are quite similar to rates of past month marijuana (Wave 5 = 6.2%, Wave 7 = 17%) and alcohol (Wave 5 = 9.2%, Wave 7 = 22%) use among similarly aged youth in our sample. Items on ECs were added to the Wave 7 survey; thus, analyses are based on 2,488 youth who completed Wave 7 and had usable data. All study procedures were approved by the institution's Institutional Review Board.

Measures

E-Cigarette Use—Using an item modified from the MTF survey (Johnston et al., 2016), we asked: “During the past year, how many times have you used or tried an electronic or e-cigarette?” This item was rated on a 6-point scale (0=*None*, 1=*1 time*, 2=*2 times*, 3=*3 to 10 times*, 4=*11 to 20 times*, 5=*more than 20 times*).

Cigarettes and Smokeless Tobacco Use—Separate items from MTF (Johnston, et al., 2016) were used to assess frequency of cigarette and smokeless tobacco (e.g., snuff, chew) use in the past year; the Likert scale was the same as for EC use. Due to low reported use of smokeless tobacco and a skewed distribution, smokeless tobacco use was dichotomized (1=*any past year use* and 0=*no use*).

Health Status

Physical health: Physical health included 3 items: general health (0=*excellent* to 4=*poor*), physically able to do activities that one enjoys (0=*with no trouble* to 4=*not able to do*), and could participate in sports/activities similar to their peers (0=*with no trouble* to 4=*not able to do*) (Jackson and Schulenberg, 2013). Items were reverse scored and summed with higher scores indicating better health ($\alpha=0.69$).

Mental health: Individual items from the five item Mental Health Index (MHI-5) (Berwick et al., 1991) were used to assess the frequency of current (past month) symptoms of anxiety (e.g., “Been a very nervous person”) and depression (e.g., “Felt downhearted and blue”) on a scale from 0=*none of the time* to 6=*all of the time*.

Health Protective Behaviors

Physical Activity: Youth reported the number of days in the past week that they were *physically active* for a total of 60 minutes or more, using items from the California Healthy Kids Survey (WestEd Health and Human Development Program for the California Department of Education, 2015) and Youth Risk Behavior Surveillance Survey (Eaton et al., 2012).

Healthy Diet: Adolescents reported the number of times in the past 24 hours that they consumed fast food, fried food, and full-calorie sweetened soda drinks. Similar measures have been used to assess dietary behavior in other surveys of youth (Eaton et al., 2012; WestEd Health and Human Development Program for the California Department of Education, 2015). Individuals were categorized in the “healthy diet” (i.e., limited consumption of unhealthy foods/beverages) group if they consumed any combination of items less than 3 times in the past day.

Sleep: Sleep duration and quality were assessed as follows: average sleep time on weekdays (hours), average sleep time on weekends (hours), and average sleep quality (1=*very bad* to 4=*very good*) (Troxel et al., 2015).

Health Risk Behaviors

AOD Use: Frequency of alcohol use, heavy drinking, marijuana use, and the use of other drugs (inhalants, cocaine, heroin, hallucinogens, methamphetamine, prescription medications to get high, and over-the-counter medications to get high) were assessed using items from MTF (Johnston et al., 2016), which asked “During the past year, how many times/days have you used or tried [substance]?” Alcohol use was defined as “at least one drink of alcohol” and heavy alcohol use was defined as “5 or more drinks of alcohol in a row.” Items were rated on a scale from 0=*Never* to 5=*more than 20 times*. Given the skewed distribution of these variables, we derived dichotomous indicators of any alcohol use, heavy drinking, marijuana use, and other drug use (1=*any past year use* and 0=*no use*).

Sedentary Behavior: Sedentary behavior was assessed as the total number of hours per day (1) spent watching television; and (2) spent playing video games or using a computer (de la Haye et al., 2014) (0=*no hours/do not engage in these activities on school days* to 7=*5 or more hours*).

Sociodemographics—Youth provided their age, gender, race/ethnicity (Caucasian, Hispanic/Latino(a), African American, Asian/Pacific Islander, other), nuclear family structure (i.e., mother and father living in home), primary language spoken at home, and parents’ birth country. Socioeconomic status (SES) was assessed using mother’s educational attainment.

Data Analysis

First, we used ANOVA and bivariate logistic regression analyses to compare EC-only users to: 1) non-users (no EC or cigarette use); 2) cigarette-only users; and 3) dual users (both EC and cigarette use) on each of the health status, health behavior, and demographic variables outlined above. We then examined the association between each of the health status and health behavior variables and *frequency* of past year EC use among EC-only users via separate ordinary least squares (OLS) regression models. These models adjusted for smokeless tobacco use, sociodemographic factors (age, gender, race/ethnicity, mother's education, nuclear family status), and intervention group at Wave 1 (note: intervention effects were no longer significant after Wave 2). OLS regression also assessed the association between frequency of past year EC use and frequency of cigarette use among dual users, controlling for smokeless tobacco use, sociodemographic factors, and intervention group at Wave 1.

RESULTS

Sample

Overall, participants averaged 17 years in age ($SD = 0.67$), 46% were male, and 47% were Hispanic. The majority (85%) reported that their mother had completed at least high school education, and 58% reported living with their nuclear family. In the full sample, 21% of individuals endorsed using ECs and 12% endorsed using cigarettes in the past year. Of the full sample, 13% were EC-only users, 4% were cigarette-only users, and 8% were dual users. EC-only users were significantly younger than both dual users and cigarette-only users; were less likely to be male than dual users, but more likely to be male than cigarette-only users; and were more likely to have a mother born in the U.S. and to only speak English at home compared to non-users.

Frequency of Use among E-cigarette and Cigarette Users

Frequency of past year EC and cigarette use across EC-only users, cigarette-only users, and dual users is shown in Table 1. Groups varied in the frequency of product use: 16% of EC-only users reported using ECs over 20 times in the past year, whereas 22% of cigarette-only users endorsed smoking cigarettes over 20 times in the past year. By comparison, roughly a third of dual users consumed both products at high frequencies: 33% reported using ECs and 29% reported smoking cigarettes over 20 times in the past year. In bivariate chi-square analyses, dual users were significantly more likely than EC-only users to report using ECs over 20 times in the past year (vs. less than 20 times; $\chi^2_{(1)}=20.74$; $p < .0001$); dual users did not significantly differ from cigarette-only users on past-year frequency of cigarette use ($p = .24$). Among dual users, frequency of EC use was significantly positively correlated with frequency of cigarette use ($B=0.30$ [95% CI 0.23 – 0.36], $p < .0001$), controlling for demographic characteristics and smokeless tobacco use.

Health Profile Differences across Non-Users, E-cigarette Users, and Cigarette Users

Table 2 shows descriptive statistics by group, and bivariate comparisons of EC-only users with non-users, cigarette-only users, and dual users on each health status and health behavior

variable. EC-only users differed from the other groups mainly on AOD use. EC-only users had significantly higher rates of each type of AOD use compared to non-users (i.e., those who did not use ECs or cigarettes), but reported significantly lower rates of each type of AOD use compared to dual users. These differences included past year use of any alcohol (non-user: 26%; EC-only: 80%; dual user: 95%), heavy drinking (13%; 55%; 84%), marijuana use (13%; 55%; 91%), other drug use (2%; 15%; 41%), and smokeless tobacco (<1%; 5%; 13%). We found significant differences in past year AOD use between EC-only and cigarette-only users for marijuana (EC-only: 55%, cigarette-only: 64%) and other drug use (EC-only: 15%, cigarette-only: 31%). For health status and behaviors, EC-only users tended to have shorter total sleep time on weekends compared to non-users, and lower anxiety and depressive symptoms compared to dual users and cigarette-only smokers. There were no differences on overall physical health, physical activity, sedentary behavior, or diet. Overall, compared to the groups that included cigarette smokers, EC-only users were less likely to engage in other forms of AOD use and showed some evidence of better mental health; however, there was little evidence that they were “healthier” than cigarette smokers with regard to physical health status and other protective health behaviors.

Health Status and Behaviors and Frequency of E-Cigarette Use among EC-Only Users

Among EC-only users, adjusting for participant demographics and smokeless tobacco use, past year AOD use (alcohol, heavy drinking, marijuana, other drugs) was associated with higher frequency of EC use (Table 3). Healthy diet (i.e., lower intake of unhealthy foods/beverages) was also significantly associated with *lower* frequency of EC use. No significant associations were observed between frequency of EC use and overall physical health, depression or anxiety symptoms, physical activity, sedentary behavior, weekday sleep time, or sleep quality.

DISCUSSION

The current study adds to the literature in this area by assessing associations between EC use, health status, and risky and protective health behaviors among adolescents utilizing one of the largest samples of EC-only users studied to date. Although EC-only users reported fewer anxiety and depressive symptoms and less AOD use than cigarette smokers, they *did not* report better physical health or greater engagement in protective health behaviors compared to dual users or cigarette-only smokers. We also found for protective health behaviors that EC-only users reported shorter weekend sleep times than non-users. Among EC-only users, AOD use and unhealthy diet were associated with more frequent EC consumption, associations that are missed by dichotomizing EC use, as many previous studies have done.

Results from the user profile analyses are consistent with previous studies (e.g., Wills et al., 2015; Leventhal et al., 2016) that have examined EC and risky health behaviors, which suggest that EC-only users represent an “intermediate risk” group of adolescents in terms of their engagement in risk behaviors. For example, EC-only users showed significantly *higher* rates of AOD use than non-users, but demonstrated significantly *lower* rates of AOD use compared to groups that included cigarette smokers. Thus, EC-only use among youth may

be associated with less engagement in risky health behaviors, and potentially lower risk of negative health outcomes, compared to cigarette smoking. However, EC-only users in this sample were also significantly younger than their cigarette-smoking peers. Thus, it is possible that some of these individuals may “catch up” to their older peers and increase their engagement in other risky behaviors, including smoking over time. They also may have increased health problems in later adolescence. Longitudinal studies examining patterns of health behaviors among EC-only users over time are needed to better understand the association between EC-only use and adolescent health.

Relative to other user groups, dual EC and cigarette users showed remarkably high rates of AOD use (e.g., over 90% of dual users endorsed past year marijuana use compared to 64% of cigarette-only smokers and 55% of EC-only users). In addition, dual users reported more frequent EC consumption and were more likely to use smokeless tobacco products compared to EC-only users, which may indicate higher total nicotine exposure in dual users.

Frequency of EC use and cigarette use were also positively correlated among dual users, suggesting that more frequent use of ECs did not offset the frequency of cigarette use in this group. Although dual users and cigarette-only users in this sample did not show statistically significant differences with respect to frequency of cigarette use (29% of dual users reported using cigarettes more than 20 times in the past year, compared to 22% of cigarette-only users), other studies suggest that adolescents who use both ECs and cigarettes are more likely to be daily (vs. nondaily) smokers compared to cigarette-only users (Goniewicz et al., 2015). Thus, unlike adult smokers, who use may *reduce* their cigarette consumption through dual use of ECs (Adriaens et al., 2014; Caponnetto et al., 2013), adolescent dual users may consume both products *more frequently*, perhaps because their engagement in other risky behaviors affords them greater access to both products (Hughes et al., 2014). This may increase risk for nicotine dependence and its myriad negative consequences among dual users. Moreover, greater exposure to nicotine may produce changes in the developing brain and sensitize users to the effects of other drugs (Yuan et al., 2015), which could compound risk for AOD problems in this group. Of note, this is consistent with recent findings from Leventhal et al. (2016), which showed that dual users had higher rates of AOD use than either cigarette-only or EC-only users. As such, dual use of ECs and cigarettes among adolescents may be associated with particularly high risk of poor health outcomes. This highlights the importance of assessing for both EC and cigarette use among adolescents, and suggests that targeted efforts to prevent EC-only users from transitioning to dual cigarette use may be helpful in reducing the potential negative public health impact of youth EC use.

Although EC-only users *as a group* showed more favorable health behavior profiles in some respects compared to their cigarette-smoking peers, they are not a homogenous group. Examination of frequency of EC use indicated that *more frequent* past-year EC consumption was associated with greater involvement in other risk behaviors and an unhealthy lifestyle. In addition, more frequent exposure to nicotine may place these individuals at greater risk for nicotine dependence, and could increase their likelihood of progressing to cigarette use in the future (Wills et al., 2016). Efforts to specifically address EC use and other risky health behaviors (e.g., tobacco use, AOD use and unhealthy diet) *among EC-only users* may be helpful in preventing their progression to riskier health behaviors, including cigarette smoking. Of note, the perception of EC use as a less-stigmatized “lower risk” behavior

(Ambrose, et al., 2014; Amrock, et al., 2015; Barrington-Trimis, et al., 2015) may be beneficial for efforts address other health risk behaviors among this group. Past work suggests that teens are less likely to report highly stigmatized (vs. less stigmatized) health behaviors to providers (Brenner et al., 2003). Given the perception of ECs as more socially acceptable than cigarettes (Barrington-Trimis et al., 2015), youth may be more inclined to report EC use (vs. cigarette smoking) to clinicians, which could identify more “at risk” individuals who could benefit from targeted screening and intervention. More research on adolescent disclosure of EC use to clinicians is needed to assess its utility as a screening metric for other risk behaviors.

The current study is limited by self-report data. However, study procedures (e.g., discussing confidentiality) were undertaken to facilitate accurate reporting, and AOD and tobacco use in this sample is similar to national samples (D’Amico & McCarthy, 2006; Dennis et al., 2002). Also, as data were cross-sectional, we were unable to examine associations between EC use and health status and behaviors over time. In addition, we did not assess reasons for EC use; thus, it is unknown whether EC-only users differed from dual users with respect to health-related motives for EC use (e.g., use of ECs because they are perceived to be less harmful to health than cigarettes); similarly, we cannot rule out the possibility that dual cigarette and EC users may have been heavy smokers who initiated EC use in an effort to quit or reduce their smoking. Furthermore, it is unclear how timing of EC use in the past year was associated with more proximal reports of health status or participation in other health behaviors at the time of the survey.

CONCLUSIONS

Though perceived as a reduced harm product, EC use among adolescents is not necessarily associated with better physical health status or greater engagement in protective health behaviors compared to cigarette use. Among EC-only users, more frequent EC consumption was correlated with AOD use and unhealthy diet, suggesting that heavier EC use may be associated with higher engagement in risky health behaviors. Findings also emphasize that dual EC and cigarette users may be at particularly high risk of negative health outcomes, due to their high rates of AOD use. This highlights the importance of screening for both cigarette and EC use in clinical settings. Interventions that specifically target EC users before youth transition to riskier health behaviors, including cigarette smoking, may be instrumental in mitigating the potential negative health impacts of EC use during adolescence.

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Table 1

Frequency distribution of past-year cigarette and e-cigarette use

	EC-Only Users (n=325)	Cigarette-Only Users (n=87)	Dual EC and Cigarette Users (n=207)	
	<i>EC Use</i>	<i>Cigarette Use</i>	<i>EC Use</i>	<i>Cigarette Use</i>
Number of Times Used in the Past Year	Percent of Users	Percent of Users	Percent of Users	Percent of Users
1 time	27.08	21.84	8.21	11.59
2 times	20.62	13.79	9.18	15.46
3–10 times	27.69	33.33	33.33	31.88
11–20 times	8.31	9.20	15.94	12.56
More than 20 times	16.31	21.84	33.33	28.50

Table 2

Characteristics of non-users, e-cigarette users, cigarette users, and dual users.

					Comparison to EC Only Users ^I			
	Non-User (N=1,868)	EC-Only User (n=325)	Cigarette-Only User (n=87)	Dual User (n=207)	v. Non-Users	v. Cig Only Users	v. Dual Users	
	M (SD)/%	M (SD)/%	Mean (SD)/%	Mean (SD)/%	p	p	p	
Health Status								
Overall Physical Health	10.01 (2.04)	9.91 (2.09)	9.52 (2.08)	9.71 (2.20)	0.39	0.12	0.27	
Anxiety Symptoms	2.83 (1.47)	2.74 (1.38)	3.16 (1.69)	3.00 (1.51)	0.06	0.05	<0.01	
Depressive Symptoms	2.69 (1.43)	2.85 (1.40)	3.19 (1.54)	3.25 (1.43)	0.29	0.02	<0.05	
Health Behaviors								
Physically Active	4.69 (2.19)	4.57 (2.26)	4.36 (2.19)	4.47 (2.24)	0.37	0.42	0.62	
Sedentary Behavior	17.87 (11.99)	18.19 (12.77)	18.14 (13.03)	17.37 (11.70)	0.66	0.97	0.44	
Limited Consumption of Unhealthy Food/ Drink (Yes)	79.01%	76.31%	78.16%	78.74%	0.55	0.98	0.79	
Sleep Time Weekend (hours)	9.17 (1.62)	8.90 (1.48)	8.77 (1.75)	8.84 (1.85)	<0.01	0.52	0.69	
Sleep Time Weekday (hours)	7.43 (1.40)	7.39 (1.34)	7.20 (1.63)	7.20 (1.42)	0.60	0.27	0.15	
Sleep Quality	2.95 (0.79)	2.89 (0.77)	2.72 (0.83)	2.78 (0.78)	0.15	0.09	0.14	
AOD Use								
Alcohol Use (Yes)	26.14%	80.31%	85.06%	95.12%	<0.0001	0.05	<0.0001	
Heavy Drinking (Yes)	12.58%	54.94%	64.37%	84.46%	<0.0001	0.01	<0.0001	
Marijuana Use (Yes)	12.58%	54.77%	64.37%	90.78%	<0.0001	<0.0001	<0.0001	
Other Drug Use ^a (Yes)	1.82%	15.38%	31.03%	40.58%	<0.0001	<0.0001	<0.0001	
Tobacco Use								
Frequency of Past Year Cigarette Use	0	0	2.95 (1.41)	3.31 (1.34)	–	–	–	
Past Year Smokeless Tobacco Use (Yes)	0.43%	4.92%	8.05%	12.56%	<0.0001	0.02	<0.0001	
Socio-demographics								
Age	17.30 (0.67)	17.27 (0.71)	17.53 (0.64)	17.42 (0.62)	0.51	<0.01	0.01	
Sex (Male)	44.22%	49.85%	31.03%	59.42%	0.45	0.001	<0.0001	
Race								

					Comparison to EC Only Users ^I			
	Non-User (N=1,868)	EC-Only User (n=325)	Cigarette-Only User (n=87)	Dual User (n=207)	v _i Non-Users	v _i Cig Only Users	v _i Dual Users	
	M (SD)/%	M (SD)/%	Mean (SD)/%	Mean (SD)/%	p	p	p	
Asian	22.43%	16.92%	9.20%	13.04%	<0.0001	0.03	0.77	
Hispanic	46.47%	44.92%	56.32%	39.61%	0.85	0.68	0.27	
White	17.88%	25.54%	19.54%	32.37%	0.16	0.33	0.19	
Other	13.22%	12.62%	14.94%	14.98%	ref	ref	ref	
Mother's Education								
<High School	14.72%	13.92%	20.99%	12.44%	0.89	<0.05	0.11	
High School	18.52%	15.53%	18.52%	12.94%	0.17	0.28	0.08	
> High School	66.76%	70.55%	60.49%	74.63%	ref	ref	ref	
Live with Nuclear Family (Yes)	60.65%	58.33%	45.98%	49.76%	<0.0001	0.06	0.19	
Mother Born in US (Yes)	41.05%	48.92%	48.28%	56.04%	<0.0001	0.95	0.01	
Father Born in US (Yes)	42.26%	48.77%	43.68%	55.83%	<0.01	0.35	<0.01	
Only Speak English at Home (Yes)	42.96%	49.69%	44.83%	56.52%	<0.01	0.38	<0.01	

Note.

^aIncludes prescription drug misuse, inhalant use, or other illicit drug use.

^JComparison p-values are from separate bivariate ANOVA (continuous outcomes) and logistic regression (categorical outcomes) analyses examining user group as a predictor of each health status/behavior and demographic variable. Frequency of Past-Year Cigarette use scaled 0 to 7. AOD=Alcohol and Other Drugs. Overall Physical Health scaled 0 to 12. Anxiety Symptoms scaled 0 to 6. Depressive Symptoms scaled 0 to 6. Physically Active scaled 0 to 7. Sedentary Behavior scaled 0 to 14. Sleep Quality scaled 1 to 4.

Table 3

Associations between health status and behaviors and frequency of past-year e-cigarette use among exclusive e-cigarette users

	Outcome: Frequency of Past Year EC Use			
Predictor	Estimate	95% Confidence Limits		<i>p</i>
Health Status				
Overall Physical Health	−0.03	−0.11	0.04	0.42
Anxiety Symptoms	0.02	−0.10	0.14	0.70
Depressive Symptoms	−0.03	−0.14	0.08	0.60
Health Behaviors				
Physically Active	0.01	−0.06	0.08	0.77
Sedentary Behavior	0.00	−0.01	0.02	0.48
Limited Consumption of Unhealthy Food/Drink (Yes/No)	−0.77	−1.13	−0.41	<0.0001
Sleep Quality	0.09	−0.13	0.30	0.43
Sleep Time Weekday (hours)	−0.07	−0.20	0.05	0.24
Sleep Time Weekend (hours)	−0.07	−0.18	0.04	0.20
AOD Use				
Alcohol Use (Yes/No)	0.67	0.26	1.08	<0.001
Heavy Drinking (Yes/No)	0.71	0.40	1.02	<0.0001
Marijuana Use (Yes/No)	0.58	0.26	0.89	<0.0001
Other Drug Use (Yes/No) ^a	0.92	0.49	1.35	<0.0001

Note. Estimates are from separate OLS regression models. Models controlled for smokeless tobacco use (yes/no), age, gender, ethnicity, mother's education, nuclear family status, and intervention group (Wave 1).

^aOther drug use includes prescription drug misuse, inhalant use, or other illicit drug use. Overall Physical Health scaled 0 to 12. Anxiety Symptoms scaled 0 to 6. Depressive Symptoms scaled 0 to 6. Physically Active scaled 0 to 7. Sedentary Behavior scaled 0 to 14. Sleep Quality scaled 1 to 4.