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Psychiatric comorbidity in adolescent electronic and conventional cigarette use

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ABSTRACT

The popularity of electronic (e−) cigarettes has greatly increased recently, particularly in adolescents. However, the extent of psychiatric comorbidity with adolescent e-cigarette use and dual use of conventional (combustible) and e-cigarettes is unknown. This study characterized psychiatric comorbidity in adolescent conventional and e-cigarette use. Ninth grade students attending high schools in Los Angeles, CA (*M* age = 14) completed self-report measures of conventional/e-cigarette use, emotional disorders, substance use/problems, and transdiagnostic psychiatric phenotypes consistent with the NIMH-Research Domain Criteria Initiative. Outcomes were compared by lifetime use of: (1) neither conventional nor e-cigarettes (non-use; N = 2557, 77.3%); (2) e-cigarettes only (N = 412, 12.4%); (3) conventional cigarettes only (N = 152, 4.6%); and (4) conventional and e-cigarettes (dual use; N = 189, 5.6%). In comparison to adolescents who used conventional cigarettes only, e-cigarette only users reported lower levels of internalizing syndromes (depression, generalized anxiety, panic, social phobia, and obsessive-compulsive disorder) and transdiagnostic phenotypes (i.e., distress intolerance, anxiety sensitivity, rash action during negative affect). Depression, panic disorder, and anhedonia were higher in e-cigarette only vs. non-users. For several externalizing outcomes (mania, rash action during positive affect, alcohol drug use/abuse) and anhedonia, an ordered pattern was observed, whereby comorbidity was lowest in non-users, moderate in single product users (conventional or e-cigarette), and highest in dual users. These findings: (1) raise question of whether emotionally-healthier ('lower-risk') adolescents who are not interested in conventional cigarettes are being attracted to e-cigarettes; (2) indicate that research, intervention, and policy dedicated to adolescent tobacco-psychiatric comorbidity should distinguish conventional cigarette, e-cigarette, and dual use.

1. Introduction

Mid-adolescence is a vulnerable developmental period for cigarette smoking uptake, the onset of mental health conditions, and the emergence of comorbid tobacco use and mental health problems (Upadhyaya et al., 2002). The over-representation of smoking among adolescents with mental health problems generalizes across various conditions (e.g., depressive, mania, anxiety, alcohol/drug use disorders), remains robust after controlling for confounders, and is mediated by theoretically-relevant factors suggesting a causal relation (e.g., beliefs that smoking has mood-modulating effects) (Audrain-McGovern et al., 2012; Upadhyaya et al., 2002). The rapid emergence and appeal of novel tobacco and nicotine products such as electronic (e−) cigarettes raises the question as to whether the same adolescent subgroup with mental health problems is at risk for using these products (Cummins et al., 2014). This is important to address because this population may be particularly vulnerable to nicotine addiction, given that neural plasticity during adolescence and neuropathology in psychiatric conditions can enhance the brain's sensitivity to nicotine (Balfour

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and Ridley, 2000; Counotte et al., 2011; Sinha, 2008).

E-cigarettes—electronic devices that deliver inhaled nicotine and emulate the sensorimotor properties of conventional (combustible) cigarettes—are gaining popularity among adolescents. According to 2014 estimates, past 30 day use of e-cigarettes is more common than conventional cigarettes among U.S. 8th- (9% vs. 4%) and 10th- (16% vs. 7%) graders, and many adolescent e-cigarette users have never tried conventional cigarettes (Johnston et al., 2015). E-cigarettes may be an attractive alternative to conventional cigarettes among youth because of beliefs that they are less harmful, addictive, malodorous, and costly than conventional cigarettes (Peters et al., 2013). Furthermore, e-cigarettes come in flavors appealing to youth and may be easier to obtain than conventional cigarettes because of inconsistent enforcement of restrictions against sales to minors (Collaco et al., 2015). Such factors may facilitate e-cigarette initiation in adolescents who would not otherwise smoke conventional cigarettes and may perhaps have fewer risk factors for smoking (Wills et al., 2015)—including mental health problems.

Dual use of conventional and e-cigarettes is also common in adolescents (Johnston et al., 2015; Wills et al., 2015), raising the possibility that some adolescents may use e-cigarettes to substitute for conventional cigarettes in situations where smoking is restricted. Indeed, school bathrooms and staircases are among the most common places adolescents report using e-cigarettes (Peters et al., 2013). Given that adolescents with (vs. without) mental health symptoms are more prone to nicotine dependence (Upadhyaya et al., 2002), these populations could be more likely to initiate use of e-cigarettes to bridge situations when they are not able to smoke, which ultimately could perpetuate the over-representation of smoking among individuals with mental health problems.

While research has yet to characterize the psychiatric comorbidity with patterns of conventional and e-cigarette use in adolescents, a recent study of Hawaiian adolescents found that alcohol/marijuana use and other psychosocial risk factors (e.g., sensation seeking, rebelliousness, emotional/behavioral dysregulation) were highest in dual users, moderate in e-cigarette only users, and lowest in non-users (Wills et al., 2015). Most pairwise comparisons involving conventional cigarette only users were not significant in that study, perhaps limited by reduced statistical power due to the smaller size of this group (N = 53) (Wills et al., 2015). Given these findings, stratification of psychiatric comorbidity across dual use, single-product use, and non-use in adolescents is plausible.

The current study characterized the mental health of adolescents who reported ever using e-cigarettes, conventional cigarettes, both, or neither. To provide a wide-ranging picture of psychiatric comorbidity, traditional syndrome-based indices of various depressive, manic, anxiety, and substance use disorders were administered. Consistent with NIMH's Research Domain Criteria Initiative (Insel et al., 2010), we also assessed several trans-diagnostic phenotypes implicated in multiple internalizing and externalizing psychopathologies and conventional cigarette use (e.g., impulsivity, anhedonia, distress tolerance; Leventhal and Zvolensky, 2015b). Up to this point, data on the psychiatric comorbidity associated with e-cigarette and dual use is virtually absent, leaving unclear as to how the mental health of these two groups compare to conventional cigarette users and non-users. Given that conventional cigarettes and e-cigarettes have both similarities (e.g., the experience of inhaling aerosol/smoke, nicotine intake) and differences (e.g., e-cigarettes are perceived as less harmful than conventional cigarettes; Ambrose et al., 2014), whether the patterns of psychiatric comorbidity are similar or different between e-cigarette only users and conventional cigarette users is unclear. As the first study to comprehensively characterize psychiatric comorbidity in adolescent e-cigarette and dual use, this study may yield data that is important to tobacco policy by identifying adolescent populations that are psychiatrically vulnerable and potentially at risk for use of traditional and emerging tobacco products. Such data could highlight the need to protect psychiatrically vulnerable adolescents from tobacco product use take via targeted tobacco product regulation and behavioral health prevention programming for this populations.

2. Methods

2.1. Participants and procedure

This report is based on a cross-sectional survey of substance use and mental health among 9th grade students enrolled in ten public high schools surrounding Los Angeles, CA, USA. The schools were recruited based on their adequate representation of diverse demographic characteristics. The percentage of students eligible for free lunch within each school (i.e., student's parental income $\leq$ 185% of the national poverty level) on average across the ten schools was 31.1% (*SD* = 19.7, range: 8.0%–62.4%). Students not in special education (e.g., severe learning disabilities) or English as a Second Language programs were eligible (N = 4100). Of the students who assented to participate (N = 3874; 94.5%), 3383 (82.5%) provided active parental consent and enrolled in the study. In-classroom paper-and-pencil surveys were administered across two 60-min data collections during the fall of 2013, conducted less than two weeks apart. Some students did not complete all questionnaires within the time allotted or were absent for data collections (n = 73), leaving a final sample of 3310. The University of Southern California Institutional Review Board approved the protocol.

2.2. Measures

Each study measure described below has shown good psychometric properties in previous adolescent samples (Audrain-McGovern et al., 2004; Bastiani et al., 2013; Eaton et al., 2010; Johnston et al., 2015; Leventhal et al., 2015, *in press*; Martino et al., 2000; Muris and Meesters, 2008; Pang et al., 2015, *in press*; Wagner et al., 2006; White and Labouvie, 1989). Unless otherwise specified, a mean score per item composite was calculated and composites were scored such that higher scores reflect higher psychopathology.

2.3. Electronic cigarettes, conventional cigarettes, and other substance use

Using items derived from the Youth Behavior Risk Surveillance (Eaton et al., 2010) and Monitoring the Future (Johnston et al., 2015) Surveys, lifetime use of e-cigarettes (described as "electronic cigarettes, personal vaporizers'; prevalence in this sample = 18.2%) and conventional cigarettes (10.3%) was measured, as well as these additional substances: marijuana (15.1%), one full drink of alcohol (26.5%), inhalants (6.0%), cocaine (1.0%), methamphetamines (0.71%), ecstasy (1.5%), LSD/mushrooms/psychedelics (1.7%), salvia (1.0%), heroin (0.5%), prescription pain killers (2.3%), tranquilizers or sedatives (3.3%), diet pills (1.7%), prescription stimulant pills (0.82%), and other drugs (1.2%). Only substances with lifetime prevalence greater than 5% were analyzed as individual outcomes.

2.4. Clinical syndromes

Revised Children's Anxiety and Depression Scale (RCADS) (Chorpita et al., 2000). The RCADS instructs respondents to report