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Early age of e-cigarette use onset mediates the association between impulsivity and e-cigarette use frequency in youth



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ABSTRACT

Background: Identifying risk factors for youth e-cigarette use is critical, given high rates of e-cigarette use and unknown health effects of long-term use. The current study examined whether an early age of onset of e-cigarette use mediates the association between impulsivity and e-cigarette frequency.

Methods: Cross-sectional survey data of e-cigarette users ($n = 927$) were collected from 8 high schools in southeastern Connecticut. The sample was 44.7% female (mean age 16.2 [SD = 1.2], mean age of e-cigarette onset 14.7 [SD = 1.6]). Two domains of self-reported, trait impulsivity were assessed using the abbreviated Barratt Impulsiveness Scale: impaired self-regulation (e.g., problems with concentration or self-control) and behavioral impulsivity (e.g., doing things without thinking). Mediation was tested with Mplus, and the model included school as a cluster variable and controlled for covariates related to e-cigarette use (i.e., sex, age, race, peer use, and other tobacco products ever tried).

Results: The hypothesized mediation was supported for both domains of impulsivity (impaired self-regulation $a_1b = 0.09$, $SE = 0.02$, 95%CI [0.03–0.14], $p = .002$; behavioral impulsivity $a_2b = 0.07$, $SE = 0.03$, 95%CI [0.01–0.14], $p = 0.03$). Specifically, impaired self-regulation ($B = -0.33$, $SE = 0.06$, $p < 0.001$) and behavioral impulsivity ($B = -0.26$, $SE = 0.11$, $p = 0.02$) predicted trying e-cigarettes at an earlier age, and earlier initiation was associated with more days of e-cigarette use in the past month ($B = -0.28$, $SE = 0.08$, $p < 0.001$).

Conclusions: Adolescents who endorse aspects of impulsivity, such as acting without thinking, are at greater risk for more frequent e-cigarette use through an early age of e-cigarette initiation. Further research is needed to evaluate these relationships longitudinally and to develop targeted e-cigarette interventions for impulsive youth.

1. Introduction

National data estimate 3 million youth currently use e-cigarettes, and e-cigarettes are now the most commonly used tobacco product among middle and high school students (Singh et al., 2016). Although limited evidence exists regarding the long-term effects of e-cigarette use, e-liquids contain chemicals that are toxic when heated and inhaled (Farsalinos et al., 2015; Kosmider et al., 2014, 2016) leading to concerns that e-cigarette use among youth could pose significant health consequences. Understanding risk factors for e-cigarette use during adolescence is critical for developing prevention and intervention efforts and is an important research priority according to the recent U.S. Surgeon General report (USDHHS, 2016).

1.1. Impulsivity and e-cigarette use

Prior research has identified impulsivity, or a predisposition toward rapid, unplanned action without regard for negative consequences (Barratt et al., 1975; Moeller et al., 2001), as a key risk factor for adolescent substance use (Fernie et al., 2013; Quinn and Harden, 2013; Stautz and Cooper, 2013), including heavier and more persistent tobacco use (Balevich et al., 2013; Chase and Hogarth, 2011; Fields et al., 2009; Primack et al., 2015; Reynolds et al., 2007) and poorer substance use treatment outcomes (Stevens et al., 2014). Although much of this research has examined conventional cigarette use, initial evidence indicates that impulsivity is also associated with e-cigarette use. For example, self-reported impulsivity is higher among youth who use e-cigarettes versus those who do not use e-cigarettes (Leventhal et al., 2015; Wills et al., 2015), and results from a recent, longitudinal cohort

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study indicate that impulsivity is associated with ever use of e-cigarettes two years later (Hanewinkel and Isensee, 2015). Although emerging evidence indicates a positive association between impulsivity and e-cigarette use, the potential reasons for this association remain unexplored. Identifying potential mediators of the relationship between impulsivity and e-cigarette use among youth could inform the development of targeted e-cigarette prevention and intervention efforts.

1.2. Impulsivity and early age of onset

Age of onset may be one factor that mediates the association between impulsivity and e-cigarette use. Evidence indicates impulsivity is associated with an earlier age of onset of a variety of substances, including combustible tobacco products (Dom et al., 2006; Elkins et al., 2007; Tarter et al., 2003; Verdejo-García et al., 2008), yet it is currently unknown whether a similar relationship exists between impulsivity and early age of onset of e-cigarette use. It is possible that e-cigarettes are especially attractive to impulsive adolescents due to novel product designs such as the ability to customize the device (Brown and Cheng, 2014) and the wide variety of unique e-liquid flavors (Zhu et al., 2014), or due to other factors such as targeted marketing (USDHHS, 2016), or social influences such as peer use (Barrington-Trimis et al., 2015; Wills et al., 2015).

1.3. Age of onset and E-cigarette use

The relationship between age of onset and future use has also not been examined for e-cigarettes, yet there is substantial evidence that youth who first try conventional cigarette smoking at an earlier age are at increased risk for heavier long-term use, greater nicotine dependence, and greater difficulty quitting smoking (Behrendt et al., 2009; Buchmann et al., 2013; Kendler et al., 2013; Lanza and Vasilenko, 2015; Nelson et al., 2015). The association between age of onset and future substance use is further supported by longitudinal evidence indicating that early adolescent substance use interventions that delay the age of onset of substance use are effective at reducing the frequency of future use and associated problems across a range of substances (e.g., alcohol, cigarettes, illicit drug use) (Spath et al., 2009). It is possible that these findings of a significant association between early age of onset and future substance use would also extend to e-cigarette use. Younger adolescents report that e-cigarettes are the first tobacco product that they tried (Krishnan-Sarin et al., 2015), and e-cigarette use is now more prevalent than conventional cigarette use among youth (Singh et al., 2016), suggesting that e-cigarettes may be an adolescent's first exposure to nicotine. Consequently, youth who try e-cigarettes at an earlier age may then be more vulnerable to heavier or more problematic future use given the sensitivity of the developing brain to the reinforcing properties of nicotine (Counotte et al., 2011; Dwyer et al., 2009; Yuan et al., 2015).

1.4. Hypothesized mediation

Based on these findings, it stands to reason that impulsivity may be associated with an earlier age of onset of e-cigarette use, which may be subsequently related to a greater frequency of e-cigarette use. However, no studies to date have tested this potential mediation. The current investigation aims to fill important gaps in the literature on e-cigarette use by examining associations among impulsivity, age of onset, and e-cigarette use frequency in a sample of high-school youth. We examined whether the relationship between impulsivity and frequency of e-cigarette use was mediated by an earlier age of onset of e-cigarette use, after controlling for covariates that have been shown to relate to e-cigarette use (i.e., sex, age, race, ever use of other tobacco products, and e-cigarette use with peers) (Barrington-Trimis et al., 2015; Krishnan-Sarin et al., 2015; Wills et al., 2015). Given prior substance use research, we expected that greater impulsivity would be associated with

an earlier age of onset, and that an earlier age of onset would predict more frequent e-cigarette use (more days of use in the past month). If impulsive adolescents are especially vulnerable to early e-cigarette initiation, and an early age of onset leads to heavier or more problematic e-cigarette use, then e-cigarette prevention efforts targeted to younger, impulsive youth may be imperatively needed.

2. Method

2.1. Survey procedures

Youth from 8 Southeastern Connecticut (CT) high schools were surveyed in Spring 2015 ($N = 7045$). To obtain a socio-demographically diverse sample, these schools were drawn from 7 of 9 district reference groups, which are groupings of schools based on family income levels, parental education and occupation levels, and use of non-English language in the home (Connecticut State Department of Education, 2006).

Study procedures were approved by the Yale University Institutional Review Board and school administrators. Parents were contacted in advance of the study and could indicate if they did not want their child to participate. Students were informed that their participation was voluntary and data were anonymous. Individual paper-and-pencil surveys were distributed school-wide (grades 9–12) during homeroom periods. The response rate based on attendance on the day of the survey administration was high (83.8%).

2.2. Sample

Two survey versions were randomly distributed throughout the 8 high schools. Current analyses focus on a subsample of youth ($n = 3474$) who received the survey version containing impulsivity items (measures described in detail below). Individuals receiving the impulsivity items did not differ from those receiving the other survey version in terms of sex, age, race, age of e-cigarette onset, ever use of e-cigarettes, or e-cigarette frequency in the past 30 days (p -values > 0.10).

2.3. Measures

2.3.1. Demographics

Participants reported demographic characteristics including age, sex (male/female), and race/ethnicity (select all that apply: White/Caucasian, Black/African American, Hispanic/Latino, Asian, American Indian or Alaskan Native, Native Hawaiian or other Pacific Islander, Middle Eastern, Other).

2.3.2. Impulsivity

Impulsivity was assessed with 8 items from the adolescent version of the Barratt Impulsiveness Scale-11 (Fossati et al., 2002; Patton et al., 1995). Prior research validated the psychometric properties of an abbreviated 8-item version (Morean et al., 2014) and confirmed that impulsivity assessed with this 8-item scale was related to tobacco use outcomes in adolescents (Morean et al., 2015). Item responses include 1 “rarely/never”, 2 “occasionally”, 3 “often”, 4 “almost always/always” and were averaged to create two, 4-item subscale scores representing: Impaired Self-Regulation (i.e., reverse-scored items: “I plan what I have to do”, “I am self-controlled”, “I concentrate easily”, and “I like to think carefully about things”) and Behavioral Impulsivity (i.e., “I do things without thinking”, “I do not pay attention”, “I say things without thinking”, and “I act on the spur of the moment”) (Morean et al., 2014, 2015). The two-factor latent structure from previous research was confirmed with the current scale in this sample based on indices of good fit to the data (model fit indices: CFI = 0.97, RMSEA = 0.06, SRMR = 0.04). The subscales also had good internal consistency (Cronbach's $\alpha = 0.80$ for both subscales).

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