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Parent, peer, and executive function relationships to early adolescent e-cigarette use: A substance use pathway?

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HIGHLIGHTS

- Lifetime e-cigarette use was almost twice the use of cigarettes in early adolescents.
- Executive function (EF) deficits related to e-cigarette, cigarette, and alcohol use.
- EF deficits were more important than demographic, peer, or parent influences on use.
- Suggests adolescent drug use prevention programs should include EF skills training.

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ABSTRACT

Introduction: Little is known about influences on e-cigarette use among early adolescents. This study examined influences that have been previously found to be associated with gateway drug use in adolescents: demographic (age, gender, ethnicity, free lunch), social contextual influences of parents and peers, and executive function deficits (EF).

Methods: A cross-sectional survey was administered to 410 7th grade students from two diverse school districts in Southern California (M age; = 12.4 years, 48.3% female, 34.9% on free lunch (low socioeconomic status), 45.1% White, 25.4% Hispanic/Latino, 14.9% Mixed/bi-racial.) Logistic regression analyses examined influences of demographic, parent e-cigarette ownership and peer use, and EF on lifetime e-cigarette, and gateway drug use (cigarette and/or alcohol use).

Results: Lifetime use prevalence was 11.0% for e-cigarettes, 6.8% for cigarettes, and 38.1% for alcohol. Free lunch and age were marginally related to e-cigarette use ($p < .10$). Parent e-cigarette ownership was associated with use of all substances, while peer use was associated with gateway drug use (p's < .05-.001). EF deficits were associated with use of all substances five times more likely than others to use e-cigarettes and over twice as likely to use gateway drugs.

Conclusions: E-cigarette and gateway drug use may have common underlying risk factors in early adolescence, including parent and peer modeling of substance use, as well as EF deficits. Future research is needed to examine longitudinal relationships of demographics, parent and peer modeling, and EF deficits to e-cigarette use in larger samples, trajectories of e-cigarette use compared to use of other substances, and the potential of EF skills training programs to prevent e-cigarette use.

1. Introduction

E-cigarettes allow users to inhale nicotine vapor, imitating the act of smoking a conventional cigarette (Centers for Disease Control and Prevention (CDC), 2013; McMillen, Maduka, & Winickoff, 2012). They include disposable e-cigarettes as well as refillable vape pens and tanks, and vary in flavor as well as substances used to produce the aerosol effect (CDC, 2013; Pepper & Brewer, 2013). Perhaps the most concerning aspect of e-cigarettes is their growing popularity and use among adolescents in the U.S. (Camenga et al., 2014; CDC, 2013), while cigarette use has declined (Eaton et al., 2012; Johnston, O'Malley, Bachman, & Schulenberg, 2013; U.S. Department of Health and Human Services, 2012). From 2011 to 2012, a national survey showed that the proportion of adolescents (grades 6–12) who had

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tried e-cigarettes increased from 3.1 to 6.8% (CDC, 2013). Studies of college students and young adults showed similar patterns (e.g., Choi & Forster, 2014; Sutfin, McCoy, Hoeppner, & Wolfson, 2013). Willingness to try e-cigarettes has also increased (Pepper et al., 2013).

Transition from elementary school to middle school (ages 11–12 or grades 6–7) may be a particularly vulnerable period for experimentation with e-cigarettes, and thus an important target for prevention efforts, for several reasons. First, experimentation with cigarettes and alcohol, often referred to as "gateway" drugs for their temporal relationship to use of other substances, increases rapidly during this period (Eaton et al., 2012; Pentz & Riggs, 2013; Riggs, Chou, Li, & Pentz, 2007), and at least 11% of early adolescents are willing to try electronic nicotine delivery systems (ENDS) such as e-cigarettes (Pepper et al., 2013). Second, early adolescence is a period of increased novelty seeking and changing social contexts of parent and peer influence, all of which are associated with increased experimentation with substances (Crawford, Pentz, Chou, Li, & Dwyer, 2003; Liao, Huang, Huh, Pentz, & Chou, 2013; Pentz & Riggs, 2013). Parents influence adolescent drug use through modeling their own use as well as having substances available in the home, e.g., alcohol (Liao et al., 2013). At the same time, in attempting to establish autonomy from parents, adolescents become more vulnerable to peer influences in the form of pressure to try something new as well as representing an increasing social norm for use (Lakon & Valente, 2012; Liao et al., 2013). Third, early adolescence is marked by rapid changes in the brain, with increased synaptic pruning and neuronal myelination which enable more efficient neural signaling and pre-frontal cortical control (Reyna & Farley, 2006). These changes aid the development of executive function (EF), neurocognitive processes which help to regulate emotions, inhibit impulsive behaviors such as experimentation with drugs, and promote positive decision-making, planning, and goal-directed behaviors as alternatives to drug use (Chambers, Taylor, & Potenza, 2003; Pentz & Riggs, 2013; Reyna & Farley, 2006). In early adolescents, problems or deficits in EF have been found to increase risk for cigarette and alcohol use, as well as other potentially addictive behaviors such as excessive videogaming and dysregulated eating (Pentz, Spruijt-Metz, Chou, & Riggs, 2011; Pentz & Riggs, 2013; Riggs, Spruijt-Metz, Chou, & Pentz, 2012). The obverse also appears to occur. Nicotine exposure during early adolescence may increase EF problems by interfering with the maturation of neural connectivity to inhibit impulsive limbic signals (Dwyer, McQuown, & Leslie, 2009; Kandel & Kandel, 2014). Couple this adverse effect with research showing that adolescents exhibit heightened sensitivity to the rewarding properties of nicotine compared to adults (Dwyer et al., 2009), and the need to evaluate the risk relationship between EF and e-cigarette use in early adolescents becomes even more compelling.

Early adolescence, then, may represent a particularly vulnerable period for e-cigarette use onset. However, relatively little is known about risk factors for e-cigarette use in this age group. Because conventional cigarette smoking is associated with e-cigarette use (Goniewicz & Zielinska-Danch, 2012; Grana, Popova & Ling, 2014; Lee, Grana, & Glantz, 2014), one way to improve our understanding of predictors of e-cigarette use in early adolescents is to examine risk factors that have been consistently found for cigarette use as a gateway drug in this age group. These include demographic characteristics, social contextual variables representing parent and peer influences, and EF deficits.

Among *demographic characteristics*, being older, female, Hispanic, and low socioeconomic status have been associated with early cigarette use (Chen & Jacobson, 2012; U.S. Department of Health and Human Services, 2012). Being older, male, and low socioeconomic status have been related to greater awareness of and willingness to try e-cigarettes (Cho, Shin, & Moon, 2011; Choi & Forster, 2014; Dutra & Glantz, 2014; Goniewicz & Zielinska-Danch, 2012; Grana, Popova, et al., 2014; Kinnunen et al., 2014; Lee et al., 2014). Being male, non-Hispanic White, and report of peer influence have been related to lifetime e-cigarette use (Cho et al., 2011; Dutra & Glantz, 2014). E-cigarette studies have been limited either by low proportions of adolescents who have actually tried e-cigarettes, or by evaluation of single demographic characteristics for their relationship to e-cigarette use.

Among *social contextual variables*, both parents and peers have been shown to influence early adolescent cigarette use, as well as alcohol use (Henry, Kobus, & Schoeny, 2011; Lakon & Valente, 2012; Liao et al., 2013; Pentz & Riggs, 2013). While parent influence encompasses many domains, including lack of rules or communication about drug use and genetic risk, one of the strongest is parent modeling of drug use behavior, either directly or inferred through having substances available in the home (Pentz & Riggs, 2013). Similarly, peer influence encompasses several domains, including actual peer use as a modeling influence, perceived peer social norms for use, and peer pressure to try substances (Liao et al., 2013). Although most research has used self-report surveys to measure estimated peer use or norms, one of the most direct ways to measure peer influence is through social network survey methods, which capture actual peer use as measured by peers themselves (Valente, 2010). Neither parent nor peer influences have been measured for their relationship to adolescent e-cigarette use.

In addition to specific demographic characteristics, parent, and peer influences, *executive function* (*EF*) deficits have also been found to predict cigarette and alcohol use in early adolescents (Pentz & Riggs, 2013; Pentz et al., 2011; Riggs et al., 2012). In contrast, training early adolescents in EF skills has shown longitudinal effects on preventing cigarette and alcohol use and on reducing externalizing (impulsive) behavior as a mediator of health risk behavior (Pentz & Riggs, 2013). EF is typically measured in either a controlled setting with an experimenter structuring a set of tasks using immediate task performance as an indicator of EF, or as a rating of competence in everyday problem-solving situations (McAuley, Chen, Goos, Schachar, & Crosbie, 2010; Toplak, West, & Stanovich, 2013).

This study examined the simultaneous influences of variables that have been shown to predict gateway drug (cigarette and/or alcohol) use in previous studies, but which have not been systematically evaluated as risk factors for e-cigarette use (Chapman & Wu, 2014). The influences included demographic characteristics, parent and peer modeling, and EF. To address ecological validity, the study included social network assessment and a rating of EF in everyday situations. The study was conducted on an ethnically diverse sample of 7th grade students as part of a larger study on EF skills training for prevention of multiple health risk behaviors.

2. Methods

2.1. Background and study design

This study, conducted in 2013, was part of a large randomized controlled trial (RCT) of child obesity, tobacco and alcohol use prevention, Pathways to Health (Pentz & Riggs, 2013; Sakuma, Riggs, & Pentz, 2012). Participants were drawn from schools that participated in a cross-sectional pilot study for this project, but did not participate in intervention or the RCT.

2.2. Participants

Participants were 7th grade students attending two large, ethnically diverse public middle schools in two different counties in Southern California. All 7th grade students in the schools were invited to participate if they provided written parental consent and student assent. No student incentives were provided. All procedures were approved by the University of Southern California IRB.

2.3. Procedure

Research staff explained the survey and answered students' questions. They defined e-cigarette products as including disposable and rechargeable e-cigarettes, vape pens, and tanks, which can vary in flavor,