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Age-varying associations between substance use behaviors and depressive symptoms during adolescence and young adulthood

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ABSTRACT

Background: Substance use and depression often co-occur, complicating treatment of both substance use and depression. Despite research documenting age-related trends in both substance use and depression, little research has examined how the associations between substance use behaviors and depression changes across the lifespan.
Methods: This study examines how the associations between substance use behaviors (daily smoking, regular heavy episodic drinking (HED), and marijuana use) and depressive symptoms vary from adolescence into young adulthood (ages 12–31), and how these associations differ by gender. Using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), we implemented time-varying effect models (TVEM), an analytic approach that estimates how the associations between predictors (e.g., substance use measures) and an outcome (e.g., depressive symptoms) vary across age.
Results: Marijuana use and daily smoking were significantly associated with depressive symptoms at most ages from 12 to 31. Regular HED was significantly associated with depressive symptoms during adolescence only. In bivariate analyses, the association with depressive symptoms for each substance use behavior was significantly stronger for females at certain ages; when adjusting for concurrent substance use in a multivariate analysis, no gender differences were observed.
Conclusions: While the associations between depressive symptoms and both marijuana and daily smoking were relatively stable across ages 12–31, regular HED was only significantly associated with depressive symptoms during adolescence. Understanding age and gender trends in these associations can help tailor prevention efforts and joint treatment methods in order to maximize public health benefit.

1. Introduction

Substance use disorders and depression are highly correlated in the general population (Hasin and Kilcoynea, 2012; Regier et al., 1990). Population-based surveys estimate that the rate of lifetime major depressive disorder (MDD) among individuals with nicotine dependence is 17%, with alcohol dependence is 38%, and with other drug dependence is 49% (Conway et al., 2006; Grant et al., 2004). Conversely, among individuals with lifetime MDD, 30% have nicotine dependence, 21% have alcohol dependence, and 6% have other drug dependence (Hasin et al., 2005). The comorbidity with depression has been found to be robust across substances, with the link between smoking and depression being particularly well-documented (Dierker et al., 2015; Kassel et al., 2003). The smoking–depression association holds for various classifications of smokers (e.g., ever, regular, and heavy smokers; Husky et al., 2008; Payne et al., 2013) as well as various stages of the smoking trajectory (Audrain-McGovern et al., 2011; Dierker and Donny, 2008; McKenzie et al., 2010; Leventhal et al., 2012). Smokers experience more depressive symptoms, a higher prevalence of lifetime MDD, and more depressive episodes than non-smokers (Wiesbeck et al., 2008; Wilhelm et al., 2006; Ziedonis et al., 2008). Alcohol use has also been linked to depression. A recent study suggests a dose-response relationship between alcohol disorder severity and depression: incidence of depressive disorders was 4% in individuals who met none of the DSM-5 alcohol use disorder criteria and increased to 45% in individuals who met all ten criteria (Boschloo et al., 2012). Similarly, marijuana use has been shown to co-occur with depression. National epidemiologic data indicate 29% of those with lifetime marijuana abuse and 47% of those with marijuana

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dependence met lifetime criteria for MDD (Conway et al., 2006). Additionally, marijuana use, especially heavy use, has been shown to be associated with depression among adolescents in the general population (Fergusson et al., 2002; Patton et al., 2002; Rey et al., 2002).

Although the co-occurrence of substance use behaviors and depression is well-established, little research has investigated age trends in these associations. Rates of substance use and depression both show notable age trends and both peak in adolescence. It is plausible that the associations between substance use behaviors and depression are also stronger during adolescence, as the profound physiological and social developmental processes occurring during adolescence may heighten vulnerability. Substance use in early adolescence is less normative and typically occurs among youth who face a myriad of risk factors, including adverse early life events, lack of parental involvement, or family and peer substance use (Green et al., 2012); substance use becomes more normative with age (SAMHSA, 2014). Thus, age-varying associations between substance use and depression may reflect age-varying risk profiles of substance users due to changes in the meaning and context of substance use over time. Alternatively, stronger associations in adolescence may reflect the imbalance in arousal and regulation that characterizes the developing adolescent brain: pubertal maturation increases emotional arousal, sensation-seeking, and reward orientation, yet adolescents do not have fully formed executive functioning to help regulate and inhibit behavior (Crews et al., 2007; Guerri and Pascual, 2010; Steinberg, 2005). In the absence of well-developed executive functioning, adolescents may have fewer cognitive and emotional resources to cope with life stressors, so they may be more likely than individuals at other ages to engage in substance use to relieve depressive symptoms (e.g., self-medicate). Furthermore, social acceptance and peer norms are extremely salient during adolescence (Christie and Viner, 2005; Eisenberg et al., 2014); youth who use substances due to these external social motivations may experience greater cognitive dissonance and distress, potentially heightening their risk for depressive symptoms. Finally, neuroscience research has shown heavy substance use to be associated with decreased neural plasticity and structural abnormalities in the brain, which may result in both short- and long-term behavioral impairments. Specifically, youth with an alcohol use disorder show structural deficits in the hippocampus and prefrontal cortex compared to youth without an alcohol use disorder (De Bellis et al., 2000; Nagel et al., 2005; Medina et al., 2008). Given that these regions are central to emotion regulation, these deficits may heighten vulnerability for depression.

The few studies to date investigating age trends have yielded mixed findings. While studies among adults typically focus on clinical definitions of substance use disorders and MDD, studies of adolescents and young adults often define these constructs more broadly as substance use and depressive symptoms, as younger individuals may be in earlier stages of substance use and depression onset and not yet meet clinical definitions. Early studies found that substance use disorders were more strongly associated with depression for those over age 30 compared to those under age 30 (Grant, 1995), and that comorbid mental health problems and alcohol dependence were more common at older ages, whereas comorbidity with alcohol abuse was more common at younger ages (Grant and Harford, 1995). Fergusson et al. (2002) found that marijuana use is more strongly associated with suicidal ideation for adolescents compared to young adults, while Pedersen (2008) found that the association may be stronger for young adults. Poulin et al. (2005) found that the association between heavy episodic drinking (HED) and depression varied by age for females but not males. A recent study regarding nicotine dependence and depression found that this association was constant across adolescence and young adulthood (Dierker et al., 2015).

Furthermore, despite notable gender differences in the prevalence of alcohol and substance use disorders, which are more common among men (Conway et al., 2006), and depression, which is more common among women (Hasin et al., 2005), few studies have examined gender differences in the associations between substance use and depression. Existing studies that have stratified on gender provide some evidence that these associations are stronger among women. Specifically, Acierno et al. (2000) reported a significant association between heavy smoking and depressive disorder among female adolescents but not male adolescents. Tu et al. (2008) found that poor mental health was associated with marijuana use among adolescent females but not males; similarly, Patton et al. (2002) found that marijuana use was associated with depression both cross-sectionally and longitudinally among adolescent females but not males. Poulin et al. (2005) reported that alcohol use and smoking were associated with elevated depressive symptoms in adolescent females, but not males, whereas marijuana use was associated with depressive symptoms for both genders. In adults, the association between marijuana dependence and MDD was nearly twice as strong for women than men (Conway et al., 2006), and among those with lifetime alcohol dependence, women had nearly twice the rate of lifetime depression as men (Kessler et al., 1997). Potential mechanisms that may explain these gender differences include greater neurotoxicity of substances (particularly alcohol) in females due to smaller body size (Guerri and Pascual, 2010), differences in timing of brain development and effects of substances on the brain arising from hormonal differences (Medina et al., 2008), and differential salience of social support and peer norms by gender (Gutman and Eccles, 2007).

Despite previous studies examining the associations between substance use and depression, gaps in the literature persist. In particular, little is known about how the strength of the associations between substance use behaviors and depression change by age, as most studies of this topic examined only adolescents or only adults. This study was designed to elucidate how the associations between substance use behaviors (daily smoking, marijuana use, and HED) and depressive symptoms change from early adolescence into young adulthood (age 12–31), using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). We define substance use behaviors and depressive symptoms more broadly for two reasons: (1) to assess whether the associations previously observed between substance use disorders and MDD generalize to substance use and depressive symptoms and (2) to facilitate examination of these associations in younger individuals, who may be in earlier stages of substance use and depression onset. We implement time-varying effect modeling (TVEM), an analytic approach that estimates the associations between predictors (e.g., smoking, marijuana use, and HED) and an outcome (e.g., depressive symptoms) as functions of continuous age. In all analyses, we examine whether gender moderates these age-varying associations. Given the increasing recognition of substance use and depression comorbidity and interest in concurrent treatment, this study was designed to elucidate critical age windows in which these associations are strongest and concurrent treatment may be most beneficial.

2. Methods

2.1. Participants

This study uses public-use data from the National Longitudinal Study of Adolescent to Adult Health (Add Health; Harris et al., 2009). Add Health is a nationally representative, longitudinal study of adolescents that focused on how behaviors and social environments during adolescence are linked to adult outcomes (Harris,