Marital Status as a Partial Mediator of the Associations Between Young Adult Substance Use and Subsequent Substance Use Disorder: Application of Causal Inference Methods

BOHYUN JOY JANG, PH.D.,[a],* MEGAN S. SCHULER, PH.D.,[b] REBECCA J. EVANS-POLCE, PH.D.,[a] & MEGAN E. PATRICK, PH.D.[a]

[a]Institute for Social Research, University of Michigan, Ann Arbor, Michigan
[b]RAND Corporation, Boston, Massachusetts

ABSTRACT. **Objective:** Young adult substance use is linked with the risk of substance use disorders (SUDs) later in adulthood. Marriage may be part of this pathway because of both selection effects (early substance use reducing marriage) and socialization effects (marriage reducing later substance use and disorder). We examine whether marital status mediates the association between young adult substance use and subsequent SUDs, using causal mediation methods to strengthen inferences. **Method:** Using panel data from high school seniors in 1990–1998, we examined whether the effects of two exposures (level of alcohol/marijuana use at age 19/20) on the outcomes (alcohol use disorder [AUD]/marijuana use disorder [MUD], nondisordered use, or abstinence at age 35) were mediated by marital status at age 29/30. Propensity score weights adjusted for potential confounding regarding both the exposures and the mediator. **Results:** Moderate and heavy alcohol/marijuana use at age 19/20 were associated with higher odds of AUD/MUD and lower odds of abstinence, each relative to nondisordered use, at age 35. The association between heavy alcohol use at age 19/20 and subsequent AUD was partially mediated by being unmarried at age 29/30; the associations between moderate and heavy marijuana use at age 19/20 and subsequent marijuana abstinence were partially mediated by being unmarried at age 29/30. **Conclusions:** Both selection and socialization effects related to marriage explain the perpetuation of substance use behaviors across adulthood. Selection effects on marriage seem to occur at different thresholds for young adult alcohol and marijuana use. (*J. Stud. Alcohol Drugs, 79,* 567–577, 2018)

SUBSTANCE USE PEAKS during early young adulthood, after which most individuals mature out of substance use (Jackson & Sartor, 2016; Schulenberg et al., 2017). However, some remain at risk or progress to problematic use in adulthood (Chassin et al., 2004; Sher et al., 2011). In the United States in 2015, about 5% of adults age 26 years or older had an alcohol use disorder (AUD) and 1% had a marijuana use disorder (MUD) (Center for Behavioral Health Statistics and Quality, 2016). Because problematic substance use contributes to numerous public health burdens (e.g., MacDonald et al., 1999; Miller & Hendrie, 2008; Whiteford et al., 2013), understanding the mechanisms that contribute to reduction or continuation of substance use is a critical public health issue.

Adult social roles, like marriage, are associated with lower levels of concurrent and future substance use (Power et al., 1999; Staff et al., 2014). Substance users have lower rates of marriage (Brook et al., 1999; Green & Ensminger, 2006; Jang et al., 2018; Waldron et al., 2011), and the lower odds of substance use after marriage are attributable to preexisting differences between married and unmarried individuals (i.e., selection effect on marriage) (Dawson et al., 2013; Gotham et al., 1997; Labouvie, 1996; Miller-Tutzauer et al., 1991). The literature regarding selection effects, however, is mixed; some studies show no differences in alcohol use before marriage (Bogart et al., 2005; Curran et al., 1998; Lee et al., 2010b; Overbeek et al., 2003; Vergés et al., 2012) or even show the opposite effect of greater likelihood of being married among alcohol users (Bachman et al., 1997; Power et al., 1999). Another explanatory theory is that marriage exerts a socialization effect on individuals. That is, marriage is a life-changing transition that may be accompanied by modifications in values, expectations, and social network, resulting in changes in substance use (Lee et al., 2010b; Leonard & Mudar, 2000). Many studies support the socialization hypothesis, finding associations between marriage and subsequent reductions in substance use (Duncan et al., 2006; Gotham et al., 2003; Jackson et al., 2001; Lee & Sher, 2017; Staff et al., 2010; Yamaguchi & Kandel, 1985a, 1985b). There are a few notable studies that do not universally support marriage as a socialization effect (Overbeek et al., 2003; Vergés et al., 2012).

Studies examining various degrees of substance use have found that marriage is particularly important for severe users (Jackson et al., 2001; Lee et al., 2013, 2015). Greater declines in alcohol use were observed after marriage among severe alcohol users, whereas relatively light drinkers continued their lower-risk alcohol use during the transition to marriage (Jackson et al., 2001; Lee et al., 2013, 2015). Similarly, having alcohol problems more so than engaging in any alcohol use is associated with lower odds of marriage (e.g., Waldron et al., 2011). The extent to which selection and socialization related to marriage differ by level of marijuana use has not been empirically tested. Different mechanisms or thresholds may underlie the association between marriage and the continuation or desistance of substance use in young adulthood, highlighting the importance of differentiating moderate and heavy substance use when examining the mediating role of marriage.

Documenting whether marital status mediates the effects of earlier substance use on later substance use disorders (SUDs) is challenging because individuals cannot be randomly assigned to use substances or get married. Propensity score techniques are commonly used to reduce or eliminate confounding and to provide a robust estimation of "causal effects" in the absence of randomization (McCaffrey et al., 2013). Because mediation analyses inherently posit a chain of events linking the exposure to the mediator to the outcome, propensity score methods have been extended to mediation analyses to strengthen causal inference in this setting (Coffman & Zhong, 2012; Coffman et al., 2015; Imai et al., 2010; VanderWeele, 2015). Given the mixed findings on marriage selection and socialization effects in the extant literature, the present study used causal inference methods to examine potential mediating effects of marital status on the relationship between alcohol and marijuana use in young adulthood and subsequent alcohol and marijuana use and disorders. Given the prior findings on different associations between the level of substance use and the outcome, we considered three levels of alcohol and marijuana at age 19/20 (nonuse, moderate use, heavy use) and at age 35 (abstinence, nondisordered use, alcohol/marijuana use disorder). We used propensity score weighting to adjust for baseline differences between both young adults with varying levels of alcohol and marijuana use as well as baseline differences between those who are married and unmarried at age 29/30. Differentiating selection and socialization effects related to marriage and identifying thresholds of substance use associated with potential selection effects on marriage will provide greater insight into the relationship between substance use and marriage. We specifically hypothesized that marital status at age 29/30 would be a significant mediator of the associations between heavy alcohol and marijuana use at age 19/20 and subsequent alcohol and marijuana use disorders at age 35 and that this mediation would reflect both selection and socialization effects.

Method

Data

The Monitoring the Future study, started in 1975, includes annual surveys of nationally representative samples of high school seniors (modal age = 18 years). Each year, a subsample (oversampled for drug use) is selected for the longitudinal study; half are surveyed 1 year later (modal age = 19 years) and the other half 2 years later (modal age = 20 years). Individuals are subsequently followed up every 2 years until age 29/30, and every 5 years after that (i.e., at modal ages 18, 19/20, 21/22, 23/24, 25/26, 27/28, 29/30, and 35 years). The current analyses used longitudinal data from individuals who were high school seniors in 1990–1998 and who participated in the age 35 follow-up survey in 2007–2015 to minimize cohort variances in substance use and marriage. Weights were used to account for attrition at age 35 and the oversampling of substance users for follow-ups. Regarding our mediator (i.e., marital status at age 29/30), we restricted our comparison to individuals who were either married or never married at each wave between ages 21/22 and 29/30; those who were married at or before age 19/20 (5.6%) or who were separated/divorced or widowed between ages 18 and 29/30 (9.5%) were excluded from the analyses. In addition, respondents with missing data on substance use behaviors (ages 19/20 or 35) or on marital status (ages 21/22–29/30) were excluded from the analyses (15.4% and 11.7% for alcohol and marijuana use analyses, respectively). These criteria yielded 6,638 respondents for alcohol use analyses and 6,934 for marijuana use analyses.

Measures

Exposures: Alcohol/marijuana use at age 19/20. Alcohol use at age 19/20 was assessed with two items: the number of occasions of drinking any alcoholic beverages during the last 30 days and the number of occasions of heavy episodic drinking (HED), namely consuming five or more drinks in a row, during the past 2 weeks. Responses were trichotomized for the distinction between moderate and heavy users and for the parsimonious estimation of propensity scores: (1) no drinking in the past 30 days (nonuse) (62.1%), (2) drinking in the past 30 days with up to one occasion of HED in the past 2 weeks (≤1 HED) (12.7%), and (3) two or more occasions of HED in the past 2 weeks (≥2 HED) (25.2%). The ≥2 HED criterion has been used previously to identify frequent heavy drinkers in adolescence and young adulthood (e.g., Jang et al., 2017; Schulenberg et al., 1996).

Marijuana use at age 19/20 was measured by the frequency of marijuana use during the last 30 days (responses from 0 to 40+ occasions). Responses were also trichotomized into (1) no use in the past 30 days (nonuse) (80.7%), (2) one to two occasions of marijuana use in the past 30 days (≤2 MJ)

(6.9%), and (3) three or more occasions of marijuana use in the past 30 days (≥3 MJ) (12.4%).

Outcomes: AUD/MUD status at age 35. At age 35, respondents were asked about problems caused by their alcohol and marijuana use, separately, over the last 5 years, including failure to fulfill role obligations, continuous use despite hazards to physical health, continuous use despite recurrent or persistent social problems, needing more of the drug to get the same effect, withdrawal, desire to cut down or quit but could not, health issues, and inability to resist use. These measures are not a clinical diagnosis but are largely consistent with items of AUD and MUD used in other surveys (e.g., Harford & Muthén, 2001; Muthén, 1996; Muthén et al., 1993; Nelson et al., 1998) and are comparable with the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (American Psychiatric Association, 2013). Responses for each substance were trichotomized into (1) abstinence (no use over the last 5 years) (10.0% for alcohol, 76.9% for marijuana), (2) nondisordered use (used over the last 5 years and reported 0–1 problem) (60.0% for alcohol, 17.2% for marijuana), and (3) AUD/MUD (used over the last 5 years and reported ≥2 problems) (30.0% for alcohol, 5.9% for marijuana) (Patrick et al., 2011, 2016; Schulenberg et al., 2015).

Mediator: Marital status at age 29/30. Respondents were asked about their marital status (married, engaged, separated/divorced, widowed, or single) at each follow-up. Marital status at age 29/30 was coded as 1 = *married,* 0 = *never married* (i.e., single or engaged at all ages 21/22–29/30). Note that we excluded individuals who married before age 21/22 and who were separated/divorced or widowed before age 29/30.

Potential confounders with respect to the exposures. All potential confounders of the two exposures (i.e., alcohol use and marijuana use at age 19/20) were measured in 12th grade, before assessment of the exposures. These include sex, race/ethnicity, high school grade point average, evenings out, high school program, religiosity, cohort, parental education, living with two parents, and high school substance use behaviors (cigarette use, HED, marijuana use, and use of other illicit drugs) (Appendix Table A1). Substance use behaviors at age 18 were included so that the models examine whether substance use during early young adulthood (regardless of previous substance use history) affects subsequent marital status and SUDs in adulthood.

Potential confounders with respect to the mediator. The potential confounders of the mediator (i.e., marital status at age 29/30) were measured between ages 21/22 and 27/28 (after exposure but before the mediator), and therefore did not affect the exposure nor were affected by the mediator (Coffman, 2011). These included parenthood, educational attainment, income, employment status, cohabiting status, living with parents, religiosity, and substance use behaviors (cigarette use, HED, marijuana use, and use of other illicit drugs) (Appendix Table A1). Parenthood and educational attainment at age 27/28 were included, as they were cumulative measures.

Analysis

Overview of propensity score weighting for casual inference. We used propensity score weighting to control for potential confounders of both the exposures (alcohol use and marijuana use at age 19/20) and the mediator (marital status at age 29/30). As defined by Rosenbaum and Rubin (1983), the propensity score is the probability that an individual receives a particular level of the exposure (or mediator) variable, given measured baseline confounders. In our context, exposure propensity score models estimated the respective probabilities of levels of alcohol and marijuana use at age 19/20, given baseline characteristics measured in 12th grade. The mediator model estimated the probability of being married at age 29/30 (compared with never married), given characteristics measured across ages 21/22–27/28. We used the inverse probability of treatment weighting (IPTW), in which an individual's weight was the inverse of his or her probability of receiving the exposure (or mediator) that he or she actually received. Conceptually, IPTW transforms the observed sample to mimic a randomized population in which the distribution of covariates is the same across groups to the extent that all relevant confounders have been measured and accounted for by the propensity scores (Austin, 2011; Morgan & Todd, 2008). Additional technical details are available elsewhere (Coffman & Kugler, 2012; Coffman & Zhong, 2012; Coffman et al., 2015; Imai et al., 2010; VanderWeele, 2015).

Inverse probability of treatment weighting. Separate exposure IPTWs were estimated for alcohol use and marijuana use by including the exposure confounders (Table 1). Missingness indicators of all confounders (0.2%–4.5% for alcohol use and 0.4%–4.3% for marijuana use) were included in the propensity score regression, such that exposure groups were balanced both on observed covariate values and degree of missingness (Cefalu et al., 2015). These propensity scores were used to construct alcohol use IPTW and marijuana use IPTW, respectively.

Mediator IPTW adjusted for preexisting differences between married and never-married individuals at age 29/30 (Table 2). Missingness indicators for each covariate (5.5%–14.4% for alcohol use and 5.4%–14.7% for marijuana use) were included in the propensity score model estimation. These propensity scores were used to construct the marriage IPTW.

All IPTW estimation was conducted with the Toolkit for Weighting and Analysis of Nonequivalent Groups (twang) package in SAS and R (Cefalu et al., 2015; Ridgeway, 2015), which uses generalized boosted modeling (GBM). GBM is a nonparametric machine learning algorithm that automatically

TABLE 1.　Sample characteristics of alcohol and marijuana use at age 19/20 before and after inverse probability of treatment weighting

	Alcohol use						Marijuana use					
	Unweighted			Weighted			Unweighted			Weighted		
Variable	Nonuse	≤1 HED	≥2 HED	Nonuse	≤1 HED	≥2 HED	Nonuse	≤2 MJ	≥3 MJ	Nonuse	≤2 MJ	≥3 MJ
N	4,121	846	1,671	–	–	–	5,597	480	857	–	–	–
Age 18 substance use												
Cig. (range: 1–7)	1.41	1.79	2.17	1.60	1.63††	1.68†	1.45	1.96	2.70	1.61	1.63††	1.74†
HED (range: 1–7)	1.27	1.74	2.54	1.59	1.62††	1.70†	1.46	2.09	2.56	1.63	1.67††	1.77†
MJ (range: 1–7)	1.28	1.65	2.19	1.50	1.51††	1.58††	1.21	1.88	3.50	1.48	1.51††	1.63†
OTM (0 = no, 1 = yes)	0.16	0.29	0.39	0.23	0.23††	0.26†	0.16	0.37	0.60	0.22	0.25†	0.27†
Demographic factors												
Female	0.64	0.55†	0.45	0.59	0.57††	0.58††	0.60	0.57††	0.49	0.59	0.58††	0.56†
Race/ethnicity												
Black	0.08	0.03	0.01	0.06	0.04†	0.04†	0.07	0.04†	0.02	0.06	0.04†	0.06††
Hispanic	0.06	0.05†	0.04†	0.06	0.04††	0.04††	0.06	0.07†	0.03†	0.06	0.06††	0.04†
Other	0.08	0.06†	0.04†	0.07	0.06††	0.06††	0.08	0.05†	0.06††	0.07	0.05†	0.06††
GPA (range: 1–9)	6.68	6.48†	6.32†	6.59	6.58††	6.56††	6.64	6.50†	6.04	6.57	6.64††	6.45†
Truancy (range: 1–7)	1.46	1.70†	1.87	1.56	1.57††	1.60††	1.48	1.83	2.16	1.58	1.63††	1.65†
Eve out (range: 1–6)	3.27	3.65	4.01	3.48	3.52††	3.59†	3.35	3.87	4.24	3.48	3.59†	3.70†
College prep	0.66	0.69†	0.68††	0.67	0.69††	0.68††	0.67	0.69†	0.61†	0.66	0.70†	0.67††
Religiosity												
Very important	0.34	0.21	0.17	0.28	0.26†	0.26††	0.31	0.16	0.14	0.29	0.24†	0.28††
Parent college-educated	0.71	0.76†	0.80	0.74	0.75††	0.75††	0.72	0.76†	0.78†	0.73	0.76†	0.75††
Two-parent home	0.78	0.79††	0.79††	0.79	0.80††	0.79††	0.79	0.76†	0.74†	0.79	0.79††	0.74†
Cohort												
1990	0.11	0.11††	0.13†	0.11	0.11††	0.12††	0.12	0.12††	0.08†	0.11	0.12††	0.10†
1991	0.12	0.14†	0.10††	0.12	0.13††	0.11††	0.12	0.11††	0.11††	0.12	0.12††	0.12††
1992	0.13	0.13††	0.11†	0.12	0.13††	0.13††	0.13	0.14††	0.08†	0.12	0.13††	0.09†
1993	0.11	0.12††	0.11††	0.11	0.12††	0.11††	0.12	0.11††	0.11††	0.12	0.14†	0.09†
1994	0.12	0.10††	0.11††	0.11	0.10††	0.11††	0.11	0.11††	0.13††	0.12	0.10††	0.12††
1995	0.12	0.12††	0.12††	0.12	0.12††	0.11††	0.12	0.09†	0.13††	0.12	0.11††	0.13††
1996	0.11	0.12††	0.12††	0.11	0.11††	0.12††	0.11	0.11††	0.13†	0.11	0.11††	0.13††
1997	0.10	0.09††	0.10††	0.09	0.09††	0.09††	0.09	0.10††	0.13†	0.10	0.09††	0.11††
1998	0.10	0.08†	0.10††	0.10	0.10††	0.11††	0.09	0.11††	0.11†	0.09	0.09††	0.12†

Notes: Cig. = cigarette use; HED = heavy episodic drinking; MJ = marijuana use; OTM = other than marijuana use (other illicit drug use); GPA = grade point average. [†]ASMD ≤ 0.2; [††]ASMD ≤ 0.05 (compared with nonuse). *≤1 HED (drinking up to 1 occasion of HED in the past 2 weeks), ≥2 HED (≥2 occasions of HED during the last 2 weeks); *≤2 MJ (1 to 2 occasions of marijuana use during the last 30 days), ≥3 MJ (≥3 occasions of marijuana use during the last 30 days).

includes covariate interactions and nonlinearities (Lee et al., 2010a). It has been shown to have optimal performance for less biased results relative to logistic regression for propensity score estimation (Lee et al., 2010a; McCaffrey et al., 2004, 2013). After IPTW estimation, we assessed whether the weights adequately balanced exposure and mediator groups with respect to covariates using the absolute standardized mean difference (ASMD) metric. The ASMD quantifies the difference in the means for a given covariate across exposure groups (or mediator groups), standardized by the overall sample standard deviation (McCaffrey et al., 2014). Smaller ASMD values indicate better balance on covariates across exposure groups; ASMD values less than 0.20 indicate sufficient balance (Cohen, 1992).

Mediation analyses

Separate mediation analyses for alcohol and marijuana were conducted to examine the effect of alcohol use (nonuse, ≤1 HED, ≥2 HED)/marijuana use (nonuse, ≤2 MJ, ≥3 MJ) at age 19/20 on adult alcohol/marijuana use at age 35 (AUD/

MUD, nondisordered use, or abstinence) and the mediated effects of marital status at age 29/30. First, we fit a weighted regression model of marital status on young adult alcohol/marijuana use (Figure 1: path a), employing alcohol/marijuana use IPTW. Second, we fit a weighted regression model of age 35 alcohol/marijuana use on young adult alcohol/marijuana use (Figure 1: path c), employing alcohol/marijuana use IPTW. Last, we fit a weighted regression model of age 35 alcohol/marijuana use on young adult alcohol/marijuana use at age 19/20 (Figure 1: path c′) and marital status at age 29/30 (Figure 1: path b). The weights for this regression model are the product of the alcohol/marijuana use IPTW and marriage IPTW; this composite weight controls for potential confounding with respect to both the exposure and the mediator.

A mediation model with categorical outcomes is different from that with continuous outcomes in which the usual decomposition of effects is used (direct effect [c′] + indirect effect [a × b] = total effect [c]) (Kenny, 2013; MacKinnon & Dwyer, 1993). In logistic regression, the scales of predictors are different across equations, and thus standardized coeffi-

TABLE 2. Sample characteristics by marital status at age 29/30 before and after inverse probability of treatment weighting

	Alcohol use model				Marijuana use model			
	Unweighted		Weighted		Unweighted		Weighted	
Variable	Never married	Married	Never married	Married	Never married	Married	Never married	Married
N	2,834	3,804	–	–	2,945	3,989	–	–
Income (range: 0–17)								
At age 21/22	6.17	6.69†	6.19	6.50†	6.19	6.69†	6.23	6.49†
23/24	8.56	9.10†	8.68	8.94†	8.57	9.09†	8.69	8.94†
25/26	11.04	11.39†	11.14	11.32††	11.02	11.40†	11.15	11.32††
27/28	12.38	12.44††	12.53	12.57††	12.35	12.44††	12.51	12.54††
Employment (0 = no, 1 = yes)								
Part-time								
At age 21/22	0.34	0.31†	0.33	0.32††	0.34	0.31††	0.33	0.33††
23/24	0.19	0.16†	0.18	0.16††	0.19	0.15†	0.18	0.16††
25/26	0.11	0.09†	0.09	0.09††	0.11	0.08†	0.09	0.09††
27/28	0.07	0.08††	0.06	0.07††	0.07	0.08††	0.07	0.07††
Full-time								
At age 21/22	0.33	0.40†	0.36	0.37††	0.34	0.39†	0.36	0.37††
23/24	0.58	0.64†	0.62	0.62††	0.58	0.64†	0.62	0.63††
25/26	0.69	0.75†	0.72	0.74††	0.69	0.76†	0.73	0.74††
27/28	0.71	0.79†	0.74	0.77†	0.71	0.78†	0.74	0.77†
Cohabited (0 = no, 1 = cohabited)								
At age 21/22	0.08	0.12†	0.10	0.10††	0.08	0.11†	0.10	0.10††
23/24	0.11	0.15†	0.13	0.13††	0.11	0.15†	0.13	0.13††
25/26	0.14	0.14††	0.15	0.14††	0.14	0.14††	0.14	0.14††
27/28	0.19	0.09	0.15	0.12†	0.18	0.08	0.15	0.12†
Have any child at age 27/28 (0 = no, 1 = yes)	0.13	0.44	0.23	0.32†	0.13	0.45	0.24	0.33†
College or more at age 27/28 (0 = no, 1 = yes)	0.63	0.65††	0.63	0.65†	0.63	0.65††	0.62	0.65†
Live with parents (0 = no, 1 = yes)								
At age 21/22	0.35	0.27†	0.33	0.30†	0.36	0.28†	0.33	0.30†
23/24	0.35	0.22	0.31	0.27†	0.36	0.22	0.31	0.27†
25/26	0.28	0.10	0.21	0.16†	0.28	0.10	0.21	0.17†
27/28	0.20	0.04	0.13	0.09†	0.21	0.04	0.13	0.09†
Religiosity (very important)								
At age 21/22	0.22	0.30†	0.25	0.28†	0.22	0.31†	0.25	0.28†
23/24	0.22	0.30†	0.25	0.27†	0.22	0.31†	0.26	0.28††
25/26	0.22	0.33	0.25	0.29†	0.22	0.33	0.26	0.29†
27/28	0.21	0.34	0.25	0.30†	0.21	0.34	0.26	0.30†
Substance use								
Cig. (range: 1–7)								
At age 21/22	1.88	1.67†	1.78	1.75††	1.87	1.65†	1.75	1.73††
23/24	1.84	1.59†	1.72	1.67††	1.81	1.58†	1.69	1.66††
25/26	1.79	1.52	1.67	1.60†	1.77	1.51	1.65	1.59††
27/28	1.77	1.43	1.61	1.52†	1.75	1.42	1.60	1.52†
HED (range: 1–7)								
At age 21/22	2.07	1.88†	1.96	1.96††	2.06	1.86†	1.94	1.94††
23/24	2.00	1.69	1.86	1.82††	1.98	1.67	1.85	1.79††
25/26	1.95	1.55	1.77	1.69†	1.91	1.53	1.74	1.66†
27/28	1.89	1.45	1.71	1.59†	1.86	1.44	1.68	1.57†
MJ (range: 1–6)								
At age 21/22	1.80	1.39	1.61	1.52†	1.77	1.37	1.59	1.50†
23/24	1.71	1.32	1.54	1.44†	1.69	1.30	1.51	1.42†
25/26	1.65	1.25	1.45	1.37†	1.63	1.23	1.43	1.35†
27/28	1.60	1.21	1.41	1.33†	1.58	1.20	1.40	1.32†
OTM (0 = no, 1 = yes)								
At age 21/22	0.21	0.12	0.18	0.14†	0.20	0.11	0.17	0.14†
23/24	0.20	0.10	0.16	0.13†	0.20	0.09	0.16	0.12†
25/26	0.19	0.09	0.15	0.12†	0.18	0.08	0.15	0.11†
27/28	0.19	0.08	0.14	0.11†	0.18	0.07	0.13	0.11†

Notes: Cig. = cigarette use; HED = heavy episodic drinking; MJ = marijuana use; OTM = other than marijuana use (other illicit drug use).
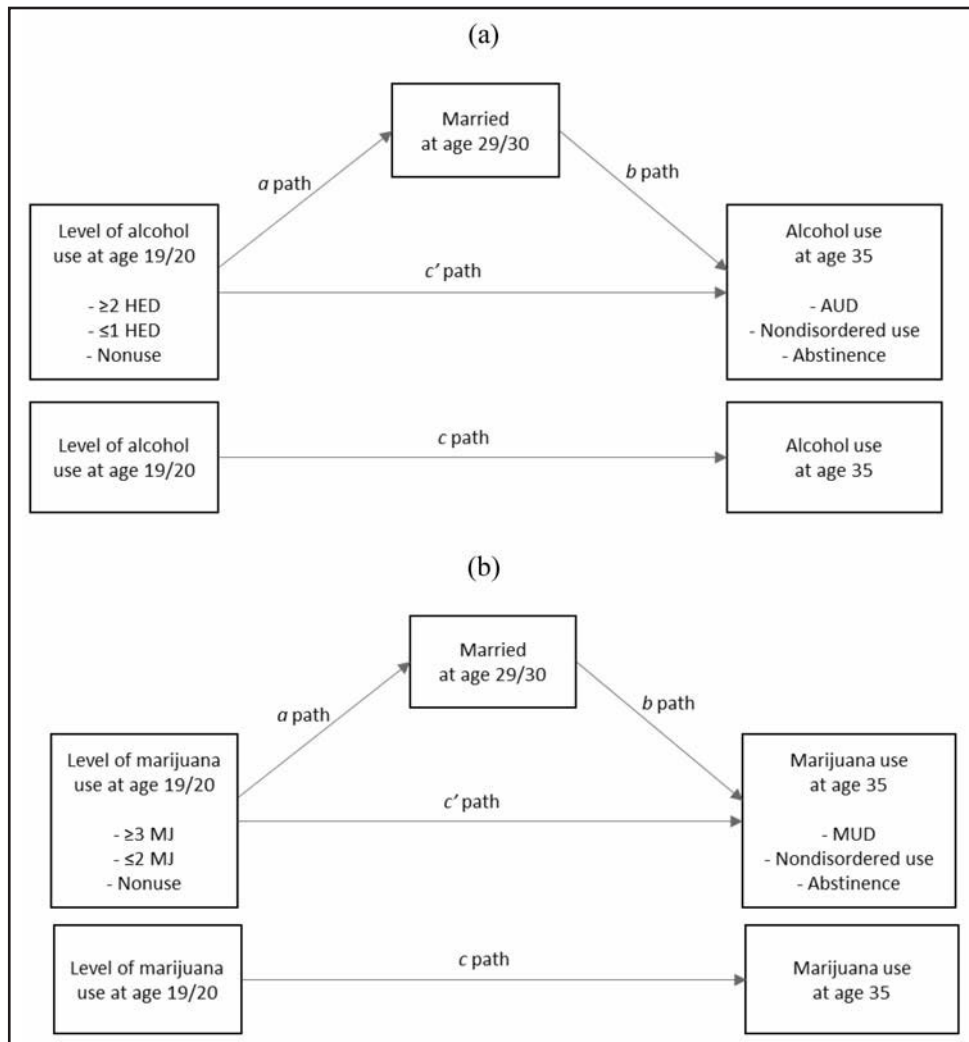†ASMD ≤ 0.2; ††ASMD ≤ 0.05.

FIGURE 1.   Conceptual mediation models of (a) level of alcohol use at age 19/20 on alcohol use at age 35 as mediated through marital status at age 29/30 and (b) level of marijuana use at age 19/20 on marijuana use at age 35 as mediated through marital status at age 29/30. *Note:* ≤1 HED (up to 1 occasion of HED in the past 2 weeks), ≥2 HED (≥2 occasions of HED in the past 2 weeks), AUD (alcohol use disorder). ≤2 MJ (1–2 occasions of marijuana use in the past month), ≥3 MJ (≥3 occasions of marijuana use in the past month), MUD (marijuana use disorder).

cients are used for comparison (Kenny, 2013; MacKinnon & Dwyer, 1993). The significance of the mediated effects was tested by PRODCLIN (distribution of the PRODuct Confidence Limits for the INdirect effects) in SAS (MacKinnon et al., 2007).

Results

Sample characteristics for the exposure groups

Before weighting, both ≤1 HED (drinking up to 1 occasion of HED in the past 2 weeks) and ≥2 HED (≥2 occasions of HED in the past 2 weeks) reported greater substance use at age 18 than nonusers (Table 1). Nonusers were more likely to be Black, reported fewer evenings out, and were more religious than both ≤1 HED and ≥2 HED. Individuals in the ≥2 HED group were more likely to be male, report truancies, and have a college-educated parent than nonusers. After IPTW, groups were balanced across all of these characteristics as each ASMD value was less than 0.2.

Similarly, before weighting, both ≤2 MJ (1 to 2 occasions of marijuana use in the past 30 days) and ≥3 MJ (≥3 occasions of marijuana use in the past 30 days) reported more frequent substance use at age 18 than nonusers (Table 1). Nonusers reported fewer truancies and evenings out and were more religious than both ≤2 MJ and ≥3 MJ. Individuals in the ≥3 MJ group were less likely to be female or Black or to report lower grade point averages than nonusers. After IPTW, the groups were similar; ASMD values for all variables were less than 0.2.
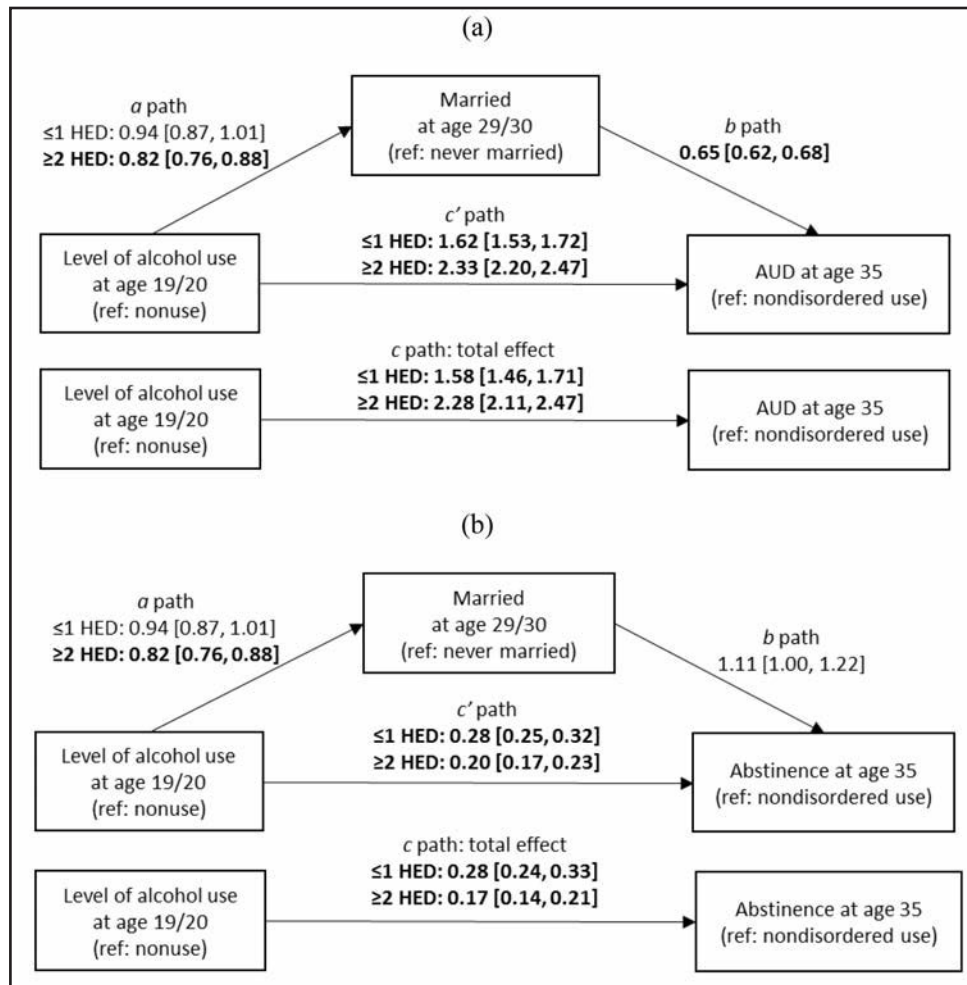
FIGURE 2.   Odds ratios from mediation model of level of alcohol use at age 19/20 on (a) alcohol use disorder and (b) alcohol abstinence at age 35 as mediated through marital status at age 29/30 ($N = 6{,}638$). *Note:* ≤1 HED (up to 1 occasion of HED in the past 2 weeks), ≥2 HED (≥2 occasions of HED in the past 2 weeks), AUD (alcohol use disorder). 95% confidence intervals are in brackets. **Bold** indicates statistically significant associations at $p < .05$. Estimation was conducted using sequential regression models.

Sample characteristics for the mediator groups

As presented in Table 2, differences between married and never-married individuals were very similar in both alcohol and marijuana samples before IPTW. Married individuals were more likely to have children, were more religious at ages 25/26 and 27/28, reported less substance use across ages 21/22–27/28, and were less likely to have lived with parents across ages 23/24–27/28. After IPTW, the groups were similar with regard to the sample characteristics in both alcohol and marijuana models.

Total effect of alcohol/marijuana use at age 19/20 on adult alcohol/marijuana use at age 35

After IPTW, both ≤1 HED and ≥2 HED at age 19/20, compared with nonuse, were significantly related to higher

odds of AUD at age 35 and lower odds of abstinence compared with nondisordered use (Figure 2: path c). Similarly, both ≤2 MJ and ≥3 MJ at age 19/20, compared with nonuse, were significantly related to higher odds of MUD at age 35 and lower odds of abstinence compared with nondisordered use (Figure 3: path c).

Direct effect of alcohol/marijuana use at age 19/20 on adult alcohol/marijuana use at age 35

The direct effects were similar in direction and magnitude to the total effects. Controlling for marital status at age 29/30, both ≤1 HED and ≥2 HED at age 19/20, compared with nonuse, were significantly associated with higher odds of AUD at age 35 and lower odds of abstinence compared with nondisordered use (Figure 2: path c′). Likewise, after we controlled for marital status at age 29/30, both ≤2 MJ
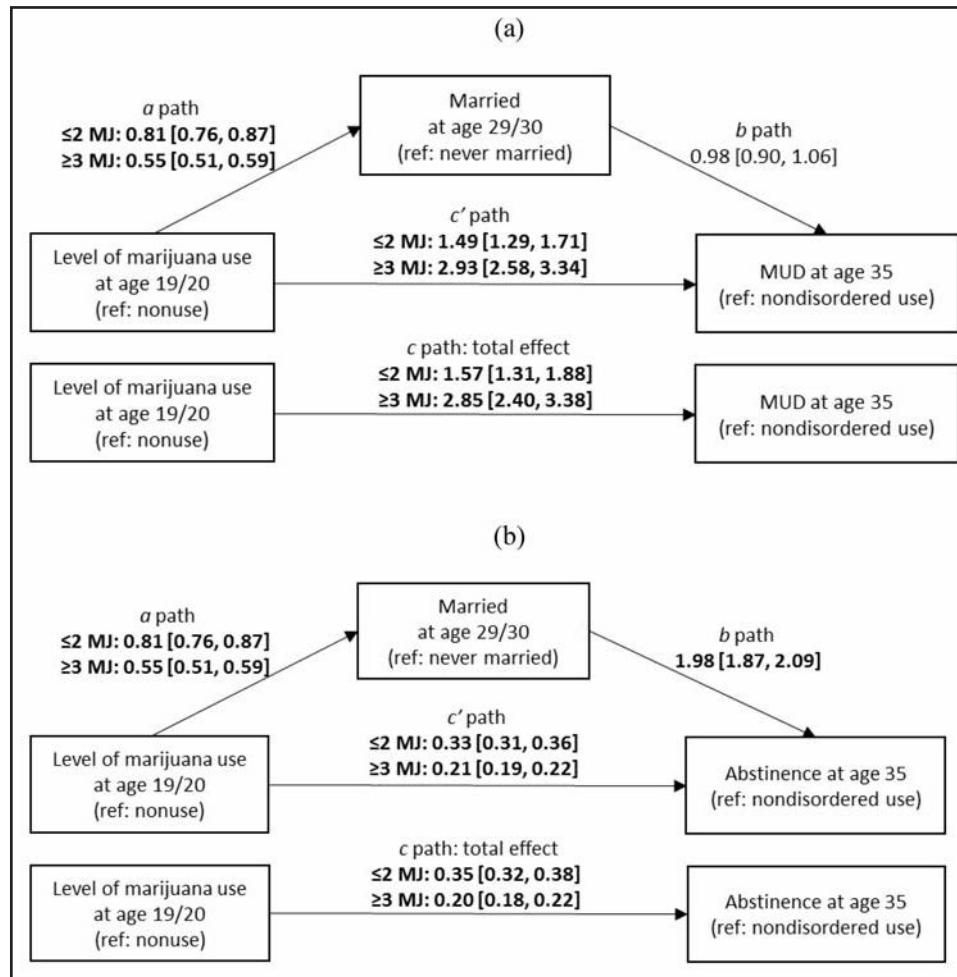
FIGURE 3.   Odds ratios from mediation model of level of marijuana use at age 19/20 on (a) marijuana use disorder and (b) marijuana abstinence at age 35 as mediated through marital status at age 29/30 (N = 6,934). *Note:* ≤2 MJ (1–2 occasions of marijuana use in the past month), ≥3 MJ (≥3 occasions of marijuana use in the past month), MUD (marijuana use disorder). 95% confidence intervals are in brackets. **Bold** indicates statistically significant associations at $p < .05$. Estimation was conducted using sequential regression models.

and ≥3 MJ at age 19/20, compared with nonuse, were significantly associated with higher odds of MUD at age 35 and lower odds of abstinence compared with nondisordered use (Figure 3: path c′).

Mediated effect of marriage

Having ≥2 HED was significantly associated with lower odds of being married at age 29/30, but the effect of ≤1 HED on marital status was not significant (Figure 2: path a). Being married at age 29/30, compared with never married, was associated with lower odds of AUD at age 35 (Figure 2: path b). Marital status was a significant mediator; being unmarried at age 29/30 partially mediated the association between ≥2 HED and elevated odds of AUD (Appendix Table 2).

Both ≤2 MJ and ≥3 MJ at age 19/20 were significantly associated with lower odds of being married at age 29/30

(Figure 3: path a). Being married at age 29/30 was significantly associated with higher odds of marijuana abstinence at age 35 (Figure 3: path b). Marital status was a significant mediator, as being unmarried at age 29/30 partially mediated the associations between both ≤2 MJ and ≥3 MJ and lower odds of abstinence (Appendix Table 2).

Discussion

The current study investigated the associations between young adult substance use and adult substance use behaviors and whether marital status acted as a mediator of these associations. This study is novel in that we used propensity score weighting techniques (i.e., causal inference methods) to control for observed confounders regarding both the exposure and mediator and thus to provide a robust estimation of the mediated effect (Coffman, 2011).

Our results showed significant associations of both moderate and heavy alcohol/marijuana use at age 19/20 with greater odds of AUD/MUD and with lower odds of abstinence at age 35 compared with nondisordered use. These findings are consistent with previous research showing long-term effects of adolescent and young adult substance use on later outcomes (Grant et al., 2006; Patrick et al., 2011). Our mediation analyses found that marital status at age 29/30 was a significant partial mediator of the associations between heavy alcohol use at age 19/20 and AUD at age 35 and of the association between moderate and heavy marijuana use at age 19/20 and marijuana abstinence at age 35. Heavy alcohol users had greater odds of AUD and both moderate and heavy marijuana users had lower odds of abstinence, each relative to nondisordered use, in part because they were less likely than nonusers to be married at age 29/30. Remaining unmarried may be an important mechanism in the continuation of heavy alcohol use and moderate and heavy marijuana use. On the other hand, the association between moderate alcohol use in young adulthood and subsequent alcohol outcomes at age 35 was not significantly mediated by marital status. For moderate alcohol users, marital status may not be an important mechanism predicting whether their use changes.

Second, we found evidence for selection effects on marriage among those with heavy alcohol use and those with moderate and heavy marijuana use at age 19/20. That is, after adjusting for preexisting confounders, there is a lower probability of being married during young adulthood among heavy alcohol users and moderate and heavy marijuana users, with concomitant risks for continued use into middle adulthood. This finding suggests differing threshold effects of alcohol and marijuana in young adulthood on marital status at age 29/30 (Bogart et al., 2005; Brook et al., 1999; Curran et al., 1998; Duncan et al., 2006), which may reflect different social norms and tolerances for degrees of alcohol versus marijuana use. Future research testing the association of substance use with other outcomes should take into account these different thresholds for alcohol and marijuana use.

Furthermore, our findings showed that being married at age 29/30 was associated with higher odds of abstinence from marijuana and lower odds of AUD at age 35 compared with nondisordered use. Given our adjustment for preexisting differences between married and never-married individuals, this suggests that being married may play a protective role for subsequent AUD and marijuana use. Of note, our mediation results provide evidence that marital status may perpetuate SUD risk among individuals rather than serving as a clear turning point that reduces the risk of SUDs as described in previous literature (e.g., Rutter, 1996; Schulenberg & Maggs, 2002), especially for heavy alcohol users and moderate and heavy marijuana users. The nonsignificant associations of marital status with alcohol abstinence and with MUD may reflect different mechanisms, which needs further exploration in the future.

A few limitations should be noted. Although we used propensity score methods to adjust for preexisting differences across both exposure and mediator groups with respect to a comprehensive set of measured confounders, residual confounding may still be present due to unobserved confounders (e.g., personality, mental health conditions). Potential bias because of unmeasured confounders is inherent in all observational studies; in mediation analyses, confounding may be present with respect to either the exposure or mediator. Our findings assessed the mediated effects of marital status at age 29/30 and may not generalize to other ages or those who are divorced or widowed. Differential missingness on substance use behaviors or on marital status may have also introduced biases to our analyses. Monitoring the Future study is a school-based survey, and thus our results may not generalize to individuals who dropped out of high school. Last, from our measure of SUD status at age 35, we cannot determine whether SUD status represents the onset or continuation from young adulthood.

Documenting the mechanism for maturing out of substance use via marriage has been challenging because randomization of individuals to substance use groups or to married/never-married groups is not possible. Using causal inference methods, the present study provides robust evidence of marital status as a partial mediator of the associations between young adult heavy alcohol use and AUD at age 35 and of the associations between moderate and heavy marijuana use and marijuana abstinence at age 35. Remaining unmarried may be an important mechanism that perpetuates substance use among heavy alcohol users and moderate and heavy marijuana users. Future research may expand our findings by examining marriage as a moderated mediator and using causal inference methods in the study of mechanisms of maturing out of substance use. This would further refine our understanding of the continuity and discontinuity of substance use via adult roles.

Acknowledgment

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: Author.

Austin, P. C. (2011). An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research, 46,* 399–424. doi:10.1080/00273171.2011.568786

Bachman, J. G., Wadsworth, K. N., O'Malley, P. M., & Johnston, L. D. (1997). *Smoking, drinking, and drug use in young adulthood: The impacts of new freedoms and new responsibilities.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Bogart, L. M., Collins, R. L., Ellickson, P. L., Martino, S. C., & Klein, D. J. (2005). Effects of early and later marriage on women's alcohol use in

young adulthood: A prospective analysis. *Journal of Studies on Alcohol, 66,* 729–737. doi:10.15288/jsa.2005.66.729

Brook, J. S., Richter, L., Whiteman, M., & Cohen, P. (1999). Consequences of adolescent marijuana use: incompatibility with the assumption of adult roles. *Genetic, Social, and General Psychology Monographs, 125,* 193–207.

Cefalu, M., Liu, S., & Martin, C. (2015). *Toolkit for weighting and analysis of nonequivalent groups: A tutorial on the TWANG commands for Stata.* Retrieved from https://www.rand.org/pubs/tools/TL170.html

Center for Behavioral Health Statistics and Quality. (2016). *Key substance use and mental health indicators in the United States: Results from the 2015 National Survey on Drug Use and Health* (HHS Publication No. SMA 16-4984). Retrieved from https://www.samhsa.gov/data/sites/default/files/NSDUH-FFR1-2015/NSDUH-FFR1-2015/NSDUH-FFR1-2015.pdf

Chassin, L., Fora, D. B., & King, K. M. (2004). Trajectories of alcohol and drug use and dependence from adolescence to adulthood: The effects of familial alcoholism and personality. *Journal of Abnormal Psychology, 113,* 483–498. doi:10.1037/0021-843X.113.4.483

Coffman, D. L. (2011). Estimating causal effects in mediation analysis using propensity scores. *Structural Equation Modeling: A Multidisciplinary Journal, 18,* 357–369.

Coffman, D. L., & Kugler, K. C. (2012). Causal mediation of a human immunodeficiency virus preventive intervention. *Nursing Research, 61,* 224–230. doi:10.1097/NNR.0b013e318254165c

Coffman, D. L., Melde, C., & Esbensen, F. (2015). Gang membership and substance use: Guilt as a gendered causal pathway. *Journal of Experimental Criminology, 11,* 71–95. doi:10.1007/s11292-014-9220-9

Coffman, D. L., & Zhong, W. (2012). Assessing mediation using marginal structural models in the presence of confounding and moderation. *Psychological Methods, 17,* 642–664. doi:10.1037/a0029311

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155–159. doi:10.1037/0033-2909.112.1.155

Curran, P. J., Muthén, B. O., & Harford, T. C. (1998). The influence of changes in marital status on developmental trajectories of alcohol use in young adults. *Journal of Studies on Alcohol, 59,* 647–658. doi:10.15288/jsa.1998.59.647

Dawson, D. A., Goldstein, R. B., & Grant, B. F. (2013). Prospective correlates of drinking cessation: Variation across the life-course. *Addiction, 108,* 712–722. doi:10.1111/add.12079

Duncan, G. J., Wilkerson, B., & England, P. (2006). Cleaning up their act: The effects of marriage and cohabitation on licit and illicit drug use. *Demography, 43,* 691–710. doi:10.1353/dem.2006.0032

Gotham, H. J., Sher, K. J., & Wood, P. K. (1997). Predicting stability and change in frequency of intoxication from the college years to beyond: Individual-difference and role transition variables. *Journal of Abnormal Psychology, 106,* 619–629. doi:10.1037/0021-843X.106.4.619

Gotham, H. J., Sher, K. J., & Wood, P. K. (2003). Alcohol involvement and developmental task completion during young adulthood. *Journal of Studies on Alcohol, 64,* 32–42. doi:10.15288/jsa.2003.64.32

Grant, J. D., Scherrer, J. F., Lynskey, M. T., Lyons, M. J., Eisen, S. A., Tsuang, M. T., . . . Bucholz, K. K. (2006). Adolescent alcohol use is a risk factor for adult alcohol and drug dependence: Evidence from a twin design. *Psychological Medicine, 36,* 109–118. doi:10.1017/S0033291705006045

Green, K. M., & Ensminger, M. E. (2006). Adult social behavioral effects of heavy adolescent marijuana use among African Americans. *Developmental Psychology, 42,* 1168–1178. doi:10.1037/0012-1649.42.6.1168

Harford, T. C., & Muthén, B. O. (2001). The dimensionality of alcohol abuse and dependence: A multivariate analysis of DSM-IV symptom items in the National Longitudinal Survey of Youth. *Journal of Studies on Alcohol, 62,* 150–157. doi:10.15288/jsa.2001.62.150

Imai, K., Keele, L., & Tingley, D. (2010). A general approach to causal mediation analysis. *Psychological Methods, 15,* 309–334. doi:10.1037/a0020761

Jackson, K. M., & Sartor, C. E. (2016). The natural course of substance use and dependence. In *The Oxford handbook of substance use and substance use disorders, Vol. 1* (pp. 67–131). New York, NY: Oxford University Press.

Jackson, K. M., Sher, K. J., Gotham, H. J., & Wood, P. K. (2001). Transitioning into and out of large-effect drinking in young adulthood. *Journal of Abnormal Psychology, 110,* 378–391. doi:10.1037/0021-843X.110.3.378

Jang, J. B., Patrick, M. E., Keyes, K. M., Hamilton, A. D., & Schulenberg, J. E. (2017). Frequent binge drinking among US adolescents, 1991 to 2015. *Pediatrics, 139*(6), e20164023. doi:10.1542/peds.2016-4023

Jang, B. J., Patrick, M. E., & Schuler, M. S. (2018). Substance use behaviors and the timing of family formation during young adulthood. *Journal of Family Issues, 39,* 1396–1418. doi:10.1177/0192513X17710285

Kenny, D. A. (2013). *Mediation.* Retrieved from http://davidakenny.net/cm/mediate.htm#CI

Labouvie, E. (1996). Maturing out of substance use: Selection and self-correction. *Journal of Drug Issues, 26,* 457–476. doi:10.1177/002204269602600208

Lee, B. K., Lessler, J., & Stuart, E. A. (2010a). Improving propensity score weighting using machine learning. *Statistics in Medicine, 29,* 337–346. doi:10.1002/sim.3782

Lee, M. R., Chassin, L., & MacKinnon, D. (2010b). The effect of marriage on young adult heavy drinking and its mediators: Results from two methods of adjusting for selection into marriage. *Psychology of Addictive Behaviors, 24,* 712–718. doi:10.1037/a0020983

Lee, M. R., Chassin, L., & MacKinnon, D. P. (2015). Role transitions and young adult maturing out of heavy drinking: Evidence for larger effects of marriage among more severe premarriage problem drinkers. *Alcoholism: Clinical and Experimental Research, 39,* 1064–1074. doi:10.1111/acer.12715

Lee, M. R., Chassin, L., & Villalta, I. K. (2013). Maturing out of alcohol involvement: Transitions in latent drinking statuses from late adolescence to adulthood. *Development and Psychopathology, 25,* 1137–1153. doi:10.1017/S0954579413000424

Lee, M. R. and Sher, K. J. (2017). Sidebar: "Maturing out" of binge and problem drinking. *Alcohol Research: Current Reviews, 39.*

Leonard, K. E., & Mudar, P. J. (2000). Alcohol use in the year before marriage: Alcohol expectancies and peer drinking as proximal influences on husband and wife alcohol involvement. *Alcoholism: Clinical and Experimental Research, 24,* 1666–1679. doi:10.1111/j.1530-0277.2000.tb01968.x

Macdonald, S., Wells, S., Giesbrecht, N., & Cherpitel, C. J. (1999). Demographic and substance use factors related to violent and accidental injuries: Results from an emergency room study. *Drug and Alcohol Dependence, 55,* 53–61. doi:10.1016/S0376-8716(98)00184-7

MacKinnon, D. P., & Dwyer, J. H. (1993). Estimating mediated effects in prevention studies. *Evaluation Review, 17,* 144–158. doi:10.1177/0193841X9301700202

MacKinnon, D. P., Fritz, M. S., Williams, J., & Lockwood, C. M. (2007). Distribution of the product confidence limits for the indirect effect: Program PRODCLIN. *Behavior Research Methods, 39,* 384–389. doi:10.3758/BF03193007

McCaffrey, D. F., Burgette, L. F., Griffin, B. A., Martin, C., & Ridgeway, G. (2014). *Toolkit for weighting and analysis of nonequivalent groups: A tutorial for the TWANG SAS Macros.* Retrieved from https://www.rand.org/pubs/tools/TL136.html

McCaffrey, D. F., Griffin, B. A., Almirall, D., Slaughter, M. E., Ramchand, R., & Burgette, L. F. (2013). A tutorial on propensity score estimation for multiple treatments using generalized boosted models. *Statistics in Medicine, 32,* 3388–3414. doi:10.1002/sim.5753

McCaffrey, D. F., Ridgeway, G., & Morral, A. R. (2004). Propensity score estimation with boosted regression for evaluating causal effects in observational studies. *Psychological Methods, 9,* 403–425. doi:10.1037/1082-989X.9.4.403

Miller, T., & Hendrie, D. (2008). *Substance abuse prevention dollars and cents: A cost-benefit analysis* (DHHS Pub. No. (SMA) 07-4298). Rockville, MD: Center for Substance Abuse Prevention, Substance Abuse and Mental Health Services Administration.

Miller-Tutzauer, C., Leonard, K. E., & Windle, M. (1991). Marriage and alcohol use: A longitudinal study of "maturing out." *Journal of Studies on Alcohol, 52,* 434–440. doi:10.15288/jsa.1991.52.434

Morgan, S. L., & Todd, J. J. (2008). A diagnostic routine for the detection of consequential heterogeneity of causal effects. *Sociological Methodology, 38,* 231–281. doi:10.1111/j.1467-9531.2008.00204.x

Muthén, B. O. (1996). Psychometric evaluation of diagnostic criteria: Application to a two-dimensional model of alcohol abuse and dependence. *Drug and Alcohol Dependence, 41,* 101–112. doi:10.1016/0376-8716(96)01226-4

Muthén, B. O., Grant, B., & Hasin, D. (1993). The dimensionality of alcohol abuse and dependence: Factor analysis of DSM-III-R and proposed DSM-IV criteria in the 1988 National Health Interview Survey. *Addiction, 88,* 1079–1090. doi:10.1111/j.1360-0443.1993.tb02127.x

Nelson, C. B., Heath, A. C., & Kessler, R. C. (1998). Temporal progression of alcohol dependence symptoms in the U.S. household population: Results from the National Comorbidity Survey. *Journal of Consulting and Clinical Psychology, 66,* 474–483. doi:10.1037/0022-006X.66.3.474

Overbeek, G., Vollebergh, W., Engels, R. C., & Meeus, W. (2003). Young adults' relationship transitions and the incidence of mental disorders: A three-wave longitudinal study. *Social Psychiatry and Psychiatric Epidemiology, 38,* 669–676. doi:10.1007/s00127-003-0689-1

Patrick, M. E., Bray, B. C., & Berglund, P. A. (2016). Reasons for marijuana use among young adults and long-term associations with marijuana use and problems. *Journal of Studies on Alcohol and Drugs, 77,* 881–888. doi:10.15288/jsad.2016.77.881

Patrick, M. E., Schulenberg, J. E., O'Malley, P. M., Johnston, L. D., & Bachman, J. G. (2011). Adolescents' reported reasons for alcohol and marijuana use as predictors of substance use and problems in adulthood. *Journal of Studies on Alcohol and Drugs, 72,* 106–116. doi:10.15288/jsad.2011.72.106

Power, C., Rodgers, B., & Hope, S. (1999). Heavy alcohol consumption and marital status: Disentangling the relationship in a national study of young adults. *Addiction, 94,* 1477–1487. doi:10.1046/j.1360-0443.1999.941014774.x

Ridgeway, G., McCaffrey, D., Morral, A., Burgette, L., & Griffin, B. A. (2015). *Toolkit for weighting and analysis of nonequivalent groups: A tutorial for the R TWANG Package.* Retrieved from http://www.rand.org/pubs/tools/TL136z1.html

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70,* 41–55. doi:10.1093/biomet/70.1.41

Rutter, M. (1996). Transitions and turning points in developmental psychopathology: As applied to the age span between childhood and mid-adulthood. *International Journal of Behavioral Development, 19,* 603–626. doi:10.1177/016502549601900309

Schulenberg, J., O'Malley, P. M., Bachman, J. G., Wadsworth, K. N., & Johnston, L. D. (1996). Getting drunk and growing up: Trajectories of frequent binge drinking during the transition to young adulthood. *Journal of Studies on Alcohol, 57,* 289–304. doi:10.15288/jsa.1996.57.289

Schulenberg, J. E., Johnston, L. D., O'Malley, P. M., Bachman, J. G., Miech, R. A., & Patrick, M. E. (2017). *Monitoring the Future national survey results on drug use, 1975–2016: Volume 2, College students and adults ages 19–55.* Ann Arbor, MI: Institute for Social Research, The University of Michigan.

Schulenberg, J. E., & Maggs, J. L. (2002). A developmental perspective on alcohol use and heavy drinking during adolescence and the transition to young adulthood. *Journal of Studies on Alcohol, Supplement 14,* 54–70. doi:10.15288/jsas.2002.s14.54

Schulenberg, J. E., Patrick, M. E., Kloska, D. D., Maslowsky, J., Maggs, J. L., & O'Malley, P. M. (2015). Substance use disorder in early midlife: A national prospective study on health and well-being correlates and long-term predictors. *Substance Abuse: Research and Treatment, 9,* 41. doi:10.4137/Sart.S31437

Sher, K. J., Jackson, K. M., & Steinley, D. (2011). Alcohol use trajectories and the ubiquitous cat's cradle: Cause for concern? *Journal of Abnormal Psychology, 120,* 322–335. doi:10.1037/a0021813

Staff, J., Greene, K. M., Maggs, J. L., & Schoon, I. (2014). Family transitions and changes in drinking from adolescence through mid-life. *Addiction, 109,* 227–236. doi:10.1111/add.12394

Staff, J., Schulenberg, J. E., Maslowsky, J., Bachman, J. G., O'Malley, P. M., Maggs, J. L., & Johnston, L. D. (2010). Substance use changes and social role transitions: Proximal developmental effects on ongoing trajectories from late adolescence through early adulthood. *Development and Psychopathology, 22,* 917–932. doi:10.1017/S0954579410000544

VanderWeele, T. (2015). *Explanation in causal inference: Methods for mediation and interaction.* New York, NY: Oxford University Press.

Vergés, A., Jackson, K. M., Bucholz, K. K., Grant, J. D., Trull, T. J., Wood, P. K., & Sher, K. J. (2012). Deconstructing the age-prevalence curve of alcohol dependence: Why maturing out is only a small piece of the puzzle. *Journal of Abnormal Psychology, 121,* 511–523. doi:10.1037/a0026027

Waldron, M., Heath, A. C., Lynskey, M. T., Bucholz, K. K., Madden, P. A., & Martin, N. G. (2011). Alcoholic marriage: Later start, sooner end. *Alcoholism: Clinical and Experimental Research, 35,* 632–642. doi:10.1111/j.1530-0277.2010.01381.x

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., . . . Vos, T. (2013). Global burden of disease attributable to mental and substance use disorders: Findings from the Global Burden of Disease Study 2010. *The Lancet, 382,* 1575–1586. doi:10.1016/S0140-6736(13)61611-6

Yamaguchi, K., & Kandel, D. B. (1985a). Dynamic relationships between premarital cohabitation and illicit drug use: An event-history analysis of role selection and role socialization. *American Sociological Review, 50,* 530–546. doi:10.2307/2095437

Yamaguchi, K., & Kandel, D. B. (1985b). On the resolution of role incompatibility: A life event history analysis of family roles and marijuana use. *American Journal of Sociology, 90,* 1284–1325. doi:10.1086/228211