Stimulant Use, Religiosity, and the Odds of Developing or Maintaining an Alcohol Use Disorder Over Time

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ABSTRACT. Objective: Little is known about whether cocaine or methamphetamine use, particularly among stimulant users residing in rural areas, is associated with increased odds of developing or maintaining an alcohol use disorder (AUD) over time. One factor that may help to protect some users against the development of an AUD is religiosity. This study examined how stimulant use and religiosity are associated longitudinally with the odds of an AUD among a rural population-based cohort of stimulant users. **Method:** Recent stimulant users ($N = 710$) were recruited via respondent-driven sampling and were interviewed every 6 months over a 3-year period. Concurrent and lagged generalized estimating equations analyses were conducted to estimate how past-30-day crack cocaine, powder cocaine, and methamphetamine use; religiosity; and other covariates were associated with the odds of an AUD.

Results: At baseline, 56% of the participants met AUD criteria. The odds of an AUD declined significantly over time in the concurrent, but not the lagged, model. Crack cocaine use was associated with increased odds of an AUD in both models, although the strength of the concurrent association between an AUD and crack cocaine use declined over time. Powder cocaine use and more frequent church attendance also were concurrently associated with decreased odds of an AUD. **Conclusions:** Rural stimulant users, especially those using cocaine, could potentially benefit from treatment for both alcohol use and stimulant use. In addition, our findings suggest that greater frequency of church attendance may be related to lower odds of the development or maintenance of an AUD. (*J. Stud. Alcohol Drugs*, 74, 369–377, 2013)

NATIONAL SURVEYS INDICATE that many cocaine users concurrently drink alcohol (Grant and Harford, 1990) and that past-year methamphetamine use is associated with daily alcohol intoxication (Furr et al., 2000). Similarly, treatment-based studies have shown that persons with alcohol use problems frequently use cocaine or methamphetamine (Caetano and Weisner, 1995; Martin et al., 1996). In prior analyses related to the study described in this article, distinct trajectories of cocaine, but not methamphetamine, were found to be associated with the number of heavy drinking days in the past 30 days (Borders and Booth, 2012). Some researchers have posited that cocaine users may drink alcohol when “coming down” from a cocaine

high (Magura and Rosenblum, 2000). Others have posited that some drinkers may use methamphetamine to offset the depressant effects of alcohol (Furr et al., 2000; Mendelson et al., 1995). Based on these collective findings, it is plausible to hypothesize that stimulant users have an elevated risk of an alcohol use disorder (AUD) and that their risk of an AUD may change over time, especially if their stimulant use changes.

In addition to further understanding the relationships between stimulant use and the risk of an AUD, more needs to be known about the behavioral or social characteristics that may serve as protective factors and might be amenable to intervention. This is especially relevant in many rural areas of the United States, where formal substance use prevention and treatment resources are frequently scarce (Borders and Booth, 2007a; Fortney and Booth, 2001) and where cocaine and methamphetamine use are now substantial public health problems (Booth et al., 2006; Borders et al., 2008; Gfroerer et al., 2007). Moreover, there is evidence that the prevalence of AUDs differs by rural, suburban, and urban residence across various regions of the United States (Borders and Booth, 2007b), which points to a need to conduct rural and regionally specific research on the correlates of AUDs.

One social characteristic that may have the potential to help at least some stimulant users lower their risk of an AUD is religiosity. A small number of prior studies have found a cross-sectional relationship between various dimensions of religiosity and an AUD, although these studies

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did not specifically focus on stimulant or other illicit drug users. For example, one study showed that frequent prayer, church attendance, and being "born again" were associated with reduced odds of a recent AUD (Koenig et al., 1994). Another study showed that greater self-rated religiosity, involvement with God, and thankfulness for God were related to lower odds of alcohol dependence (Kendler et al., 2003). In addition, an 18-month longitudinal study of at-risk drinkers conducted in six southern states found that greater overall religiosity was associated with a lower risk of an AUD (Booth et al., 2004). However, related follow-up analyses showed that the protective benefits of religiosity, at least over a 6-month time frame, were confined to persons who had not already developed an AUD at the time of study enrollment (Borders et al., 2010). More specifically, among persons with no AUD at study entry, those who attended church frequently or coped through prayer had lower odds of developing an AUD over the following 6 months; among persons who had an AUD at study entry, no aspect of religiosity was related to the 6-month remission of an AUD.

In summary, the literature offers little information about the factors associated with longitudinal changes in the odds of an AUD among cocaine and methamphetamine users, particularly those residing in rural communities. The current study aimed to fill this void by (a) describing longitudinal changes in AUD status by recent stimulant (powder cocaine, crack cocaine, and methamphetamine) use; (b) determining whether recent stimulant use is associated with increased AUD odds; and (c) examining whether religiosity is associated with decreased AUD odds among stimulant users.

Method

Study design and setting

A prospective, 3-year "natural history" study was conducted among recent (past-30-day) users of cocaine and/or methamphetamine who were not receiving formal substance use treatment at the time of study enrollment (Booth et al., 2006). The study took place in three rural counties in each of three states: Arkansas, Kentucky, and Ohio. *Rural residence* was defined as residence in a nonmetropolitan county, or a county with 50,000 or fewer residents (Rickets et al., 1999). The counties were chosen because substance use treatment and criminal justice data provided evidence of cocaine and/or methamphetamine use and because they were within convenient driving distance from the investigators' universities. A certificate of confidentiality was granted by the National Institute on Drug Abuse to protect participants' identity, the study was approved by relevant institutional review boards at each university, and written informed consent was obtained from all participants.

Sampling and recruitment

The study sites had identical recruitment, interviewing, and measurement methods. Respondent-driven sampling (RDS; Heckathorn, 1997, 2002), a variant of snowball sampling, was used to identify and recruit stimulant users within the targeted rural communities. To begin the RDS process, a variety of methods was used to identify study "seeds." These methods included approaching and talking with persons in local areas thought to be frequented by illicit drug users and distributing study cards to persons who might contact the study for an eligibility screening. Potential participants completed a screener, either by telephone or in person, to determine whether they met the following minimum study eligibility criteria: (a) age 18 years or older; (b) residence in one of the targeted rural counties; (c) self-reported use of crack cocaine, powder cocaine, and/or methamphetamine by any means of administration at least once in the past 30 days; and (d) no formal substance use treatment within the past 30 days.

Persons deemed eligible were asked to appear at study site offices to complete an in-person interview. After completing a baseline interview, study seeds were asked to hand out study referral coupons to up to three other persons "that were like them." Each participant received \$10 for each referral who contacted the study and completed an interview. Each referral also was allowed to refer others to the study and received the same financial incentives. Participants were asked to return for follow-up interviews every 6 months over 3 years, for a total of seven interviews, and they received \$50 for each completed interview. We conducted urinalysis at each follow-up interview to help ensure the veracity of self-reported drug use (Hser, 1997). However, because we did not have baseline urinalysis data, we did not use the follow-up data in the analysis.

Recruitment took place between October 2002 and September 2004, culminating in a total sample size of 710 persons that was approximately balanced by state. The sample sizes by interview were as follows: baseline (710), 6 months (601), 12 months (575), 30 months (563), and 36 months (519). Study staff members collected extensive tracking information at each interview to assist in locating participants for follow-up. Participation rates between successive interviews (e.g., baseline to 6 months, 6 to 12 months) ranged between 80% and 99%. Approximately 73% of participants in the baseline interview completed the final 36-month interview. Attrition analyses showed that Whites, men, unmarried individuals, individuals with higher incomes, and younger persons (the mean age for persons in the 6-month follow-up was 33 years, whereas the mean age for persons not in this interview was 30 years) were more likely to be lost to follow-up.

Measures

Dependent variable. Recent alcohol abuse and dependence disorders were assessed with the University of Arkansas for Medical Sciences–Substance Abuse Outcomes Module (SAOM). The SAOM has been shown to provide valid and reliable estimates of AUDs according to criteria in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; American Psychiatric Association, 1994) (Smith et al., 2006). At baseline, we assessed whether persons met criteria for a past-12-month AUD. However, at each follow-up interview, we assessed whether persons met criteria for a past-6-month AUD.

Independent variables. The majority of the independent variables were derived from the Substance Abuse and Health Services Utilization Assessment (SAHSUA; Siegal et al., 1998). This assessment includes measures of the frequency of stimulant and other drug use; the frequency and quantity of alcohol use; and items measuring various demographic, social, economic, and health factors as well as the utilization of drug use treatment. The SAHSUA has been shown to have reasonable test–retest reliability among cocaine users (Siegal et al., 1998).

The primary independent variables pertaining to illicit drugs were the past-30-day use of crack cocaine, powder cocaine, and methamphetamine, which were assessed by asking, “On how many days in the past 30 days did you use [drug]?” Based on responses to these questions, we created binary variables indicating any past-30-day crack cocaine, powder cocaine, and methamphetamine use. We chose these binary variables because prior research indicates that they are sufficiently sensitive to detect significant declines in past-30-day drug use over time (Borders et al., 2008).

Based on our review of the substance use literature, we selected and included potential confounders of the relationship between stimulant use and an AUD. Time-invariant covariates, or those that were assessed at the baseline interview and did not change over time, included gender, race/ethnicity (White, Black/African American, and other), and the state where the study was conducted (Arkansas, Kentucky, or Ohio). Time-variant covariates, or those that were assessed at baseline and were reassessed at each follow-up interview, included age, educational attainment (high school education and more than a high school education vs. less than a high school education), marital status (married vs. single), the Brief Symptom Inventory–Global Severity Index (BSI-GSI) to assess overall psychological distress in the past week (Derogatis and Melisaratos, 1983), and the Patient Health Questionnaire-9 (PHQ-9) to assess for the presence of a major depressive disorder (Kroenke et al., 2001).

We also included time-variant binary variables indicating the past-30-day use of the following commonly used substances, or drugs that were used by more than 10% of the sample at the baseline interview: marijuana, amphetamines,

nonprescribed tranquilizers, and nonprescribed prescription painkillers such as oxycodone. Although no participants were receiving formal substance use treatment in the 30 days before the baseline interview, they could have received treatment over the follow-up period. Therefore, we included a binary variable that was set at 1 at the first follow-up interview for which a participant reported receiving treatment (e.g., if a person reported treatment at the 12-month interview, then the treatment variable was repeated as 1 throughout the remaining interviews).

Religiosity was assessed by three items, but rather than creating a summary religiosity variable, we treated each as a separate variable for two primary reasons. First, the Cronbach’s coefficient alpha for the three items measured at the first interview was .696, indicating marginal internal consistency. Second, prior research indicates that specific dimensions of religiousness may be differentially associated with an AUD (Borders et al., 2010). The first question measured overall religiosity by asking “How religious do you feel you are?” Response options were on a 5-point scale ranging from 1 (*not at all*) to 5 (*very*). This question and its responses are similar to the overall religious self-ranking item, “To what extent do you consider yourself a religious person?” included in the General Social Survey (Smith et al., 2010). The importance of religion in one’s life was assessed by asking “How important is religion in your life?” Response options to this question were on the same 5-point scale. Third, organized religious attendance was assessed by asking, among our largely Christian sample, “How often do you go to church?” with response options of *more than once a week*, *weekly*, *monthly*, *yearly*, *holidays*, and *don’t attend*. This question and its responses also are similar to an item “How often do you attend religious services?” included in the General Social Survey (Smith et al., 2010).

Persons who engage in religious activities, such as attending church, may have stronger social support systems that enable them to better cope with their substance use. We therefore included in our analysis a summary measure of support provided by an individual’s non-drug-using social support system based on four statements. Two of the statements were adapted from the Medical Outcomes Study Social Support questionnaire (Sherbourne and Stewart, 1991): (a) “There are people I can have a good time with” and (b) “There are people who show they love or care for me.” The additional two statements were (c) “There is someone I can talk to about important decisions in my life” and (d) “There are people who recognize my abilities.” Response options for all of the statements were 1 (*strongly disagree*), 2 (*disagree*), 3 (*agree*), and 4 (*strongly agree*). Responses were averaged to create an index ranging from 1 to 4, with 4 indicating more social support. The Cronbach’s coefficient α for the social support variables measured at the baseline interview was .806, indicating reasonable internal consistency.

Statistical analysis

The frequency of a recent AUD (within the past 12 months at baseline and past 6 months at each follow-up interview) was calculated at each interview for the overall sample, and by past-30-day powder cocaine, crack cocaine, and methamphetamine use. Because we had longitudinal data with repeated measures collected from the same participants, we conducted multivariate generalized estimating equations (GEE) using the PROC GENMOD commands in SAS/STAT Version 9.3 (SAS Institute Inc., Cary, NC). GEE is an extension to generalized linear models that use quasi-likelihood estimation and is frequently used in longitudinal analyses (Twisk, 2003). A major benefit of GEE is that it allows for the inclusion of all possible data in the analyses rather than excluding participants who did not have information for any of the six follow-up interviews. Time (the baseline, 6-, 12-, 18-, 24-, 30-, and 36-month interviews) was treated as a linear variable, thereby allowing us to determine whether there were changes in the odds of an AUD from baseline through the study follow-up period. With the exception of race, gender, and the state of residence, all of the independent variables were treated as time variant, meaning that their values could change over the study period. We specified two different types of GEE models, concurrent and lagged. In the concurrent model, the independent variables and the dependent variable (AUD status) are from the same interview. In the lagged model, the independent variables are from the interview immediately preceding the dependent variable.

Results

Descriptive statistics

Table 1 displays baseline descriptive statistics. As described earlier, all participants had to be using crack cocaine, powder cocaine, and/or methamphetamine at study entry. Thus, the use of each of these drugs was frequent. Several other illicit drugs, including marijuana, amphetamines, nonprescribed tranquilizers, and nonprescribed prescription painkillers, also frequently were used.

Regarding the religiosity measures, the mean scores were 2.94 for “how much you feel religious” and approximately 3.26 for “importance of religion in life” on a 5-point scale ranging from *not at all* (1) to *very* (5). The mean score for the frequency of religious attendance was 2.30 on a 6-point scale from *do not attend* (1) to *attend more than once a week* (6). The sample had a high mean level of social support of 3.24 on a 4-point scale.

Regarding mental health, the mean BSI-GSI was 0.86, indicating that the sample had a high level of overall psychological distress. The PHQ-9 indicated that approximately 32% of the sample met criteria for major depression.

TABLE 1. Baseline descriptive statistics

Variable	Baseline % or <i>M</i> (<i>SD</i>)
Past-30-day drug use, yes vs. no	
Crack cocaine	59.15%
Powder cocaine	48.59%
Methamphetamine	43.24%
Marijuana	80.99%
Amphetamine	12.39%
Tranquilizers	26.66%
Nonprescribed prescription painkillers	45.63%
Religiosity ^a	
How much feel religious, continuous, 1–5	2.94 (1.17)
Importance of religion in life, continuous, 1–5	3.26 (1.40)
Frequency of church attendance, continuous, 1–6	2.30 (1.60)
Social support, continuous, 1–4 scale ^b	3.24 (0.58)
Mental health	
BSI-GSI, continuous, 0–1 scale ^c	0.86 (0.70)
PHQ-9 MDD	32.28%
Sociodemographics	
Age in years, continuous	33.05 (10.35)
Gender	
Male	61.41%
Female	38.59%
Race	
African American	29.30%
White	67.88%
Other	2.82%
Educational status	
<High school	41.40%
High school	42.68%
>High school	15.92%
Marital status	
Married, vs. single	15.77%
Single	84.23%

Notes: BSI-GSI = Brief Symptom Inventory–Global Severity Index; PHQ-9 MDD = Patient Health Questionnaire-9 major depressive disorder. ^aFor the religiosity variables, a higher score indicates greater religiosity; ^bfor the social support scale, a higher score indicates greater social support; ^cfor the BSI-GSI, a higher score indicates worse global psychological distress.

Regarding social and demographic factors, the sample was rather young, with a mean age of 33 years, approximately evenly distributed across the three states where the study was conducted; mostly male (61.41%); mostly White (67.88% White, 29.30% Black/African American, and 2.82% other races); lowly educated (41.40% had less than a high school education, 42.68% had a high school degree/equivalency, and 15.92% had more than a high school education); and mostly single (15.77% were married).

The first row in Table 2 describes the frequency of an AUD for the total sample. As noted earlier, at the baseline interview we assessed whether persons had an AUD in the prior 12 months, whereas in the follow-up interviews we assessed whether persons had an AUD in the prior 6 months. Among the total sample at baseline, approximately 57% met criteria for a past-12-month AUD; at the 6-month interview, approximately 39% met criteria for an AUD, and this declined to 26% at the 36-month follow-up. Table 2 also shows the frequency of an AUD by the past-30-day use/no use of powder cocaine, crack cocaine, and methamphetamine at each interview. At each interview, the frequency of an AUD

TABLE 2. Frequency of an alcohol use disorder (AUD) at each interview for the total sample and by past-30-day powder cocaine, crack cocaine, and methamphetamine use

Interview	AUD, %						
	Baseline (<i>n</i> = 710)	6 mo. (<i>n</i> = 601)	12 mo. (<i>n</i> = 581)	18 mo. (<i>n</i> = 575)	24 mo. (<i>n</i> = 561)	30 mo. (<i>n</i> = 563)	36 mo. (<i>n</i> = 519)
Total sample	56.62	38.60	34.94	30.78	31.37	29.31	26.01
Powder cocaine use, past 30 days							
Yes	64.35	52.44	45.71	37.98	41.07	34.29	44.05
No	49.32	33.41	31.52	28.70	28.95	28.17	22.53
Crack cocaine use, past 30 days							
Yes	63.33	44.44	43.14	35.86	38.04	36.96	28.40
No	46.90	34.64	30.50	28.12	28.12	25.59	24.86
Meth. use, past 30 days							
Yes	53.42	32.69	32.17	26.67	32.76	20.75	21.28
No	59.06	40.67	35.62	31.55	31.21	30.20	26.48

Notes: At baseline, the AUD time frame is 12 months; at each follow-up, the AUD time frame is 6 months. Mo. = month, meth. = methamphetamine.

was higher among persons reporting past-30-day powder and crack cocaine use compared with no use. For example, at the baseline interview, 64% of persons who had used powder cocaine in the past 30 days met criteria for a past-12-month AUD compared with 49% of persons who did not use powder cocaine. Similarly, 63% of persons using crack cocaine in the past 30 days met criteria for a past-12-month AUD compared with 47% of persons who did not use crack cocaine. However, at the baseline interview, the frequency of an AUD was lower (53%) among persons reporting past-30-day methamphetamine use compared with persons not using methamphetamine (59%). By the 36-month interview, the frequency of an AUD declined for persons using and not using powder cocaine, crack cocaine, and methamphetamine.

Although not shown in the tables, we also calculated the frequency of alcohol abuse and alcohol dependence. At the baseline interview, 19.15% met criteria for past-12-month alcohol abuse, and 37.46% met criteria for alcohol dependence. By the 36-month interview, 11.95% met criteria for past-6-month alcohol abuse, and 14.07% met criteria for past-6-month alcohol dependence.

Adjusted odds of an alcohol use disorder from concurrent generalized estimating equations model

Table 3 shows the adjusted odds ratios (ORs) from the concurrent GEE model (or the model in which the independent and dependent variables are from the same interviews) over time, including all of the independent variables. Overall, we found that the odds of having an AUD declined over time, but there was a significant interaction between crack cocaine use and time. Among persons using crack cocaine as well as those not using crack cocaine, there was a significant time effect, indicating that the odds of an AUD declined over the course of study (OR = 0.87 for those using crack

cocaine and OR = 0.93 for those not using crack cocaine). The magnitude and significance of the relationship between crack cocaine use and the odds of an AUD declined over the course of the study. At baseline, recent crack cocaine use (vs. no recent crack cocaine use) was associated with increased odds of an AUD (OR = 1.54). The magnitude of the odds ratio declined but remained significant through the 18-month interview (OR = 1.43 at 6 months, OR = 1.33 at 12 months, and OR = 1.23 at 18 months). At the 24-, 30-, and 36-month interviews, the odds of having an AUD did not differ between persons using and not using crack cocaine.

There was no interaction between time and powder cocaine use, but recent powder use was associated with increased odds of an AUD (OR = 1.21). Although methamphetamine use was not associated with AUD status, recent use of nonprescribed tranquilizers (OR = 1.28) and nonprescribed prescription painkillers (OR = 1.29) was associated with increased odds of an AUD.

Only one of the religiosity variables, the frequency of church attendance, was significant. Greater frequency of church attendance was associated with lower odds (OR = 0.94) of an AUD. Worse overall psychological functioning, as indicated by the BSI-GSI, was associated with greater odds (OR = 1.81) of an AUD. Male gender also was associated with greater odds (OR = 2.41) of an AUD.

Finally, social support, a history of prior substance use treatment, race, educational status, and marital status were not significantly associated with AUD status.

Adjusted odds of an alcohol use disorder from lagged generalized estimating equations model

Table 4 shows adjusted ORs from the lagged GEE model, or the model in which the independent variables are from the interview preceding the dependent variable. Time was not

TABLE 3. Adjusted odds ratios for an alcohol use disorder from a concurrent GEE model

Variable	AOR	[95% CI]
Time, continuous		
Past-30-day crack cocaine use		
Yes	<i>0.87</i>	[<i>0.82, 0.92</i>]
No	<i>0.93</i>	[<i>0.89, 0.98</i>]
Past-30-day crack cocaine use		
Baseline, yes vs. no	<i>1.54</i>	[<i>1.23, 1.92</i>]
6 months, yes vs. no	<i>1.43</i>	[<i>1.19, 1.71</i>]
12 months, yes vs. no	<i>1.33</i>	[<i>1.13, 1.56</i>]
18 months, yes vs. no	<i>1.23</i>	[<i>1.04, 1.46</i>]
24 months, yes vs. no	1.14	[0.94, 1.39]
30 months, yes vs. no	1.06	[0.84, 1.35]
36 months, yes vs. no	0.99	[0.74, 1.32]
Powder cocaine, yes vs. no	<i>1.21</i>	[<i>1.02, 1.44</i>]
Methamphetamine, yes vs. no	0.80	[0.63, 1.01]
Marijuana, yes vs. no	1.09	[0.92, 1.29]
Amphetamine, yes vs. no	1.34	[0.99, 1.80]
Tranquilizers, yes vs. no	<i>1.28</i>	[<i>1.08, 1.52</i>]
Nonprescribed prescription painkillers, yes vs. no	<i>1.29</i>	[<i>1.10, 1.51</i>]
Religiosity		
How much feel religious, continuous, 1–5	1.00	[0.93, 1.09]
Importance of religion in life, continuous, 1–5	1.00	[0.93, 1.08]
Frequency of church attendance, continuous, 1–6	<i>0.94</i>	[<i>0.90, 0.99</i>]
Social support	1.02	[0.90, 1.16]
Mental health		
BSI-GSI, continuous, 0–1 scale	<i>1.81</i>	[<i>1.55, 2.11</i>]
PHQ MDD, yes vs. no	1.00	[0.81, 1.24]
Substance use treatment ^a	1.17	[0.94, 1.46]
Sociodemographics		
Age in years, continuous	0.99	[0.98, 1.00]
Male, vs. female	<i>2.41</i>	[<i>1.93, 3.01</i>]
Race, vs. white		
African American	1.33	[0.98, 1.81]
Other	0.81	[0.39, 1.71]
Educational status, vs. <high school		
High school	0.83	[0.65, 1.06]
>High school	0.87	[0.62, 1.21]
Married, vs. single	0.90	[0.74, 1.10]

Notes: Analyses also were adjusted for the site of residence (Arkansas, Kentucky, or Ohio). Data in *italics* are statistically significant. GEE = generalized estimating equations; AOR = adjusted odds ratio; CI = confidence interval; BSI-GSI = Brief Symptom Inventory–Global Severity Index; PHQ-9 MDD = Patient Health Questionnaire-9 major depressive disorder. ^aIndicates if a person received formal substance use treatment in any prior 6-month period but after enrollment into the study.

associated with AUD status. In contrast to the concurrent model, there was no interaction between time and crack cocaine use. Rather, crack cocaine use was consistently associated with the odds of an AUD (OR = 1.29) across all of the interviews. Past-30-day marijuana use and amphetamine use in the prior interview were each associated with increased odds of an AUD (ORs = 1.21 and 1.59, respectively). In contrast to the concurrent model, the frequency of church attendance as assessed at the prior interview was not predictive of an AUD. None of the other religiosity measures was associated with an AUD. As was found in the concurrent model, worse BSI-GSI scores were associated with greater odds of an AUD (OR = 1.49). To some surprise, meeting criteria for major depression, as assessed by the PHQ, was associated with decreased odds of an AUD (OR = 0.68). Finally, greater age was associated with lower odds of an AUD.

Discussion

Results from both cross-sectional and treatment-based studies have shown an association between alcohol and stimulant use (Caetano and Weisner, 1995; Furr et al., 2000; Grant and Harford, 1990; Martin et al., 1996). Prior research also has shown that many rural cocaine and methamphetamine users reduce their use of cocaine and methamphetamine over time even without receiving formal substance use treatment (Borders et al., 2008). Explanations for this spontaneous remission remain unclear, but it is possible that some persons simply “burn out” from using stimulants or that they substitute their use of stimulants with other illicit or legal substances, such as alcohol. In fact, in a related study, we found that different trajectories of powder cocaine, crack cocaine, and methamphetamine use are associated with heavy

TABLE 4. Adjusted odds ratios for an alcohol use disorder from a lagged GEE model

Variable	AOR	[95% CI]
Time, continuous	0.96	[0.92, 1.01]
Crack cocaine use	<i>1.29</i>	<i>[1.05, 1.58]</i>
Powder cocaine, yes vs. no	1.14	[0.95, 1.37]
Methamphetamine, yes vs. no	0.90	[0.71, 1.14]
Marijuana, yes vs. no	<i>1.21</i>	<i>[1.01, 1.44]</i>
Amphetamine, yes vs. no	<i>1.59</i>	<i>[1.19, 2.12]</i>
Tranquilizers, yes vs. no	1.05	[0.86, 1.27]
Nonprescribed prescription painkillers, yes vs. no	1.08	[0.89, 1.30]
Religiosity		
How much feel religious, continuous, 1–5	0.96	[0.87, 1.05]
Importance of religion in life, continuous, 1–5	1.08	[0.99, 1.17]
Frequency of church attendance, continuous, 1–6	0.99	[0.94, 1.05]
Social support, continuous, 1–4 scale	0.95	[0.83, 1.09]
Mental health		
BSI-GSI, continuous, 0–1 scale	<i>1.49</i>	<i>[1.26, 1.76]</i>
PHQ MDD, yes vs. no	<i>0.68</i>	<i>[0.53, 0.86]</i>
Substance use treatment ^a	1.09	[0.86, 1.37]
Sociodemographics		
Age in years, continuous	<i>0.98</i>	<i>[0.97, 0.99]</i>
Male, vs. female	1.22	[0.97, 1.54]
Race, vs. white		
African American	1.27	[0.92, 1.74]
Other	0.89	[0.39, 2.02]
Educational status, vs. <high school		
High school	0.94	[0.72, 1.22]
>High school	0.81	[0.56, 1.16]
Married, vs. single	0.88	[0.71, 1.10]

Notes: Analyses also were adjusted for the site of residence (Arkansas, Kentucky, or Ohio). Data in *italics* are statistically significant. GEE = generalized estimating equations; AOR = adjusted odds ratio; CI = confidence interval; BSI-GSI = Brief Symptom Inventory–Global Severity Index; PHQ-9 MDD = Patient Health Questionnaire-9 major depressive disorder. ^aIndicates if a person received formal substance use treatment in any prior 6-month period but after enrollment into the study.

drinking (Borders and Booth, 2012). Specifically, we found that persons who had a longitudinal trajectory of steady and moderate powder cocaine use had significantly more heavy drinking days than those with a trajectory characterized by a rapid decline to low powder cocaine use. Persons who had trajectories of steady and high as well as declining crack cocaine use had significantly more heavy drinking days compared with those with a rapid decline to low crack cocaine use. These findings raised the question as to whether many stimulant users have an increased risk of an AUD.

A primary objective of this current report was to examine changes in the frequency of an AUD over time among users of cocaine and methamphetamine. In unadjusted analyses, there was a clear reduction in the frequency of a past-6-month diagnosis of an AUD from 39% at the 6-month interview to 26% at the 36-month interview. Our analyses adjusting for other factors yielded mixed findings. In the concurrent model, or the model in which the dependent and independent variables were from the same interview, there was a significant reduction in the adjusted odds of an AUD over time. A significant decline in the frequency of an AUD is obviously a positive event, but we acknowledge that participants may have attenuated their responses to the AUD questions over time. Although our findings provide some

evidence that rural stimulant users' odds of an AUD decline over time, such declines may occur more rapidly with the provision of appropriate treatment programs. In contrast, in the lagged model, or the model in which the dependent variable was from the interview immediately following the independent variables, there was no significant change in the odds of an AUD. One explanation for these divergent findings is a lower level of power in the lagged model because AUD status was available from only 6 time points, as compared with the 7 time points in the concurrent model.

A second objective of this study was to determine whether particular groups of cocaine or methamphetamine users were at increased risk for continuing to have an AUD. In our concurrent model, having an AUD was associated with recent crack and powder cocaine use, although the relationship with crack cocaine use declined over time. Our lagged model provided additional evidence that crack cocaine use in a prior interview is prospectively associated with increased odds of an AUD. Persons using powder cocaine also had increased odds of an AUD in the concurrent, but not the lagged, analyses. To some surprise, methamphetamine use was not associated with AUD status in either model. One potential explanation for this finding is that there was a very steep decline in methamphetamine use over time (Borders

and Booth, 2012; Borders et al., 2008). Taken as a whole, our findings suggest that public health professionals should consider allocating scarce resources by specifically targeting alcohol prevention and treatment programs toward rural stimulant users using cocaine.

A third objective of this study was to determine whether various aspects of religiosity might help to protect against maintaining or developing an AUD. Neither self-reported religiousness nor the importance of religion in one's life was related to AUD status. However, in our concurrent analyses, persons with greater frequency of church attendance had lower odds of an AUD. This relationship remained even after adjusting for social support, which theoretically could be associated with church attendance. Additional research is necessary to further understand how church attendance helps some rural stimulant users cope with their alcohol consumption, but this is potentially a means of helping to protect against their development of an AUD, at least in the rural South. Of course, it also is possible that there is an opposite direction of the relationship between church attendance and alcohol consequences. Some persons may have reduced their alcohol consumption and then made the decision to attend church, which could explain why church attendance was nonsignificant in the lagged model. Moreover, we acknowledge that some persons may have continued to use cocaine over time while they were attending church. Finally, religiosity may help to protect against the decision to use stimulants in the first place, but this question was beyond the scope of the current study.

Our findings also indicate that other subgroups of rural stimulant users are at heightened risk for developing or maintaining an AUD. Persons in our sample with poorer overall mental health, as evidenced by scores on the BSI-GSI, had greater odds of an AUD status in our concurrent analysis. Thus, greater access to mental health services could also help to prevent the onset of an AUD among rural stimulant users. In addition, as has been found nationally (Grant et al., 2004), male stimulant users in our sample had substantially greater odds of an AUD compared with female stimulant users, underscoring the potential need to target and tailor substance use prevention and treatment services toward rural men.

A major strength of the research described herein is that it was carried out in three different rural regions of the United States. Rural-specific research is greatly needed, because there is evidence that the risk of an AUD differs greatly across rural, suburban, and urban areas (Borders and Booth, 2007b). However, we recognize that the results may not be applicable to other distinct urban or rural areas. A strength as well as a limitation of this study is that it used RDS to identify illicit drug users. Use of nonrandom sampling may raise additional concerns with generalizability and bias. However, the gold standard (random sampling) is not feasible with hidden and rare populations such as illicit drug users. RDS

is a variant of chain-referral sampling, a strategy that has been used successfully in drug use research for decades. In essence, RDS expands on snowball sampling by adding incentives to recruit eligible participants. We believe that this strategy enhanced our ability to recruit extremely stigmatized and hidden cocaine and methamphetamine users. There also may be concerns with potential variation in methods across the study sites. However, data collection was closely monitored by the investigators and staff members to ensure that the recruitment and data collection methods were consistent.

In closing, this study advances understanding of the frequency of an AUD and how the recent use of powder cocaine, crack cocaine, and methamphetamine is associated with the risk of an AUD among stimulant users residing in rural areas. AUDs are clearly of concern among this population subgroup because a high proportion satisfied criteria for recent alcohol abuse or dependence. Our findings indicate that rural users of cocaine have heightened odds of maintaining or developing an AUD, at least over the course of 3 years. In addition, our findings suggest that the frequency of church attendance is concurrently associated with lower odds of having an AUD.

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