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A Multivariate Analysis of the Sociodemographic Predictors of Methamphetamine Production and Us

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Abstract

To date, research testing the community characteristics associated with methamphetamine production and use has found that the community-level sociodemographic predictors of methamphetamine production and use vary from those of drug use in general. In this study, the authors furthered the research in this area using data from all 102 counties in Illinois. These data included measures of sociodemographic characteristics taken from the U.S. census, measures of methamphetamine production and use, and a measure of arrests for controlled-substance violations. Negative binomial regression models showed that poverty and the racial and ethnic compositions of communities were the strongest and most consistent predictors of the authors' methamphetamine measures. The results also showed that the sociodemographic characteristics associated with methamphetamine measures were different in important ways from those associated with arrests for controlled-substance violations.

Keywords

methamphetamine, community, sociodemographic

The emergence and subsequent proliferation of methamphetamine is an important public policy issue. The 2004 National Survey on Drug Use and Health found that approximately 11.7 million people older than 12 years of age had used methamphetamine (U.S. Department of Health and Human Services, 2006). The growth of the methamphetamine problem is illustrated by changes in the national rate of admissions to drug treatment for methamphetamine. Treatment admission rates for methamphetamine increased by over 400% between 1993 and 2003, from 13 to 56 admissions per 100,000 population (Drug and Alcohol Services Information System, 2006).[1] Increases in the methamphetamine problem are further evident in changes to methamphetamine-related admissions to hospital emergency rooms. According to Drug Abuse Warning Network (2006) data, in 2004, there were 73,400 methamphetamine-related visits to hospital emergency rooms, up from 13,505 visits in 2000, an increase of over 440%.

In addition to describing trends, research on methamphetamine has also focused on understanding its physiological impacts (Bae et al., 2006), the most effective treatment approaches for methamphetamine addiction (Cretzmeyer, Sarrazin, Huber, Block, & Hall, 2003; Roll et al., 2006), the organization of the methamphetamine industry (Jenkins, 1992), and the environmental impacts of methamphetamine production (Centers for Disease Control and Prevention, 2000). Studies of methamphetamine use have also explored its behavioral con- sequences, including high-risk sexual behavior (Bogart et al., 2005) and, to a limited extent, violence (Cohen et al., 2003).

Although work in the areas described above is very important, there is only a limited literature addressing the community correlates of methamphetamine use and production. This limitation is particularly problematic in an environment in which criminal justice system policy regarding methamphetamine is rapidly evolving. To effectively combat methamphetamine use and production, decision makers need to understand the characteristics of communities that are at risk for high rates of methamphetamine production and use. Such an understanding will facilitate the most efficient allocation of resources, helping ensure that communities most in need of methamphetamine prevention and treatment-related resources receive them.

To inform public policy formulated to address the methamphetamine problem, the

current study examined the characteristics of communities that predict methamphetamine production and use. Using data from all counties in the state of Illinois, we advance the existing literature with multivariate negative binomial regression models testing the relationship between county characteristics and three indicators of methamphetamine production and use: (a) submissions of methamphetamine to state police labs for testing, (b) methamphetamine lab seizures, and (c) treatment admissions for methamphetamine.

Community Characteristics and Drug Use

Given the limited literature testing the relationship between community characteristics and methamphetamine production and use, we begin with a discussion of research testing the relationship between community characteristics and drug use in general. Studies examining the community characteristics associated with drug use have found that many of the community-level sociodemographic characteristics used in ecological explanations of crime also predict drug use. Ecological explanations of crime include social disorganization theory and more contemporary explanations of crime consistent with the basic social disorganization model. In Shaw and McKay's (1948) original articulation of social disorganization theory, community characteristics contribute to rates of delinquency through their influence on the ability of communities to realize shared values or address jointly experienced problems (Bursik, 1988). The social disorganization model identified by Kornhauser (1978) holds that com- munity structural characteristics, including poverty, population heterogeneity, and mobility, are related to rates of crime and delinquency through their influence on community social control. Sampson, Raudenbush, and Earls (1997) offered a contemporary ecological explanation of crime consistent with the basic social disorganization model. In this explanation, community structural characteristics, including concentrated disadvantage, immigrant concentration, and residential stability, affect violent crime directly and indirectly through their influence on collective efficacy.

Research testing the community-level correlates of drug use has found that the community structural characteristics important to both early social disorganization theory and to more contemporary explanations of community influences on crime are also

important predictors of drug use. This research has found that both survey respondents' perceptions of neighborhood conditions (Arthur, Hawkins, Pollard, Catalano, & Baglioni, 2002; Hawkins, Arthur, & Catalano, 1995; Hawkins, Catalano, & Miller 1992; Jang & Johnson, 2001) and community measures based on census data (Boardman, Finch, Ellison, Williams, & Jackson, 2001; Esbensen & Huizinga, 1990; Ford & Beveridge, 2006) are predictive of drug use and drug sales. In early work with census-data measures of community characteristics, bivariate analyses showed that drug use is highest in socially disorganized neighborhoods with elevated levels of poverty and unemployment (Esbensen & Huizinga, 1990). More recent work using hierarchical linear models to analyze data with large numbers of respondents nested within census tracts has found that tract-level measures of neighborhood disadvantage based on census data are predictive of both drug use and drug sales (Boardman et al., 2001; Ford & Beveridge, 2006)

Community Characteristics and Methamphetamine Use

The studies discussed above demonstrate that the community characteristics predictive of crime also predict drug use. There is some question, however, regarding the extent to which the community-level predictors of drug use and drug sales generalize to the prediction of methamphetamine production and use. Research testing the demographic characteristics of methamphetamine users as well as studies assessing the community correlates of methamphetamine have initially demonstrated that the community sociodemographic characteristics associated with methamphetamine production and use are distinct from those associated with drug use in general.

In recent work based on Arrestee Drug Abuse Monitoring data, Herz (2000) and Pennell, Ellett, Rienck, and Grimes (1999) found that among recently booked arrestees, methamphetamine users were more likely to be White and to live in private-sector (as opposed to public) housing than those who did not use methamphetamine, but the two groups were similar in age and educational level. Should the characteristics of recently booked arrestees reflect those of the larger community, this would suggest that methamphetamine use is more prevalent in communities with less public housing and

fewer minorities.

Other bivariate research in this area has found that methamphetamine production and use are concentrated in rural areas. For example, in 2000, the National Center on Addiction and Substance Abuse at Columbia University (2000) found that self-reported rates of methamphetamine use in the prior year were elevated in rural areas. Similarly, Warner and Leukefeld (2001) showed that the percentage of inmates reporting methamphetamine use in the past 30 days was higher among inmates incarcerated from rural areas (30.0%) than among those incarcerated from urban areas (23.1%).

Weisheit and Fuller (2004) tested the community-level predictors of methamphetamine use using data describing county sociodemographic characteristics and methamphetamine lab seizures in Illinois during 2002. Their results demonstrated that at the bivariate level, counties with more robust economies had fewer lab seizures. Weisheit and Fuller also found that measures of juvenile characteristics, including teen births, truancy, and reports of abuse or neglect, were positively correlated with methamphetamine lab seizures, whereas measures of crime rates were unrelated to lab seizures.

In the most methodologically sophisticated study in this area, Rodriguez, Katz, Webb, and Schaefer (2005) explored the relationship between community characteristics and methamphetamine use with data from the Arrestee Drug Abuse Monitoring program in Maricopa and Pima counties in Arizona. To quantify community characteristics, arrestee information was linked to U.S. census data using ZIP codes. Structured in this way, data consisted of arrestees nested within ZIP code and were analyzed with hierarchical generalized linear models.

Rodriguez et al. (2005) found that the community characteristics predictive of methamphetamine use included percentage with college educations, percent- age Spanish-speaking households, and percentage unemployed. Each of these characteristics was negatively related to positive urinalysis results for methamphetamine among recent arrestees. In contrast, a community-level measure of racial and ethnic heterogeneity was unrelated to methamphetamine use. Rodriguez et al. also included direct measures of race at the individual level and found that Hispanics, African

Americans, and Native Americans were all less likely to test positive for methamphetamine use than Whites.

The increased likelihood of positive urinalysis results for methamphetamine among Whites is in contrast to the results of Oetting et al. (2000). With data from over 600,000 students obtained through the American Drug and Alcohol Survey, Oetting et al. conducted a bivariate analysis of the relationship between race and self-report measures of lifetime methamphetamine use and methamphetamine use in the past month. Their results showed that across both measures, rates of methamphetamine use were highest for American Indians, followed consecutively by Hispanics, those categorized as of other races or ethnicities, and White non-Hispanics. African Americans and Asians had the lowest rates of use.

Differences between the results of Oetting et al. (2000) and those of Rodriguez et al. (2005) may be explained by the nature of their analyses. Rodriguez et al. conducted a multivariate analysis that accounted for a number of individual and contextual factors, whereas the analysis of Oetting et al. was bivariate. It is also possible that the contrasting results are at least in part attributable to the different measures of methamphetamine used in the respective studies. Differences in the results of the studies may also be attributable to differences in their levels of analysis. Oetting et al. analyzed data at the individual level, whereas Rodriguez et al. conducted a multilevel analysis.

In any case, these limited and varying results demonstrate that additional research in this area is needed. To better assist decision makers with the appropriate and efficient allocation of resources intended to address the rapid proliferation of methamphetamine production and use, it is critical to expand our understanding of the community structural characteristics that distinguish areas at high risk for methamphetamine manufacture and consumption. With this goal in mind, our aim in the current work was to extend earlier research on the com- munity predictors of methamphetamine. Specifically, we sought to advance the work of Weisheit and Fuller (2004) with multivariate negative binomial models allowing us to determine which community factors are the most robust predictors of methamphetamine. We also built on the work of Rodriguez et al. (2005) by including a wider range of community-level

measures and three distinct measures of methamphetamine production and use: (a) submissions of methamphetamine to state police labs for testing, (b) methamphetamine lab seizures, and (c) treatment admissions for methamphetamine. To shed light on divergent findings from previous research, we also paid particular attention to the racial compositions of the communities in our analysis.

Our analyses were structured around the two following research questions:

> *Research Question 1:* How are measures of community sociodemographic characteristics related to measures of methamphetamine production and use?
>
> *Research Question 2:* Are community measures of race important predictors of methamphetamine production and use?

Method

Data

Our analyses of the community predictors of methamphetamine production and use were based on data describing all 102 counties in Illinois. Data included measures of sociodemographic characteristics taken from the U.S. census and multiple measures of methamphetamine derived from official data provided by the Illinois Criminal Justice Information Authority (ICJIA). These measures were linked to 2000 census data at the county level. County-level measures included a number of sociodemographic characteristics potentially related to measures of methamphetamine use and production.[2]

Methamphetamine Measures

Our first methamphetamine measure was the number of methamphetamine lab seizures reported to Illinois State Police and the El Paso Intelligence Center by state agencies, local agencies, and the Drug Enforcement Administration. A lab seizure is reported when an operating lab is found or when key components of methamphetamine manufacture are found in one location. Consistent with our measure of methamphetamine submissions, lab seizures were aggregated at the county level.

Our second measure of methamphetamine was the number of submissions of methamphetamine by police agencies to crime labs in Illinois. Submissions occur when

Illinois law enforcement agencies seize methamphetamine. After agencies take possession of the drug, all or a portion of the amount seized is submitted to a crime lab for identification. For our analyses, data on the number of submissions were aggregated at the county level.

Our third measure of methamphetamine was methamphetamine-related admissions to drug treatment. Treatment admissions measured the number of individuals admitted to drug treatment for methamphetamine abuse, aggregated to the county level. Data for this measure were obtained from the Office of Alcoholism and Substance Abuse of the Illinois Department of Human Services.

We also included a measure of arrests for controlled-substance violations. This measure included arrests for methamphetamine, heroin, cocaine, and crack cocaine and is reported in ICJIA data as violations of the Illinois Controlled Substances Act.[3] Each of these measures was based on data from 2000. Descriptive statistics for these measures are presented in Table 1. Correlations among dependent variables are presented in Appendixes A and B.

Measures of County Sociodemographic Characteristics

Measures of county sociodemographic characteristics were based on the 2000 U.S. census. These measures included variables important to social disorganization theory and to contemporary explanations of the relationship between community characteristics and acts of crime and delinquency. As noted earlier, research exploring the relationship between community characteristics and drug use has found that many of these measures are demonstrably related to drug use and sales. Descriptive statistics for these measures are presented in Table 1.

Analyses included two measures of economic disadvantage: poverty and unemployment. Poverty was coded as the percentage of the population below the poverty level, and unemployment was calculated as the percentage of the eligible workforce older than 18 years that was unemployed. As a measure of residential stability, we included the percentage of households occupied by persons who had

Table 1. Descriptive Statistics for Measures of Methamphetamine and Controlled-Substance Arrests (n = 102).

Measure	*M*	*SD*
Methamphetamine measures		
Submissions	44.62	78.40
Lab seizures	16.81	28.58
Treatment admissions	24.87	56.96
Controlled-substance arrests	113.17	132.46
Sociodemographic characteristics		
Poverty	10.53	4.40
Unemployment	3.44	0.96
Residential stability	60.84	5.54
Family disruption	5.09	0.10
Education	19.11	5.30
Percentage rural population	50.99	26.58
Heterogeneity	.13	.12
Measures of race		
Percentage African American	4.46	6.74
Percentage Hispanic	2.76	3.83
Percentage White	92.56	8.26

Note: Descriptive statistics for methamphetamine measures and the controlled-substance arrest measures are based on rates per 100,000 population. Other measures, with the exception of the heterogeneity index, are percentages.

been living in the same residences since 1995 (e.g., Sampson, 1985; Warner & Pierce, 1993). Family disruption was defined as the percent- age of female-headed households (e.g., Sampson, 1985; Warner & Pierce, 1993). Education was quantified as the percentage of the population older than 18 years with less than a high school degree. In light of recent research finding that methamphetamine production and use can be concentrated in rural areas (Weisheit & Fuller, 2004), we also incorporated a measure of percentage rural population. To index the extent to which different ethnic groups were present in a particular county, we included a measure of population heterogeneity (Blau, 1977). This measure was computed on the basis of the proportions of different racial and ethnic groups:

$$\text{Heterogeneity} = 1 - [(P_{\text{Black}})^2 + (P_{\text{Hispanic}})^2 + (P_{\text{White}})^2].$$

Our analysis included three racial and ethnic designations: African American, Hispanic, and White. With three ethnic groups, the measure of heterogeneity can vary from 0, when all individuals are from a single ethnic group, to .667, when individuals are distributed equally across groups.

To address divergent findings regarding race in earlier studies of the correlates of methamphetamine (see Oetting et al., 2000; Rodriguez et al. 2005), we also included

direct measures of race in our analysis. These measures indexed percentage African American, percentage Hispanic, and percentage White. Each of these measures was calculated as the percentage of the total population identified by the census as belonging to a particular racial group.

Analysis

Our analysis began with an exploration of the multivariate relationship between community sociodemographic characteristics and measures of methamphetamine production and use and a measure of arrests for controlled substances. For this exploration, negative binomial regression models were used. These models were developed for the multivariate analysis of dependent variables on the basis of counts of events (Land, McCall, & Nagin, 1996; Lawless, 1987). Recently, Osgood (2000) generalized these models to the study of aggregate crime rates. Here, we followed the approach of Osgood and extended the use of Poisson-based regression models to the study of aggregate measures of methamphetamine use and production. In this approach, the natural logarithm of the size of the population at risk in each county was included.[4] This accounted for variation across counties in the sizes of the population at risk and transformed the Poisson-based regression model into a test of the predictors of rates rather than counts (see Gardner, Mulvey, & Shaw, 1995; King, 1989; Liao, 1994). In this stage of our analysis, the sociodemographic measures included poverty, unemployment, residential stability, family disruption, education, percentage rural, and ethnic heterogeneity.

Next we estimated multivariate models that included specific measures of race. Each of our models for this section of our analysis included all of the sociodemographic characteristics from earlier multivariate regression models, with the exception of heterogeneity, along with a single measure of race. We were unable to include multiple measures of race, because of the extremely strong correlation between percentage White and percentage African American ($r = -.939$). Race measures included percentage White, percentage African American, and percentage Hispanic. This approach resulted in a total of 12 regression models (three race measures by three methamphetamine measures and one measure of controlled-substance arrests).

Results

Community Sociodemographic Characteristics and Methamphetamine Production and Use

We addressed our first research question, how measures of community socio-demographic characteristics are related to measures of methamphetamine production and use, with negative binomial regression models. Likelihood ratio tests assessing the explanatory power of measures of sociodemographic characteristics showed that for each of our measures of methamphetamine, the inclusion of sociodemographic measures resulted in a statistically significant increase in the explanatory power of the model.[5]

The results for our first set of regression models are presented in Table 2.[6] Separate models tested the relationships between our sociodemographic measures and each of our three measures of methamphetamine production and use. We also estimated a model testing the relationship between our sociodemographic measures and arrests for controlled substances.[7]

Coefficients presented in Table 2 show that there was a robust relationship between poverty, heterogeneity, and each methamphetamine measure. The coefficients for poverty were all positive, indicating that counties with higher levels of poverty also tended to have elevated levels of submissions of methamphetamine to state police laboratories for testing, elevated levels of seizures of methamphetamine laboratories, and increased amounts of treatment admissions for methamphetamine. Regression coefficients for heterogeneity were all negative, indicating that counties with more racial heterogeneity tended to have lower levels of methamphetamine production and use.

To illustrate the relationship between poverty, heterogeneity, and our measures of methamphetamine, we graphed projected values for each of our methamphetamine measures at varying levels of poverty and heterogeneity. Figure 1A presents the predicted values of the number of submissions of meth- amphetamine for testing. These predicted values are presented across increasing levels of poverty for different levels of heterogeneity. To calculate the predicted values for these figures, low, medium, and high values were defined as the cut points for the 25th, 50th, and 75th percentiles for both poverty and heterogeneity. When estimating predicted values, all other values were

kept at their means.

A review of the trend lines in Figure 1A shows that the trend line for low heterogeneity was associated with the highest predicted values of submission across each of the poverty levels. This general pattern was also true for predicted values of methamphetamine lab seizures (Figure 1B) and treatment admissions for methamphetamine (Figure 1C). In each case, predicted values were highest when heterogeneity is lowest.

Table 2. Results for Multivariate Regression Models Testing the Association Between Sociodemographic Characteristics and Measures of Methamphetamine Use and Production.

Sociodemographic	Methamphetamine Measure				
	Admissions	Lab Arrests	Treatment	Substance Measure Submissions	Controlled-Seizures
Poverty					
b	0.241	0.357	0.285	0.100	
SE	0.056	0.064	0.059	0.039	
p	.000	.000	.000	.010	
Unemployment					
b	–0.523	–0.271	–0.059	0.099	
SE	0.185	0.200	0.197	0.146	
p	.005	.177	.766	.497	
Residential stability					
b	–0.031	–0.022	0.100	0.068	
SE	0.034	0.052	0.042	0.027	
p	.362	.675	.018	.012	
Family disruption					
b	0.253	0.474	–0.161	–0.210	
SE	0.202	0.287	0.255	0.186	
p	.211	.099	.527	.258	
Education					
b	0.086	–0.003	0.042	–0.021	
SE	0.027	0.044	0.034	0.025	
p	.002	.941	.214	.404	
Percentage rural					
b	0.000	0.016	–0.025	–0.018	
SE	0.007	0.010	0.009	0.006	
p	.994	.107	.005	.005	
Heterogeneity					
b	–9.69		–14.173	–8.7521.42	
SE		1.582	2.350	1.9101.35	
p		.000	.000	.000	.292

We also found that increases in poverty were associated with increases in the predicted values of each of our methamphetamine measures. This is illustrated by the upward slope in predicted values present at each of the heterogeneity levels in all three panels of Figure 1. The effect for poverty appeared more pronounced for the predicted values of lab seizures and the number of submissions of methamphetamine for testing. The magnitude

of the effect of poverty is reflected in the slopes of the lines in Figure 1: The steeper the slope, the larger the effect of poverty. Beyond poverty and heterogeneity, our sociodemographic measures were inconsistently related to our measures of methamphetamine. The submission of methamphetamine to state crime labs for testing was positively associated with the percentage of the population with less than a high school education but negatively associated with unemployment. Counties with higher levels of education and higher levels of unemployment tended to have lower levels of submissions of methamphetamine.

We also found that treatment admissions for methamphetamine were significantly predicted by both residential stability and percentage rural population. The relationship between treatment admissions and residential stability was positive, indicating that increases in residential stability were associated with increases in treatment admissions, whereas the relationship between treatment admissions and percent rural population was negative, indicating that increases in the percentage rural population were associated with decreases in admissions to treatment for methamphetamine.

The negative relationship between percentage rural population and treatment admissions for methamphetamine is contrary to that anticipated by earlier bivariate work finding that self-reported rates of methamphetamine use are higher in rural areas (National Center on Addiction and Substance Abuse at Columbia University, 2000; Warner & Leukefeld, 2001). It is possible that this negative relationship is explained by lower levels of treatment availability in rural counties rather than lower levels of methamphetamine use. In contrast, the results for our model testing the predictors of methamphetamine lab seizures are more consistent with this earlier work. We found a positive relationship between percentage rural population and lab seizures, but this relationship was not significant at the traditional threshold of $p < .05$.

Regression results for models testing the sociodemographic correlates of controlled-substance arrests indicated that arrests were positively related to poverty and residential stability and negatively related to percentage rural. The results also showed that controlled-substance arrests were not significantly related to heterogeneity. The lack of a relationship between heterogeneity and controlled- substance arrests is in contrast to the negative relationship between heterogeneity and methamphetamine measures found

in this study. This finding demonstrates that the sociodemographic predictors of methamphetamine are to an extent different from the sociodemographic predictors of general controlled-substance arrests.

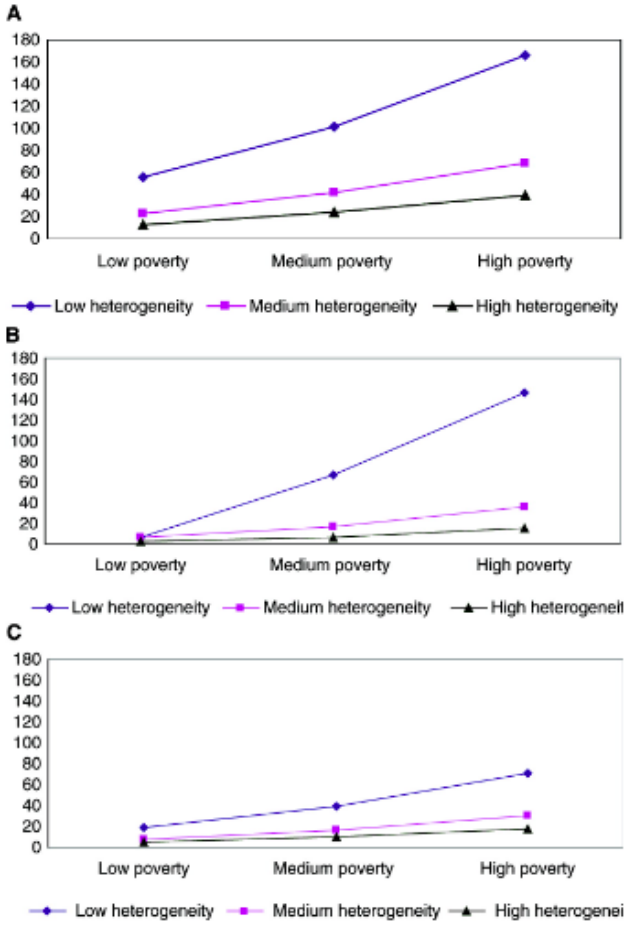

Figure 1. Changes in predicted values of methamphetamine measures: (A) submissions of methamphetamine for testing per 100,000 population, (B) methamphetamine lab seizures per 100,000 population, and (C) treatment admissions for methamphetamine per 100,000 population.

Community Measures of Race and Methamphetamine Production and Use

Next we address our second research question: Are community measures of race important predictors of methamphetamine production and use? The results of models testing the multivariate association between direct measures of race and our measure of methamphetamine are presented in Table 3. Recall that because of extremely high correlations between our race measures, we were unable to include multiple measures of race in a single model. Therefore, we estimated separate regression models for each race variable across our measures of methamphetamine

production and use and measure of controlled-substance arrests. This resulted in a total of 12 regression models.

Table 3. Results for Multivariate Regression Models Testing the Association Between Direct Measures of Race and Measures of Methamphetamine Use and Production.

	Methamphetamine Measure			
Measure of Race	Submissions	Lab Seizures	Treatment Admissions	Controlled-Substance Arrests
Percentage African American				
b	–0.119	–0.190	–0.123	0.003
SE	0.032	0.045	0.039	0.025
p	.000	.000	.002	.912
Percentage Hispanic				
b	–0.181	–0.384	–0.145	0.036
SE	0.031	0.084	0.036	0.025
p	.000	.000	.000	.157
Percentage White				
b	0.128	0.201	0.120	–0.018
SE	0.021	0.034	0.025	0.017
p	.000	.000	.000	.314

Note: To simplify the presentation of our results, we omit coefficients from nonrace sociodemographic measures. In each case, these measures were entirely consistent with the results for nonrace sociodemographic measures presented in Table 2.

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Table 3 presents coefficients only for the race measures. The coefficients for the other community characteristics associated with the methamphetamine measures are omitted because the directions, relative magnitudes, and statistical significance of these coefficients were consistent with results presented in Table 2. The results presented in Table 3 show that percentage African American and percentage Hispanic were both negatively associated with each of the methamphetamine measures. In contrast, percentage White was positively associated with each measure of methamphetamine. These results support the earlier work of Rodriguez et al. (2005), who found that rates of methamphetamine use among recent arrestees were highest for Whites.

Discussion and Conclusions

In the current work, we build on a limited but important literature addressing the correlates of methamphetamine use and production. Here we discuss our major findings in the context of prior research. In the first section of our analysis, we found that each of

our measures of methamphetamine was strongly related to poverty and the racial composition of counties. The strong positive relationship between poverty and measures of methamphetamine production and use is consistent with work that has found that summary measures of neighborhood disadvantage are related to drug sales and use (Boardman et al., 2001; Ford & Beveridge, 2006).

Our multivariate regression models also demonstrated that the community structural characteristics related to methamphetamine are to a certain extent distinct from those related to other types of drugs. In our analysis, counties with higher levels of unemployment tended to have lower levels of submissions of methamphetamine to state labs for testing (see also Rodriguez et al., 2005). Multivariate analyses also found that residential stability was positively related to treatment admissions for methamphetamine. Counties with greater stability tended to have higher levels of methamphetamine-related treatment admissions.

To extend early research showing that self-reported methamphetamine use and treatment admission for methamphetamine use are higher in rural areas, we tested the relationship between percentage rural population and each of our methamphetamine measures (Drug and Alcohol Services Information System, 2006; National Center on Addiction and Substance Abuse at Columbia University, 2000; Warner and Leukefeld, 2001). Consistent with this early research, we found that the bivariate correlation between percentage of the population that is rural and methamphetamine lab seizures was positive and statistically significant ($r = .231$, $p < .05$; not shown), but this relationship was attenuated in multivariate models. This attenuation demonstrates that the bivariate relationship between percentage rural population and our measure of methamphetamine production, lab seizures, was in part mediated by the consideration of other sociodemographic measures, including those indexing poverty and racial composition.

In the second section of our analyses, multivariate regression models tested the association between measures of race and measures of methamphetamine production and use while controlling for other community characteristics. Our findings from this section of our analysis inform prior research testing the distribution of methamphetamine use across ethnic groups. Oetting et al. (2000) found that American

Indians and Hispanics were most likely to use methamphetamine, whereas Rodriguez et al. (2005) showed that Hispanics, African Americans, and Native Americans were all less likely to test positive for methamphetamine use than Whites. Consistent with the results of Rodriguez et al., we found that our measures of methamphetamine production and use tended to be highest in counties with larger percentages of Whites and lowest in counties with larger percentages of African Americans and Hispanics.

Differences between the results of Oetting et al. (2000) and both Rodriguez et al. (2005) and the current work may be explained by the methodological features of these studies. Rodriguez et al. and the current study both used multivariate statistical techniques that accounted for contextual characteristics. In contrast, Oetting et al. assessed the bivariate relationship between methamphetamine use and race. In light of the strong relationship between poverty and the different measures of methamphetamine production and use employed in the current study, it seems reasonable to suggest that some of the elevated rates of use among Native Americans and Hispanics found by Oetting et al. may be partly explained by higher rates of poverty among these groups. It is also possible that differences in results across studies are driven by differences in measurement of methamphetamine use. In the current work, we used measures of methamphetamine submissions to state labs for testing, methamphetamine lab seizures, and methamphetamine-related admissions to drug treatment. Rodriguez et al. measured methamphetamine with positive urinalysis results among recent arrestees, whereas Oetting et al. used survey data. Although each method has its strengths and weaknesses, confluence between the current results and those of Rodriguez et al. does suggest that when contextual characteristics are taken into account, rates of methamphetamine production and use are higher among Whites.

Theoretical Implications

Prior to discussing the theoretical implications of the current work, it is important to acknowledge that we must be cautious when applying our results to ecological explanations of crime. Our data were measured at the county level and in many cases do not approximate the concept of community as articulated by social disorganization theory and other contemporary ecological explanations of crime. However, the application

of analyses based on county-level data to eco- logical explanations of crime is not without precedent (see Osgood & Chambers, 2000). Furthermore, Land et al. (1996) found that the structural correlates of crime rates are robust across the city, county, and state levels of aggregation. Thus, we should anticipate that the relationships found in our county level analysis will parallel those that would be found with a more precise operationalization of community. Finally, we note that our analysis is an initial assessment of the extent to which the community-level predictors of crime emphasized in social disorganization theory also apply to methamphetamine production and use. Because there is no prior research addressing this issue, the current work represents a meaningful extension of the literature.

Our results suggest that within the social disorganization perspective, the structural characteristics important for the prediction of methamphetamine vary from those important to the prediction of general drug use and other acts of crime and delinquency. More specifically, the community structural characteristics that are important for methamphetamine appear to be poverty and direct measures of race, with percentage White being positively associated with meth- amphetamine and percentage African American and percentage Hispanic being negatively associated with methamphetamine. In our analysis, poverty was only marginally related ($p < .10$) to our measure of general drug involvement, controlled-substance arrests, and the relationship between percentage White and controlled-substance arrests was negative and lacked statistical significance.

The relationship between poverty and methamphetamine is consistent with social disorganization theory and suggests that poverty may have both direct effects on methamphetamine use and production and indirect effects through key community dynamics, including informal social control. The social disorganization model identified by Kornhauser (1978) holds that structural variables such as community mobility, heterogeneity, and poverty will affect crime through an influence on community social control. This occurs when heterogeneity and poverty undermine community cohesion, thereby reducing the willingness of residents to intervene in situations conducive to crime. Our results demonstrate a link between poverty and methamphetamine, future work should test the possibility that this link is explained by the influence of poverty on

social control.

The strong persistent link between percentage White and methamphetamine is difficult to interpret within social disorganization theory. In the data analyzed here, communities with higher percentages of residents identified as White are more homogeneous. Social disorganization theory argues that more homogeneous and less heterogeneous communities should have higher levels of social control and lower levels of crime (Bursik, 1988; Kornhauser, 1978; Shaw & McKay, 1948). In our analysis, we found that more homogeneous communities (higher percentages of residents identified as White) had higher levels of meth- amphetamine production and use. The direction of this relationship was opposite that anticipated by social disorganization theory. It is possible that the relationship between percentage White and methamphetamine may be explained by variables outside traditional social disorganization theory. For example, it may be that methamphetamine is more widely available in communities with larger percentages of Whites. This suggestion seems to be supported in our analysis by the relationship between percentage White and methamphetamine laboratory seizures. In any case, specifying the community characteristics that mediate the relationship between structural characteristics, such as poverty and percentage White, and methamphetamine will require data that incorporate measures of these community characteristics. As such, data with measures of community characteristics including community social control and the availability of meth- amphetamine will be capable of making strong contributions to the literature.

We also found that residential stability over the past 5 years increases the risk for treatment admissions for methamphetamine and arrests for controlled substances. Although we are unable to draw strong conclusions regarding the cause of the positive relationship between treatment admissions for methamphetamine and arrests for controlled substances, we suspect that stability may indicate communities better able to secure the resources that are linked to the provision of treatment and the arrest of those using controlled substances. However, we are not sure why this would not result in elevated rates of submissions of methamphetamine to state labs and elevated rates of seizures of methamphetamine laboratories as well.

Our results also showed that family disruption was unrelated to measures of

methamphetamine production and use and our measure of arrests for controlled substances. It may be that the lack of a relationship between family disruption and our dependent variables is attributable to our measure of family disruption, female single-parent households. This is an indirect measure of the dimensions of family that appear reliably related to antisocial behavior, including a lack of supervision and parental support and the presence of emotional and physical abuse. More direct measures of family function will likely yield different results.

Policy Implications and Methodological Considerations

Our results demonstrate that when decision makers are crafting drug prevention policy and allocating resources, they need to be mindful of the different dimensions of the methamphetamine problem. If we allow our submissions of methamphetamine and our treatment admissions of methamphetamine variables as proxies for use, we find the community correlates of use are in some cases different from the predictors of production (lab seizures). This demonstrates that policy makers need to consider variability in the community structural characteristics associated with the different dimensions of methamphetamine when formulating policy to address these different dimensions. For example, in our results, unemployment was negatively related to the submission of methamphetamine to laboratories for testing, while it was not significantly related to either lab seizures or admissions to methamphetamine treatment. This suggests that policies implemented in areas with low levels of unemployment may have a larger impact on submissions of methamphetamine by virtue of the fact that submissions occur at elevated levels in these communities. We should note, however, that strong inference regarding the relationship between com- munity sociodemographic characteristics and methamphetamine production and use awaits further evidence.

The key findings of our analysis should be interpreted in the context of the important methodological features of our study, including the unit of analysis and our measures of methamphetamine. To further the research base for policy makers attempting to create an evidence-based response to the methamphetamine problem, we assessed the community structural characteristics that are associated with methamphetamine production and use. Our unit of analysis in this effort was at the county level. As such,

our findings do not necessarily generalize to individuals. Robinson (1950) demonstrated that the pattern of relationships between the characteristics of individuals and a phenomenon of interest may be different from the pattern of relationships between the characteristics of groups and that phenomenon. In the context of our analysis, this means that the county-level correlates of methamphetamine use and production may be different from the individual- level correlates of methamphetamine use and production.

Our measures of methamphetamine are also important to an understanding of the implications of our analysis. Although our multiple measures of methamphetamine allow us to make an important contribution to the existing literature, these measures are limited by the extent to which they may be influenced by things other than the manufacture and consumption of methamphetamine. A consideration of our measure of seizures of methamphetamine laboratories can illustrate this point. The number of seizures of methamphetamine laboratories in a particular county is likely influenced by both the volume of methamphetamine production and the level of criminal justice system enforcement efforts. Although a similar point may be made about our measure of submissions of methamphetamine to state laboratories for testing, it seems reasonable to suggest that our measure of admissions to treatment for methamphetamine addiction is less directly influenced by criminal justice system policy. It is also important to recognize that our measure of submissions of methamphetamine to labs for testing is a simple count and does not take into account the amount of methamphetamine seized.

While acknowledging the potential limitations of our measures, we argue that the measures are not unduly influenced by measurement error. This argument is supported by the nature of our results. In our results, we found consistent relationships between certain sociodemographic characteristics and diverse methamphetamine measures. Furthermore, we would note that despite any limitations in our measurement strategy, our results still represent a substantial extension of the existing literature.

Methamphetamine is a rapidly growing and important public policy problem. Currently, public policy, including criminal justice system policy and treatment efforts, is evolving in an environment in which there is little sound research. Doubtless, policy makers find it hard to create evidence-based policy when there is not much evidence. Although our analysis offers a substantial contribution to the existing research on the

correlates of methamphetamine, additional research is needed to provide a solid research base to inform decisions regarding how to best address the methamphetamine problem. Possible avenues for further research include additions to the research on the relationship between community structural characteristics and methamphetamine. In this area, advances to the literature may be realized through multilevel data, with individuals nested within communities, and through the use of multiple measures of methamphetamine.

Appendix A

Correlations Between Dependent Variables (n = 102)

	Submissions	Lab Seizures	Treatment Admissions
Submissions Lab seizures	.517 (.000)		
Treatment admissions	.726 (.000)	.217 (.029)	
Controlled-substance arrests	.307 (.002)	−.043 (.669)	.300 (.002)

Appendix B

Correlations Between Sociodemographic Measures (n = 102)

	1	2	3	4	5	6
1. Poverty						
2. Unemployment (.000)	.689					
3. Residential stability	−.161 (.107)	−.229 (.002)				
4. Family disruption	.590 (.000)	.531 (.000)	−.319 (.001)			

(continued)

Appendix B (continued)

	1	2	3	4	5	6
5. Education	.470 (.000)	.150 (.132)	.287 (.003)	.175 (.079)		
6. Percentage rural	.121 (.226)	−.074 (.459)	.685 (.000)	−.406 (.000)	.331 (.001)	
7. Heterogeneity	.347 (.000)	.344 (.000)	−.566 (.000)	.707 (.000)	.166 (.095)	−.553 (.000)

Authors' Note

Points of view or opinions contained within this article are those of the authors and do not necessarily represent the official position or policies of the U.S. Department of Justice or the ICJIA.

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Notes

1. These rates are for the population aged 12 years or older.
2. We wish to note that despite offering social disorganization theory as a conceptual framework for our analysis, the current work was a test of the community correlates of methamphetamine production and use, not a test of social disorganization theory. Furthermore, although we draw theoretical implications for social disorganization theory in “Discussion and Conclusions,” we acknowledge that these implications are limited by the use of county-level data in our test. The limitations of the use of county-level data for inferences regarding social disorganization theory are addressed in “Discussion and Conclusions.”
3. ICJIA data do not include a specific measure of arrests for methamphetamine. Information on arrests for methamphetamine is incorporated only in the measure of violations of the Illinois Controlled Substances Act.
4. The population at risk refers to those aged 18 to 64 years.
5. The likelihood ratio test compares the log likelihood of a baseline model to the log likelihood of the full model. For the test, twice the difference of the log like- lihoods is assessed relative to the χ^2 distribution. Degrees of freedom are equal to the difference in the number of parameters between the two models that are being compared. For further explanation of the likelihood ratio test in the context of negative binomial regression models, see Osgood (2000).
6. Prior to multivariate analysis, the extent to which regression models were potentially

influenced by multicollinearity was explored. For this exploration, we examined correlations among the sociodemographic measures used in our analysis and followed a procedure outlined by Osgood and Chambers (2000) that assesses the extent to which correlation among independent variables results in variance inflation by comparing the variance of regression coefficients in reduced models with the variance of regression coefficients in models including variables that may result in multicollinearity. Following this procedure, we found that our results were uninfluenced by multicollinearity.

7. We tested the potential influence of outliers on our analysis with the procedure described by Osgood (2000). In this procedure, potential outliers are identified through the calculation of standard residuals. This resulted in the identification of four outliers. These outliers were then deleted from the data and the models reestimated. The deletion of outliers resulted in only small changes to the magnitudes of regression coefficients and no changes to statistical significance. The overall pattern of results was identical to that produced by when outliers were included. Results based on all 102 Illinois counties are presented.

References

Arthur, M. W., Hawkins, J. D., Pollard, J. A., Catalano, R. F., & Baglioni, A. J., Jr. (2002). Measuring risk and protective factors for substance use, delinquency, and other adolescent problem behaviors. *Evaluation Review*, *26*, 575-601.

Bae, S. C., Loo, I. K., Sung, Y. H., Yoo, J., Chung, A., Yoon, S. J., et al. (2006). Increased white matter hyperintensities in male methamphetamine abusers. *Drug and Alcohol Dependence*, *81*, 83-88.

Blau, P. M. (1977). *Inequality and heterogeneity: A primitive theory of social struc- ture*. New York: Free Press.

Boardman, J. D., Finch, B. K., Ellison, C. G., Williams, D. R., & Jackson, J. S. (2001). Neighborhood disadvantage, stress, and drug use among adults. *Journal of Health and Social Behavior*, *42*, 151-165.

Bogart, L. M., Kral, A. H., Scott, A., Anderson, R., Flynn, N., Gilbert, M. L., et al. (2005). Sexual risk among injection drug users recruited from syringe exchange

programs in California. *Sexually Transmitted Diseases*, *31*, 27-34.

Bursik, R. J., Jr. (1988). Social disorganization and theories of crime and delinquency: Problems and prospects. *Criminology*, *26*, 519-551.

Centers for Disease Control and Prevention. (2000). Public health consequences among first responders to emergency events associated with illicit methamphetamine laboratories. *Morbidity and Mortality Weekly Reports*, *49*(45), 1021-1024.

Cohen, J. B., Dickow, A., Horner, K., Zweben, J. E., Balabis, J., Vandersloot, D., et al. (2003). Abuse and violence history of men and women in treatment for methamphetamine dependence. *American Journal on Addictions*, *12*, 377-385.

Cretzmeyer, M., Sarrazin, M. V., Huber, D. L., Block, R. I., & Hall, J. A. (2003). Treatment of methamphetamine abuse: Research findings and clinical directions. *Journal of Substance Abuse Treatment*, *24*, 267-277.

Drug Abuse Warning Network. (2006). *Drug Abuse Warning Network, 2004: National estimates of drug-related emergency department visits*. Retrieved November 5, 2006, from https://dawninfo.samhsa.gov/files/DAWN2k4ED.htm

Drug and Alcohol Services Information System. (2006). *Trends in methamphetamine/amphetamine admission to treatment: 1993-2003*. Retrieved October 26, 2006, from http://www.oas.samhsa.gov/2k6/methTX/methTX.pdf

Esbensen, F., & Huizinga, D. (1990). Community structure and drug use: From a social disorganization perspective. *Justice Quarterly*, *7*, 691-709.

Ford, J. M., & Beveridge, A. A. (2006). Varieties of substance use and visible drug problems: Individual and neighborhood factors. *Journal of Drug Issues*, *36*, 377-392.

Gardner, W., Mulvey, E. P., & Shaw, E. C. (1995). Regression analyses of counts and rates: Poisson, over dispersed Poisson, and negative binomial. *Psychological Bulletin*, *118*, 392-405.

Hawkins, J. D., Arthur, M. W., & Catalano, R. F. (1995). Preventing substance abuse. In M. Tonry & D. Farrington (Eds.), *Crime and justice, Vol. 19: Building a safer society: Strategic approaches to crime prevention* (pp. 343-427). Chicago: University of Chicago Press.

Hawkins, J. D., Catalano, R. F., & Miller, J. Y. (1992). Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance abuse prevention. *Psychological Bulletin*, *112*, 64-105.

Herz, D. C. (2000). *Drugs in the heartland: Methamphetamine use in rural Nebraska*. Washington, DC: National Institute of Justice.

Jang, S. J., & Johnson, B. R. (2001). Neighborhood disorder, individual religiosity, and adolescent use of illicit drugs: A test of multilevel hypothesis. *Criminology*, *39*, 109-143.

Jenkins, P. (1992). The speed capital of the world: Organizing the methamphetamine industry in Philadelphia 1970-1990. *Criminal Justice Policy Review*, *6*, 18-39.

King, G. (1989). *Unifying political methodology: The likelihood theory of statistical inference*. Cambridge, UK: Cambridge University Press.

Kornhauser, R. R. (1978). *Social sources of delinquency: An appraisal of analytic methods*. Chicago: University of Chicago Press.

Land, K. C., McCall, P. L., & Nagin, D. S. (1996). A comparison of Poisson, negative binomial, and semi-parametric mixed Poisson regression models. *Sociological Methods and Research*, *24*, 387-442.

Lawless, J. F. (1987). Regression methods for Poisson process data. *Journal of the American Statistical Association*, *82*, 808-815.

Liao, T. F. (1994). *Interpreting probability models: Logit, probit, and other generalized linear models* (Sage University Paper Series on Quantitative Applications in the Social Sciences 07-101). Newbury Park, CA: Sage.

National Center on Addiction and Substance Abuse at Columbia University. (2000). *No place to hide: Substance abuse in mid-size cities and rural areas*. Retrieved October 4, 2005, from http://www.casacolumbia.org/absolutenm/ articlefiles/379-no_place_to_hide_01–28–00.pdf

Oetting, E., Deffenbacher, J., Taylor, M., Luther, N., Beauvais, F., & Edwards, R. (2000). Methamphetamine use by high school students: Recent trends, gender, and ethnicity differences, and use of other drugs. *Journal of Child and Adolescent Substance Abuse*, *10*, 33-50.

Osgood, D. W. (2000). Poisson-based regression analysis of aggregate crime rates.

Journal of Quantitative Criminology, *16*, 21-43.

Osgood, D. W., & Chambers, J. M. (2000). Social disorganization outside the metropolis: An analysis of rural youth violence. *Criminology*, *38*, 81-115.

Pennell, S., Ellett, J., Rienck, C., & Grimes J. (1999). *Meth matters: Report on meth-amphetamine users in five western cities*. Washington, DC: National Institute of Justice.

Robinson, W. S. (1950). Ecological correlations and the behavior of individuals. *American Sociological Review*, *15*, 351-357.

Rodriguez, N., Katz, C., Webb, V. J., & Schaefer, D. R. (2005). Examining the impact of individual, community, and market factors on methamphetamine use: A tale of two cities. *Journal of Drug Issues*, *35*, 665-694.

Roll, J. M., Petry, N. M., Stitzer, M. L., Brecht, M. L., Pierce, J. M., McCan, M. J., et al. (2006). Contingency management for the treatment of methamphetamine use disorders. *American Journal of Psychiatry*, *163*, 1993-1999.

Sampson, R. J. (1985). Neighborhood and crime: The structural determinants of personal victimization. *Journal of Research in Crime and Delinquency*, *22*, 7-40.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*, *277*, 918-924.

Shaw, C. R., & McKay, H. D. (1948). *Juvenile delinquency and urban areas*. Chicago: University of Chicago Press.

U.S. Department of Health and Human Services. (2006). *2004 National Survey on Drug Use and Health*. Retrieved October 23, 2006, from http://www.oas.samhsa.gov/NSDUH.htm#NSDUHinfo

Warner, B., & Leukefeld, C. G. (2001). Rural-urban differences in substance use treatment utilization among prisoners. *American Journal of Drug and Alcohol Abuse*, *27*, 265-280.

Warner, B. D., & Pierce, G. L. (1993). Reexamining social disorganization theory using calls to the police as a measure of crime. *Criminology*, *31*, 493-517.

Weisheit, R. A., & Fuller, R. J. (2004). Methamphetamines in the heartland: A review and initial exploration. *Journal of Crime and Justice*, *27*, 131-151.

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