Drug use and risk among youth in different rural contexts

Isaac C. Rhew*, J. David Hawkins, Sabrina Oesterle

Social Development Research Group, School of Social Work, University of Washington, 9725 3rd Avenue NE, #401, Seattle, WA 98115, USA

ARTICLE INFO

ABSTRACT

This study compared levels of drug use and risk and protective factors among 18,767 adolescent youths from communities of less than 50,000 in population living either on farms, in the country but not on farms, or in towns. Current alcohol use, smokeless tobacco use, inhalant use, and other illicit drug use were more prevalent among high school-aged youths living on farms than among those living in towns. Prevalence of drug use did not significantly vary across youths living in different residential contexts among middle school youths. While risk and protective factors showed associations of similar magnitude with drug use across residential location, high school students living on farms were exposed to greater numbers of risk factors across multiple domains than were students living in towns. The findings suggest that outreach to farm-dwelling youths may be particularly important for interventions seeking to prevent adolescent drug use in rural settings.

© 2011 Elsevier Ltd. All rights reserved.

1. Background

The prevention of alcohol, tobacco, and other drug use among adolescents is an important national priority (Centers for Disease Control and Prevention, 2004, Substance Abuse and Mental Health Services Administration—U.S. Department of Health and Human Services, 2007). Earlier use of drugs is associated with an elevated risk of later abuse and dependence as well as other medical and psychiatric conditions (Hingson et al., 2006). In the US in 2009, the prevalence of any lifetime use among high school students was 70% for alcohol, 46% for cigarette smoking, and 37% for marijuana (Eaton et al., 2010). Data from US National Survey on Drug Use and Health indicate geographic differences in distribution of use depending on the specific substance. For example, examining past year use across US regions among youth 12–17 years old in 2009, report of alcohol use was highest in the Northeast (32.0%) and lowest in the South (28.9%); cigarette use was highest in the Midwest (16.4%) and lowest in the Northeast (13.7%); and the West showed the highest prevalence of marijuana (15.7%) and inhalant (4.6%) use while the South showed the lowest marijuana use prevalence (11.9%) and the Northeast had the lowest inhalant use prevalence (3.0%) (Substance Abuse and Mental Health Services Administration, 2010). Studying the distribution of drug use across different spatial contexts

would further elucidate its etiology and inform prevention and treatment strategies (McLafferty, 2008).

There has been particular interest in comparing the occurrence of youth drug use between urban and rural populations. Despite previous indications that drug use during adolescence was more prevalent among urban youth, the prevalence of drug use among rural-dwelling youth now equals or has surpassed that of urban youth. Several recent studies have observed an increased likelihood of use of alcohol, smokeless tobacco, and cigarettes among rural youth compared to urban youth (Cronk and Sarvela, 1997; Hanson et al., 2009; Gfroerer et al., 2007; Aronson et al., 2009; National Center on Addiction and Substance Abuse at Columbia University, 2000; Coomber et al., in press). There is also evidence that rural youth are more likely to use drugs such as marijuana, cocaine, methamphetamines, and inhalants than are urban youth (Aronson et al., 2009; National Center on Addiction and Substance Abuse at Columbia University, 2000; Lambert et al., 2008; Gfroerer et al., 2007; Coomber et al., in press); although the literature is somewhat inconsistent (Cronk and Sarvela, 1997; Hanson et al., 2009). Further, rural youth are more likely to use alcohol in excess (e.g., binge drink) and to engage in dangerous behaviors associated with drug use such as driving under the influence of alcohol or other drugs (Lambert et al., 2008).

The problem of drug use may be increased among rural youth because of reduced access to education and treatment services due to demographic characteristics of rural families as well as the geographic context of rural areas (Conger, 1997; DeVoe et al., 2009). With the decline of agricultural, mining, and manufacturing industries over the past few decades, rural residents have experienced serious economic consequences. Because many rural

---

* Corresponding author. Tel.: +1 206 685 5208; fax: +1 206 543 4507.
E-mail addresses: rhew@u.washington.edu (I.C. Rhew),
jdh@u.washington.edu (J. David Hawkins), soe@u.washington.edu (S. Oesterle).

residents are self-employed and have low income, obtaining appropriate medical and mental health services necessary for drug education or treatment is difficult (Hutchison and Blakely, 2003). In regards to contextual factors, geographic concentration of socioeconomic disadvantage and lack of community material and social resources in rural areas may contribute to interference with substance abuse treatment (Jacobson, 2004). Further, rural social norms may also prevent utilization of services as rural residents are more likely than urban residents to cite social stigma as a reason for not utilizing mental health services compared to urban residents (Fox et al., 1999). Finally, due to the shortage of clinics and treatment centers, rural residents often must travel longer distances to receive appropriate care than those living in urban areas, which likely contributes to less utilization of needed drug abuse services (Beardsley et al., 2003; Borders and Booth, 2007).

Youths from different residential contexts may be more or less vulnerable to drug use because they are exposed to different levels of risk and protective factors for drug use; and/or because the magnitude of the associations between risk and protective factors and drug use varies across residential contexts. Different aspects of the residential environment itself may be related to drug use among youth depending on the drug outcome. For example, residential instability has been linked to a higher risk for alcohol- and marijuana-use disorders (Buu et al., 2009). Youths from more socioeconomically disadvantaged neighborhoods have been found to be less likely to use alcohol and marijuana (Snedker et al., 2009; Song et al., 2009). However, recent research suggests that neighborhood socioeconomic disadvantage is associated with increased likelihood of hospitalization due to illicit drug use (Sellstrom et al., in press). Further, general neighborhood disadvantage (based on a measure of factors including safety, disorder, and cohesion) has been found to be associated with increased opportunities for cocaine use (Crum et al., 1996).

A number of other risk and protective factors for drug use across community, school, family, and peer-individual domains have been identified (Hawkins et al., 1992). For example, within the community domain, risk factors for youth drug use include community norms favorable to drug use and community disorganization (Maddahian et al., 1988; Beyers et al., 2003). Low attachment to school and academic failure are risk factors in the school domain predictive of substance use and misuse (Hawkins et al., 1997; Mason and Windle, 2001). Youth exposed to family risk factors such as poor family management, favorable parental attitudes towards drugs, and high family conflict are more likely to use drugs (Guo et al., 2001; Peterson et al., 1994). Interactions with drug-using peers reinforce favorable attitudes towards drugs and increase access to drugs, and are associated with substance use initiation and greater levels of use (Mason and Windle, 2001). Individual characteristics such as rebelliousness and sensation seeking are also related to drug use (Scheier et al., 1999; Zuckerman, 1987).

Factors that protect against drug use and other problem behavior have also been identified across domains. Opportunities and rewards for prosocial involvement within the community, school, family, and peer domains have been found to reduce drug use (Dornbusch et al., 2001; O'Donnell et al., 1995). Additional family factors such as attachment to parents (Chassin et al., 1986; Guo et al., 2001) and peer-individual factors such as interaction with prosocial peers and belief in a moral order have also been shown to protect against drug use.

Prior research indicates that the same risk factors for drug use are present in urban and rural samples (Oetting et al., 1997). However, levels of risk have been found to differ by urban and rural classification as defined at the county level. For example, a study conducted in Midwestern states compared the cumulative number of parent-reported risk factors for drug use among youth from rural and urban

counties and found that rural youth were exposed to higher cumulative risk (Spoth et al., 2001). Examining cumulative in addition to specific risk and protection is useful in light of studies showing that the cumulative number of risk and protective factors that youth are exposed to is more predictive of a variety of problem behaviors than exposure to any single risk or protective factor (Sameroff et al., 1993; Newcomb et al., 1986). Although similar sets of risk factors have been observed among urban and rural youth, there has been some evidence to suggest that place of residence may amplify the effect of certain factors. For example, Wilson and Donnermeyer (2006) observed that the association between peer influence and alcohol use was stronger among youths living in urban counties than among those living in rural counties.

Most studies exploring comparisons between rural and urban drug use have defined rural or urban at the county level. However, within any given county classified as rural (or urban, for that matter), there are diverse residential settings with varying degrees of rurality and varied socio-environmental characteristics. A number of researchers have cautioned against treating rural areas as homogenous and have suggested that differences in health outcomes among rural residents may be as strong as differences between urban and rural residents (Philo et al., 2003; Hill and Fraser, 1995; Wainer and Chesters, 2000). Examples of different rural residential contexts can include the farm, the countryside but not on a farm, or the city/town. These settings may provide unique social ecologies. Compared to non-farming families, farming families have been subject to great financial pressures and uncertainty, their work roles are more closely tied to family roles, and they are more geographically isolated (Fraser et al., 2005). Perhaps as a reflection of the challenges of living on a farm, studies have found that farm residents show elevated anxiety and depressive symptoms as well as a higher likelihood of suicide (Gregoire, 2002; Sanne et al., 2004).

To our knowledge, only one study has compared drug use among youth living in these three different residential contexts. Using data from the Monitoring the Future study collected between 1976 and 1997, Donnermeyer and Scheer (2001) assessed drug use among 12th graders who reported either living on a farm; in the country but not on a farm; or in a city, town, or the suburbs. In both metropolitan and non-metropolitan counties, they observed that 12th graders living on farms or in the country were less likely than those dwelling in the city/town to use most types of drugs during the past year for most of the years assessed. However, examination of those data suggests that differences in drug use across residential contexts decreased in later years of that study, and levels of alcohol use, in particular, were quite similar across residential contexts during the 1990s. More recent data are needed to examine whether drug use among farm, country, and city/town-dwelling youths have become more similar as suggested by studies comparing urban vs. rural youths (Gfroerer et al., 2007; Lambert et al., 2008), or whether there are differences in adolescent drug use associated with different places of residence in nonurban settings.

Using data from a large community-randomized trial conducted in 24 small to moderate-sized towns, this study had three aims. The first was to compare the prevalence of drug use among farm-, country-, and city/town-dwelling youth. The second was to examine levels of domain-specific cumulative risk and protection across the three residential contexts. Finally, we examined whether associations between drug use and cumulative risk and protection varied in magnitude across residential contexts.

2. Methods

Data for this study were collected as part of the Community Youth Development Study (CYDS), a community-randomized trial

designed to test the efficacy of the Communities That Care (CTC) intervention program to prevent substance use and antisocial behavior among adolescent youth (Hawkins et al., 2008). This study was reviewed and approved by the Institutional Review Board at the University of Washington. The communities participating in CYDS consisted of 24 small to moderate-sized towns in Washington, Oregon, Utah, Colorado, Illinois, Kansas, and Maine. Population sizes of the communities ranged from approximately 1500–40,000 residents according to the 2000 US Census. These communities are all geographically distinct incorporated towns with clear boundaries and were not suburbs of metropolitan cities. All 24 communities are classified as rural according to the United States Department of Agriculture (USDA) Business and Industry definition of being located outside of Census places with a population of $\geq 50,000$ people, and 19 communities are located in counties that are classified as non-metropolitan as defined by Rural-Urban Continuum Codes from the USDA Economic Research Service (United States Department of Agriculture Economic Research Service, 2007). Pairs of communities were matched within states according to population size, crime rates, economic indicators, and racial/ethnic composition. In 2003, one community within each pair was randomly assigned either to the intervention or control condition.

For this study, we used data from a cross-sectional student survey administered at the pre-intervention baseline assessment during the spring of 2004. No intervention activities had yet been implemented at the time of this survey. Participants were students in the 6th, 8th, 10th, and 12th grades at public schools within each of the 24 communities. Of the 23,755 youth who attended the participating schools, 19,757 (83.2%) completed the survey. Of these students, 990 (5.0%) were excluded from analyses because they reported that they did not respond to the survey questions honestly, indicated use of a fictitious drug, or reported unrealistically frequent use of illicit drugs (e.g., 120 or more occasions of marijuana, cocaine, LSD, and inhalant use combined within the past 30 days) or antisocial behaviors (e.g., consistently reporting the same high frequency [at least 20–29 times in the past year] for each of eight behaviors). The final analysis sample consisted of 18,767 participants.

2.1. Instrument and measures

Measures of drug use, risk and protective factors, and demographic characteristics were ascertained using the Communities That Care Youth Survey (CTC-YS). This self-administered paper-and-pencil questionnaire was designed to be administered in a classroom setting during a single 50-min class period and is appropriate for adolescents aged 11–18 years (Arthur et al., 2002).

Place of residence. Participants' residential context was ascertained through asking a question "Where are you living now?" Participants were asked to indicate either: "on a farm," "in the country, not on a farm, "or" in a city, town, or suburb."

Drug use. Participants were asked to report their use of the following drugs: alcohol, cigarettes, smokeless tobacco, marijuana, inhalants, cocaine, stimulants, hallucinogens, ecstasy, and other illicit drugs. Participants indicated their frequency of use (e.g., 0 occasions, 1–2 occasions, 3–5 occasions, etc.) during their lifetime and in the past 30 days. For analyses, responses for each drug outcome were dichotomized (0 occasions vs. 1 or more occasions). Further, reports of cocaine, stimulants, hallucinogens, ecstasy, and other drugs were combined to create "Other illicit drugs" lifetime and 30 day use variables for use in analyses because of their relatively low prevalences. In addition, a separate question was asked about the frequency of binge drinking (five or more alcoholic drinks in a row) during the past two weeks.

This item was also recategorized into a dichotomous variable (0 occasions vs. 1 or more occasions).

Risk and protective factors. For this study, 32 risk and protective factors were assessed within four domains: community, school, family, and peer-individual. Table 1 presents the complete list of risk and protective factor scales used in this study. Each of these scales consisted of between two and eight items that were measured on a 4-point scale. For each scale, the individual items were standardized within grade and then averaged to calculate the composite scale score. All scales display strong internal reliability ($\alpha > 0.65$ for all scales used in this study) and validity (Arthur et al., 2002; Glaser et al., 2005). Prior studies have shown measurement invariance across racial/ethnic groups and gender, suggesting that these scales assess the factors equally well across these demographic groups (Glaser et al., 2005). For the purposes of the present analyses, cumulative risk and cumulative protection indices were created based on the total number of elevated risk and protective factors within each domain. The highest tertile of each scale was established as the cutpoint defining elevated risk or protection. The total count of risk and protective factors across domains was also calculated with a maximum possible count of 20 risk factors and 12 protective factors.

2.2. Data analysis

To address the first aim, logistic regression models were estimated to calculate odds ratios (ORs) of use versus no use of each drug by residential type. Residential type was specified as indicator variables for country and farm residence, with town residence being the referent group. Thus, the ORs for country and

Table 1
Risk and protective factor scales by domain.

Domain	Risk factors	Protective factors
Community	Low neighborhood attachment	Opportunities for prosocial involvement
	Laws favorable to drug use	Rewards for prosocial involvement
	Norms favorable to drug use	
	High community disorganization	
	Perceived availability of drugs	
School	Academic failure	Opportunities for prosocial involvement
	Low commitment to school	Rewards for prosocial involvement
Family	Poor family management	Attachment to mother
	Family conflict	Attachment to father
	Parental attitudes favorable toward drug use	Opportunities for prosocial involvement
	Parental attitudes favorable to antisocial behavior	Rewards for prosocial involvement
Peer/individual	Rebelliousness	Interaction with prosocial peers
	Perceived risks of drug use	Belief in the moral order
	Early initiation of drug use	Prosocial involvement
	Peers' favorable attitudes toward drug use	Rewards for prosocial involvement
	Peers' favorable attitudes toward antisocial behavior	
	Sensation seeking	
	Rewards for antisocial involvement	
	Friends' use of drugs	
	Interaction with antisocial peers	

farm residence indicate the relative odds for substance use compared to town-dwelling youth. For final analyses, 6th- and 8th-grade (middle school) and 10th- and 12th-grade (high school) data were combined because of relatively small samples of students who resided on a farm.

To address the second aim, Poisson regression models were used to estimate differences in the number of domain-specific elevated risk and protective factors among the residential types, stratified by grade level. Coefficients for the country and farm contexts describe the difference in the log count of risk or protective factors compared to town residence; and the exponentiated coefficients can be interpreted as the ratio of the number of risk or protective factors experienced by country- or farm-dwelling youth compared to town-dwelling youth. Robust standard errors were calculated, which provide valid standard error estimates in the presence of over-dispersion.

To address the third aim, interaction terms between residential context and domain-specific cumulative counts of risk and protective factors were created and included in logistic regression models with drug use outcomes as the dependent variables. Only those drug outcomes for which we observed a statistically significant elevation in odds among farm youth compared to town youth were selected. The significance of country by cumulative risk/protection and farm by cumulative risk/protection product terms were tested using Wald's tests. These interaction terms tested differences in the associations of cumulative risk/ protection with drug use between town-dwelling youth and country- and farm-dwelling youth. For presentation, ORs were also calculated using logistic regression describing associations between drug outcomes and cumulative risk or protection stratified by residential context.

All models were adjusted for participant age, gender, highest level of parent education, race (White, non-White), and Hispanic ethnicity. Because of the large number of comparisons tested, statistical significance was defined as $p < 0.01$. However, for tests of interactions, a less conservative $p < 0.05$ definition was chosen because of limited sample size for farm-dwelling participants.

Because this study has a nested design where individuals were sampled from 24 communities, sensitivity analyses using mixed effects logistic regression models specifying random intercepts for the 24 communities were performed for those drug outcomes showing statistically significant differences by residential context. In each case, coefficients and their standard errors were essentially unchanged, indicating that clustering did not result in biases.

Among the youths participating in this study, the percentage of missing data for substance use outcomes or risk and protective scales ranged from 2.2% to 29.7%. To account for missingness, multiple imputation was used (Graham, 2009). We created 40 imputed datasets using 'proc mi' in SAS 9.0 (SAS Institute, Cary, NC). Imputation models included all covariates and outcomes used in the analyses above as well as other individual behaviors (e.g., frequency of delinquent acts) and community characteristics. All logistic and Poisson regression models were estimated and summarized across the 40 imputations using the 'mim' procedure (Carlin et al., 2008) in Stata 10.0 (Stata Corporation, College Station, TX). Using Rubin's rules (Rubin, 1987), this procedure averages parameter estimates and calculates standard errors that account for the uncertainty of the imputed values across the multiple datasets.

3. Results

In this sample a large majority of youth (76.1%) lived in town, followed by a much smaller percentage (18.1%) living in the country

but not on a farm, and a small minority (5.9%) living on a farm. Across the 24 communities in this study, the percentage of town-dwelling youth ranged from 43% to 93%, the percentage of country-dwelling youth was between 5% and 43%, and the percentage of youth living on a farm was between 1.5% and 18.1%. Demographic characteristics according to place of residence are shown in Table 2. Compared to town-dwelling youth, country- and farm-dwelling youth included greater proportions of females, high school students, youth with parents who completed higher levels of education, White students, and non-Hispanic youths.

Table 3 presents the unadjusted prevalence estimates for substance use outcomes across the three residential contexts as well as the ORs comparing country- and farm-dwelling youth to town-dwelling youth, adjusted for demographic covariates. Among middle school students in grades 6 and 8, there were no statistically significant differences at $p < 0.01$ in drug use comparing country- to town-dwelling youth. Prevalence estimates of drug use were generally highest for middle school students living on farms; however, only smokeless tobacco use during the past 30 days was significantly higher among middle school students living on farms than among students living in town (OR=1.88; $p=0.002$). Differences in the prevalence of past-30-day alcohol and inhalant use approached, but did not reach statistical significance among farm- versus town-dwelling middle school students.

More differences in drug use across residential contexts were found among high school students in grades 10 and 12, particularly between those living on a farm and those living in town. Adjusting for individual characteristics, high school students living on farms were significantly more likely than high school youth living in town to use alcohol (OR=1.33, $p=0.004$), smokeless tobacco (OR=2.57, $p < 0.001$), inhalants (OR=2.08, $p < 0.001$), and other illicit drugs which included cocaine, stimulants, hallucinogens, ecstasy, and other drugs (OR=1.51, $p=0.002$) during the past 30 days, as well as to engage in binge drinking during the past two weeks (OR=1.37, $p=0.002$). High school students living on a farm were also significantly more likely to have used smokeless tobacco (OR=1.83, $p < 0.002$) and inhalants (OR=1.49, $p=0.001$) in their lifetimes than students living in town. When comparing high school youth living in the country to those living in town, only lifetime and past-30-day use of smokeless tobacco were significantly higher for those living in the country but not on farms (lifetime: OR=1.21, $p=0.010$; 30-day: OR=1.51, $p < 0.001$).

Addressing the second aim, Tables 4 and 5 present domain-specific unadjusted mean counts of cumulative exposure to risk

Table 2
Selected demographic characteristics according to residential type.

Characteristic	Town $N=14,286$ (%)	Country $N=3382$ (%)	Farm $N=1099$ (%)
Female	51.6	49.8	47.6
Grade			
6	29.2	25.3	23.0
8	27.8	27.1	27.0
10	24.1	25.9	26.9
12	18.9	21.7	23.1
Highest level of parent's education			
Completed high school or less	28.3	25.2	24.6
Some college	23.8	25.1	25.5
Completed college	31.5	32.7	31.8
Graduate or professional school	16.4	17.0	18.1
Non-white	27.3	20.1	25.4
Hispanic	18.8	11.7	15.5

Table 3
Prevalence and adjusted[a] odds ratios for drug use according to residential context, stratified by grade level.

Drug outcome	Middle school			High school		
	Prevalence per 100	OR	p	Prevalence per 100	OR	p
Lifetime alcohol use						
Town (ref)[b]	35.9	1.00	–	66.7	1.00	–
Country	35.5	0.99	0.843	67.1	1.05	0.447
Farm	39.1	1.14	0.189	69.6	1.15	0.179
30-day alcohol use						
Town (ref)	16.8	1.00	–	41.4	1.00	–
Country	17.4	1.07	0.423	42.4	1.07	0.294
Farm	21.2	1.31	0.024	48.3	1.33	0.004
Binge drinking, past two weeks						
Town (ref)	8.9	1.00	–	26.6	1.00	–
Country	9.0	1.05	0.620	28.3	1.10	0.143
Farm	11.3	1.29	0.092	33.7	1.37	0.002
Lifetime cigarette use						
Town (ref)	24.2	1.00	–	45.9	1.00	–
Country	21.5	0.87	0.060	46.2	1.05	0.427
Farm	23.3	0.94	0.587	44.3	0.94	0.519
30-day cigarette use						
Town (ref)	7.4	1.00	–	20.0	1.00	–
Country	7.0	0.98	.850	19.9	0.99	.861
Farm	7.7	1.03	.872	21.1	1.05	.655
Lifetime marijuana use						
Town (ref)	12.6	1.00	–	40.8	1.00	–
Country	12.3	0.99	.933	42.7	1.11	.094
Farm	14.5	1.14	.347	39.3	0.82	.047
30-day marijuana use						
Town (ref)	6.6	1.00	–	20.5	1.00	–
Country	6.4	0.98	.855	20.7	1.03	.725
Farm	7.5	1.07	.734	22.9	1.11	.343
Lifetime smokeless tobacco use						
Town (ref)	9.1	1.00	–	19.1	1.00	–
Country	11	1.24	0.029	22.5	1.21	0.010
Farm	10.8	1.18	0.318	31.4	1.83	< 0.001
30-day smokeless tobacco use						
Town (ref)	3.4	1.00	–	6.9	1.00	–
Country	4.1	1.30	0.084	10.2	1.51	< 0.001
Farm	6.1	1.88	0.002	16.3	2.57	< 0.001
Lifetime inhalant use						
Town (ref)	17.0	1.00	–	14.3	1.00	–
Country	16.1	0.95	0.497	12.9	0.90	0.226
Farm	18.3	1.12	0.367	20.3	1.49	0.001
30-day inhalant use						
Town (ref)	7.6	1.00	–	3.9	1.00	–
Country	7.9	1.05	0.644	3.4	0.90	0.523
Farm	10.6	1.49	0.013	7.9	2.08	< 0.001
Lifetime other illicit drug use[c]						
Town (ref)	9.9	1.00	–	21.9	1.00	–
Country	8.9	0.91	0.356	21.9	1.03	0.700
Farm	11.0	1.11	0.483	23.1	1.03	0.804
30-day other illicit drug use[c]						
Town (ref)	5.0	1.00	–	10.3	1.00	–
Country	5.2	1.03	0.825	11.0	1.10	0.337
Farm	5.3	1.01	0.980	15.3	1.51	0.002

[a] Adjusted for age, highest level of parental education, race, Hispanic ethnicity, and sex.
[b] (ref)=reference category.
[c] Other illicit drugs are based on report of cocaine, stimulants, hallucinogens, ecstasy, and/or other drugs.

Table 4
Cumulative risk in each domain by residential location: Mean count of risk factors and adjusted[a] Poisson regression coefficients stratified by grade level.

Risk factor domain	Middle school			High school		
	Mean (SD)	β	p	Mean (SD)	β	p
Community						
Town (ref)	1.63 (1.48)	0.000	–	1.60 (1.34)	0.000	–
Country	1.71 (1.46)	0.055	0.024	1.70 (1.33)	0.078	0.001
Farm	1.74 (1.52)	0.048	0.241	1.79 (1.36)	0.102	0.004
School						
Town (ref)	0.66 (0.76)	0.000	–	0.65 (0.75)	0.000	–
Country	0.66 (0.75)	0.002	0.940	0.69 (0.76)	0.073	0.026
Farm	0.69 (0.76)	0.038	0.450	0.74 (0.80)	0.117	0.022
Family						
Town (ref)	1.28 (1.26)	0.000	–	1.31 (1.21)	0.000	–
Country	1.28 (1.27)	0.012	0.663	1.33 (1.20)	0.030	0.269
Farm	1.32 (1.31)	0.018	0.707	1.45 (1.30)	0.089	0.033
Peer-individual						
Town (ref)	2.59 (2.49)	0.000	–	2.59 (2.39)	0.000	–
Country	2.59 (2.51)	0.009	0.730	2.70 (2.46)	0.044	0.098
Farm	2.63 (2.61)	−0.001	0.981	3.02 (2.66)	0.131	0.001
Total combined risk						
Town (ref)	6.17 (4.93)	0.000	–	6.15 (4.48)	0.000	–
Country	6.25 (4.91)	0.033	0.143	6.43 (4.47)	0.053	0.009
Farm	6.38 (5.23)	0.057	0.129	7.00 (4.95)	0.115	< 0.001

[a] Adjusted for age, highest level of parental education, race, Hispanic ethnicity, and sex.

those youths living in town. Among middle school students, there were no statistically significant differences in the cumulative number of risk factors to which youths were exposed across domains among country or farm youth compared to town youth, although there was a trend toward exposure to a higher number of elevated community risk factors among youths living in the country compared to youths living in town. There were no statistically significant differences in the counts of protective factors across the domains, although elevations in the cumulative number of community and peer-individual protective factors among farm- compared to town-dwelling middle school students approached statistical significance.

As with the drug outcomes, stronger differences emerged in cumulative risk and protection across the residential contexts among high school youths. After adjusting for demographic characteristics, farm-dwelling compared to town-dwelling youths had a 0.102 higher log count of community risk factors ($p=0.004$), and 0.131 higher log count of peer-individual ($p=0.001$) risk factors. This suggests that, compared to town-dwelling youths, high school students living on farms were exposed to 1.11 and 1.14 times the number of community and peer-individual risk factors, respectively. Further, high school students living on farms had higher counts of school ($\beta=0.117$, $p=0.022$) and family ($\beta=0.089$, $p=0.033$) risk factors compared to town-dwelling youths, but these differences did not reach statistical significance at the $p < 0.01$ level. The total combined count of risk factors across domains was 1.12 times greater among farm youths compared to town youths ($\beta=0.115$, $p < 0.001$). Despite experiencing greater cumulative risk in the community domain, high school students living on farms also were exposed to 1.22 times the number of elevated *protective* factors in the community domain ($\beta=0.20$, $p=0.003$). However, farm youths were exposed to a significantly lower number of elevated school protective factors ($\beta=-0.22$, $p < 0.001$).

There were also differences in cumulative risk and protection exposure between high school youths living in the country and

and protective factors, respectively, across residential contexts and adjusted regression coefficients from Poisson models comparing these counts among country- and farm-dwelling youths to

Table 5
Cumulative protection in each domain by residential location: Mean count of protective factors and adjusted[a] Poisson regression coefficients stratified by grade.

Protective factor domain	Middle school			High school		
	Mean (SD)	β	p	Mean (SD)	β	p
Community						
Town (ref)	0.66 (0.80)	0.000	–	0.58 (0.77)	0.000	–
Country	0.66 (0.80)	−0.023	0.504	0.60 (0.78)	0.007	0.870
Farm	0.76 (0.83)	0.133	0.012	0.71 (0.82)	0.199	0.003
School						
Town (ref)	0.67 (0.79)	0.000	–	0.69 (0.79)	0.000	–
Country	0.64 (0.79)	−0.041	0.218	0.63 (0.75)	−0.099	0.009
Farm	0.61 (0.77)	−0.079	0.165	0.55 (0.75)	−0.220	< 0.001
Family						
Town (ref)	1.22 (1.37)	0.000	–	1.34 (1.43)	0.000	–
Country	1.23 (1.38)	−0.002	0.943	1.28 (1.42)	−0.051	0.128
Farm	1.27 (1.38)	0.043	0.426	1.39 (1.47)	0.047	0.353
Peer-individual						
Town (ref)	1.33 (1.25)	0.000	–	1.33 (1.26)	0.000	–
Country	1.31 (1.24)	−0.028	0.267	1.32 (1.27)	−0.019	0.488
Farm	1.47 (1.28)	0.101	0.010	1.37 (1.23)	0.047	0.250
Total combined protection						
Town (ref)	3.89 (3.09)	0.000	–	3.94 (3.00)	0.000	–
Country	3.84 (3.06)	−0.031	0.163	3.83 (2.93)	−0.039	0.084
Farm	4.11 (3.12)	0.039	0.271	4.03 (3.07)	0.032	0.367

[a] Adjusted for age, highest level of parental education, race, Hispanic ethnicity, and sex.

Table 6
Adjusted[a] odds ratios for drug use outcomes associated with cumulative risk by domain, stratified by residential type.

Outcome	City/town		Country		Farm	
	OR	p	OR	p	OR	p
High school 30-day alcohol						
Community risk	1.64	< 0.001	1.66	< 0.001	1.77	< 0.001
School risk	1.99	< 0.001	1.96	< 0.001	1.78	< 0.001
Family risk	1.88	< 0.001	1.76	< 0.001	2.48[b]	< 0.001
Peer-individual risk	1.85	< 0.001	1.75	< 0.001	1.81	< 0.001
Total combined risk	1.36	< 0.001	1.35	< 0.001	1.40	< 0.001
High school binge						
Community risk	1.64	< 0.001	1.71	< 0.001	1.73	< 0.001
School risk	2.01	< 0.001	2.09	< 0.001	2.02	< 0.001
Family risk	1.86	< 0.001	1.82	< 0.001	2.29	< 0.001
Peer-individual risk	1.79	< 0.001	1.74	< 0.001	1.92	< 0.001
Total combined risk	1.35	< 0.001	1.37	< 0.001	1.41	< 0.001
High school lifetime smokeless						
Community risk	1.50	< 0.001	1.44	< 0.001	1.44	< 0.001
School risk	1.76	< 0.001	1.57	< 0.001	1.37	0.022
Family risk	1.58	< 0.001	1.49	< 0.001	1.53	< 0.001
Peer-individual risk	1.54	< 0.001	1.50	< 0.001	1.43	< 0.001
Total combined risk	1.24	< 0.001	1.23	< 0.001	1.19	< 0.001
Middle school 30-day smokeless						
Community risk	2.10	< 0.001	2.11	< 0.001	1.66	0.001
School risk	2.82	< 0.001	2.29	< 0.001	2.46	0.002
Family risk	2.19	< 0.001	1.88	< 0.001	1.87	< 0.001
Peer-individual risk	1.97	< 0.001	1.92	< 0.001	1.88[b]	< 0.001
Total combined risk	1.40	< 0.001	1.37	< 0.001	1.31	< 0.001
High school 30-day smokeless						
Community risk	1.52	< 0.001	1.35	< 0.001	1.32	0.006
School risk	1.98	< 0.001	1.78	< 0.001	1.43	0.031
Family risk	1.57	< 0.001	1.46	< 0.001	1.48	< 0.001
Peer-individual risk	1.54	< 0.001	1.50	< 0.001	1.35[b]	< 0.001
Total combined risk	1.25	< 0.001	1.22	< 0.001	1.16[b]	< 0.001
High school lifetime inhalants						
Community risk	1.46	< 0.001	1.69	< 0.001	1.68	< 0.001
School risk	1.97	< 0.001	1.87	< 0.001	2.25	< 0.001
Family risk	1.64	< 0.001	1.58	< 0.001	1.83	< 0.001
Peer-individual risk	1.51	< 0.001	1.49	< 0.001	1.51	< 0.001
Total combined risk	1.24	< 0.001	1.26	< 0.001	1.27	< 0.001
High school 30-day inhalants						
Community risk	1.58	< 0.001	1.84	< 0.001	1.76	< 0.001
School risk	2.15	< 0.001	2.36	< 0.001	3.81[b]	< 0.001
Family risk	1.71	< 0.001	1.74	< 0.001	2.18[b]	< 0.001
Peer-individual risk	1.59	< 0.001	1.53	< 0.001	1.73	< 0.001
Total combined risk	1.27	< 0.001	1.30	< 0.001	1.34	< 0.001
High school 30-day other illicit drugs[c]						
Community risk	1.79	< 0.001	1.77	< 0.001	1.91	< 0.001
School risk	2.30	< 0.001	2.42	< 0.001	3.36	< 0.001
Family risk	1.89	< 0.001	1.76	< 0.001	2.20	< 0.001
Peer-individual risk	1.82	< 0.001	1.84	< 0.001	2.08	< 0.001
Total combined risk	1.37	< 0.001	1.39	< 0.001	1.46	< 0.001

[a] Adjusted for age, highest level of parental education, race, Hispanic ethnicity, and sex.
[b] Risk by context interaction-$p < 0.05$.
[c] Other illicit drugs are based on report of cocaine, stimulants, hallucinogens, ecstasy, and/or other drugs.

those living in town, though these differences were generally smaller than those observed between farm- and town-dwelling youths. High school students living in the country compared to students living in towns had greater exposure to community risk factors ($\beta=0.078$, $p=0.001$) and total combined risk factors ($\beta=0.053$, $p=0.009$). In regards to protective factors, country-dwelling youths had 9.4% fewer school protective factors than did town youth ($\beta=-0.099$, $p=0.009$). No other significant differences in the number of elevated protective factors between high school students living in the country and students living in towns were observed.

Addressing the third and final aim, ORs for the association between cumulative risk and drug outcomes stratified by residential context are presented in Table 6. Higher cumulative risk in all domains was strongly associated with an increased likelihood of use for all observed drug outcomes among middle and high school students. Interaction analyses showed that few of these associations differed across residential context, and there was no systematic pattern in regards to particular domains or residential contexts where associations were consistently stronger or weaker. For example, cumulative family risk was more strongly associated with 30-day alcohol use ($OR_{farm}=2.48$; $OR_{town}=1.88$; interaction-$p=0.018$) and 30-day inhalant use ($OR_{farm}=2.18$; $OR_{town}=1.71$; interaction-$p=0.048$) among high school students

living on a farm compared to high school students living in town; but associations between 30-day smokeless tobacco use and cumulative peer-individual risk ($OR_{farm}=1.35$; $OR_{town}=1.54$; interaction-$p=0.010$) and total risk across domains ($OR_{farm}=1.16$; $OR_{town}=1.25$; interaction-$p=0.012$) were weaker among high school students living on farms compared to those living in town. The association between cumulative risk and any of the drug use outcomes did not differ significantly between students living in the country and students living in towns.

Cumulative count of protective factors also showed strong associations with drug outcomes across most domains (Table 7). With few exceptions, youth exposed to a higher number of elevated protective factors, within and across all domains, had a significantly lower likelihood of drug use. For the most part, these associations did not vary significantly across residential contexts. However, school cumulative protection was strongly and inversely associated with 30-day (OR=0.726, $p < 0.001$) and lifetime (OR=0.767, $p < 0.001$) smokeless tobacco use among town-dwelling high school-aged youths but was not statistically significantly associated among high school youths living on farms. In addition, the cumulative number of elevated family-specific

Table 7
Adjusted[a] odds ratios for drug use outcomes associated with cumulative protection by domain, stratified by residential type.

Outcome	City/town		Country		Farm	
	OR	p	OR	p	OR	p
High school 30-day alcohol						
Community	0.649	< 0.001	0.759	< 0.001	0.673	0.001
School	0.734	< 0.001	0.849	0.032	0.763	0.032
Family	0.823	< 0.001	0.872	0.001	0.794	< 0.001
Peer-individual	0.587	< 0.001	0.605	< 0.001	0.575	< 0.001
Total	0.825	< 0.001	0.855	< 0.001	0.822	< 0.001
High school binge						
Community	0.698	< 0.001	0.733	< 0.001	0.650	0.001
School	0.731	< 0.001	0.701	< 0.001	0.630	0.001
Family	0.821	< 0.001	0.844	< 0.001	0.794	0.002
Peer-individual	0.581	< 0.001	0.589	< 0.001	0.516	< 0.001
Total	0.826	< 0.001	0.827	< 0.001	0.792	< 0.001
High school lifetime smokeless						
Community	0.783	< 0.001	0.881	0.164	0.773	0.064
School	0.767	< 0.001	0.835	0.051	1.060[b]	0.674
Family	0.876	< 0.001	0.937	0.188	0.831	0.013
Peer-individual	0.683	< 0.001	0.678	< 0.001	0.693	< 0.001
Total	0.874	< 0.001	0.898	< 0.001	0.886	0.001
Middle school 30-day smokeless						
Community	0.627	< 0.001	0.488	0.006	0.506	0.058
School	0.496	< 0.001	0.532	0.005	0.465	0.036
Family	0.716	< 0.001	0.818	0.090	0.704	0.078
Peer-individual	0.474	< 0.001	0.563	< 0.001	0.691	0.060
Total	0.744	< 0.001	0.784	< 0.001	0.784	0.008
High school 30-day smokeless						
Community	0.839	0.027	0.850	0.205	0.723	0.070
School	0.726	< 0.001	0.817	0.131	1.012	0.944
Family	0.813	< 0.001	1.020[b]	0.774	0.809	0.028
Peer-individual	0.613	< 0.001	0.675	< 0.001	0.641	0.001
Total	0.843	< 0.001	0.917[b]	0.016	0.861	0.003
High school lifetime inhalants						
Community	0.750	< 0.001	0.836	0.149	0.617	0.004
School	0.685	< 0.001	0.642	< 0.001	0.745	0.094
Family	0.786	< 0.001	0.862	0.018	0.854	0.072
Peer-individual	0.662	< 0.001	0.608	< 0.001	0.674	0.001
Total	0.834	< 0.001	0.841	< 0.001	0.852	0.001
High school 30-day inhalants						
Community	0.748	0.009	0.827	0.406	0.420	0.010
School	0.645	< 0.001	0.445	0.006	0.433	0.024
Family	0.794	< 0.001	0.886	0.327	0.815	0.151
Peer-individual	0.625	< 0.001	0.486	< 0.001	0.425	< 0.001
Total	0.823	< 0.001	0.800	0.002	0.721	< 0.001
High school 30-day other illicit drugs						
Community	0.594	< 0.001	0.669	0.005	0.377	0.001
School	0.591	< 0.001	0.702	0.013	0.499	0.017
Family	0.819	< 0.001	0.879	0.092	0.755	0.028
Peer-individual	0.518	< 0.001	0.534	< 0.001	0.411	< 0.001
Total	0.785	< 0.001	0.820	< 0.001	0.699	< 0.001

[a] Adjusted for age, highest level of parental education, race, Hispanic ethnicity, and sex.
[b] Risk by context interaction-$p < 0.05$.

protective factors and the total number of elevated protective factors across domains showed weaker associations with 30-day smokeless tobacco use for high school students living in the country compared to town-dwelling youths (Family protection: interaction-$p = 0.006$; Total protection: interaction-$p = 0.050$).

4. Discussion

These findings indicate that the distribution of drug use varies among farm-, country-, and town-dwelling youths during high school. In this study, high school youths residing on a farm compared to those living in towns were more likely to report past-30-day use of alcohol, smokeless tobacco, inhalants and other illicit drugs (cocaine, stimulants, hallucinogens, ecstasy, and/or other drugs). High school youths living on farms also had a higher likelihood of binge drinking within the past two weeks. With the exception of smokeless tobacco use, prevalence estimates of drug use were similar among youths living in the country (but not on a farm) and youths living in town. Among middle school students, few differences in drug use were observed across residential contexts. Only past-30-day smokeless tobacco use was significantly more prevalent among farm-dwelling compared to town-dwelling middle school youths. Cumulative levels of risk exposure in the community and peer-individual domains, as well as the total number of risk factors to which youths were exposed across domains were greater among high school students living on farms compared to town-dwelling youths. Although greater cumulative risk exposure was observed in this study for farm-dwelling youths, the relations between drug use and cumulative risk and protection were similar across residential contexts. These findings indicate that the higher rates of drug use among farm-dwelling youths compared to high school youths living in town were likely due to differences in levels of risk exposure and not stronger associations of risk exposure with drug use.

This study's findings are consistent with recent studies suggesting that youths from more rural residential settings are at higher risk for drug use than youths living in urban counties (Aronson et al., 2009; National Center on Addiction and Substance Abuse at Columbia University, 2000; Cronk and Sarvela, 1997; Gfroerer et al., 2007). Recent studies defining urbanicity on a continuum based on both population density and proximity to metropolitan areas also have found that the more rural the region, the higher the likelihood of drug use (Lambert et al., 2008). These patterns may be explained in part by limited access to prosocial recreational opportunities and other community resources in more rural areas, which could lead to boredom and engagement in high risk behaviors such as drug use (The National Center on Addiction and Substance Abuse at Columbia University, 2003; Quine et al., 2003).

Findings from this study were not consistent with results of an earlier study of adolescent drug use between 1976 and 1997 (Donnermeyer and Scheer, 2001) that found that farm-dwelling youths were *less* likely to use alcohol, cigarettes, or marijuana than youths living in a town or in the country but not on farms. Possible reasons for the inconsistency in findings are that the present study examined a more recent cohort of middle and high school students surveyed in 2004 and measured past-30-day and lifetime drug use instead of drug use during the past year. We found that higher rates of drug use among farm youths were more common for past-30-day drug outcomes than for lifetime outcomes, which suggests that farm youth were more likely to use drugs recently, and possibly more regularly.

Another explanation could be related to changes in the rural socioeconomic environment. During the past 20 years, declines in

the agricultural industry have imposed significant burdens on farming families. There has been greater financial uncertainty for farming individuals because of volatility of commercial markets and changing government regulations (Conger, 1997). These factors may contribute to a sense of loss of control, increased pressure to work long hours, and a greater experience of psychosocial stress (Sanne et al., 2004; Booth and Lloyd, 2000). Studies have also observed elevated risk for depression and anxiety disorders as well as suicide among farming compared to non-farming adults (Fraser et al., 2005; Gregoire, 2002). These problems could negatively impact youths living on farms in several ways. The financial instability of farming could place more pressure on youths to bear greater work responsibilities. These responsibilities could be a significant source of stress and would also limit time to devote to other pursuits including schoolwork, other school-related activities, community organizations, and supportive peer friendships. Work roles may also be a source of tensions within families, leading to greater conflict and dissatisfaction. Psychosocial stress and associated adverse mental health outcomes experienced by farming parents could further disrupt family relationships (Fraser et al., 2005).

In this study, we observed fewer differences in drug use between farm- and town-dwelling middle school students compared to high school students. One explanation is that the lower prevalence of drug use in middle school reduces the power to detect statistically significant differences across groups. The direction of risk estimates for middle school farm-dwelling youths suggests elevated drug use compared to youths living in town, but these differences were only marginally significant. Another possible explanation for higher occurrence of drug use among high school students but not middle school students from farm environments is that the transition into high school may be particularly difficult for farm youth who may be experiencing greater stressors and more work responsibilities that place them at increased risk in community, school, and family domains. Findings from this study support this explanation since analyses showed higher levels of cumulative risk across domains among high school students living on farms compared to youths living in towns, but only modest, nonsignificant differences among middle school students. Further, post-hoc analyses examining specific risk factors within the family domain suggest that farm-dwelling compared to town-dwelling youths were more likely to report poorer family management and parental attitudes that are more favorable towards drug use during high school. The assumption of more adult responsibilities on the farm during the high school years might be accompanied by more permissive parental norms regarding drug use.

It is notable that farm-dwelling youths had higher cumulative risk in the community domain, but they also showed higher cumulative protection in the community domain. Additional exploratory analyses examining specific risk factors within the community domain showed that two risk factors were particularly elevated among farm-dwelling youths: (1) community laws favorable towards drug use (including a lower perceived likelihood of getting caught by police for using drugs) and (2) community norms favorable towards drug use (including tolerance of drug use among adults in the community). On the other hand, farm youths were more attached to their neighborhoods than were town-dwelling youths, suggesting that they may experience a greater sense of a shared identity, closer relations, and community cohesion (Fraser et al., 2005). These findings are consistent with the social development model, which posits that problem behavior arises when youth bond to socializing units that hold antisocial values or beliefs (Catalano and Hawkins, 1996). Thus, when youth are bonded to communities or other groups that show greater tolerance of drug use, it is likely they will behave in a manner consistent with these norms and values.

One of the limitations of this study is that the sample consisted of students in 24 small to mid-sized communities from seven states. Thus, findings from this study may not be nationally representative. Further studies conducted in other large samples examining the distribution of drug use outcomes by rural residential contexts in other large samples are necessary to understand whether these findings are generalizable to other communities and regions. Because cross-sectional data were used, temporal and causal ordering of the relationships between drug use and risk and protective factors cannot be determined empirically. Another limitation is that a limited set of sociodemographic factors was available in the data set. For example, factors such as household income were not assessed in this study. Finally, the relatively small number of students living on farms may have limited power to detect interactions between residential context and cumulative risk.

In conclusion, this study suggests that farm-dwelling youth in high school are more likely to use alcohol, smokeless tobacco, inhalants, and other illicit drugs than their peers living in the country but not on a farm and their peers living in nearby towns. The greater prevalence of drug use among adolescents living on farms may be explained by exposure to a greater number of risk factors and fewer protective factors than their peers across a number of domains. Investigations into the possible mechanisms through which the farm context places youth at risk (e.g., work and family roles, geographic and social isolation, permissive norms associated with adult responsibilities) would be informative. If replicated in further studies, this research may have important implications for preventive intervention. Risk and protective factors across all measured domains were associated with drug use across residential contexts. Therefore, these factors should continue to be the focus of prevention activities for youth regardless of their residential context. However, because levels of drug use and risk are elevated among farm-dwelling youths, concerted efforts to reach these youths and their families with preventive interventions are warranted.

References

Aronson, K.R., Feinberg, M.E., Kozlowski, L., 2009. Alcohol, Tobacco, and Other Drug Use Among Youth in Rural Pennsylvania. Center for Rural Pennsylvania, Harrisburg, PA.

Arthur, M.W., Hawkins, J.D., Pollard, J.A., Catalano, R.F., Baglioni Jr., A.J., 2002. Measuring risk and protective factors for substance use, delinquency, and other adolescent problem behaviors. The Communities That Care Youth Survey. Eval. Rev. 26 (6), 575–601.

Beardsley, K., Wish, E.D., Fitzelle, D.B., O'Grady, K., Arria, A.M., 2003. Distance traveled to outpatient drug treatment and client retention. J. Subst. Abuse Treat. 25 (4), 279–285.

Beyers, J.M., Bates, J.E., Pettit, G.S., Dodge, K.A., 2003. Neighborhood structure, parenting processes, and the development of youths' externalizing behaviors: a multilevel analysis. Am. J. Community Psychol. 31 (1–2), 35–53.

Booth, N.J., Lloyd, K., 2000. Stress in farmers. Int. J. Soc. Psychiatry 46 (1), 67–73.

Borders, T.F., Booth, B.M., 2007. Research on rural residence and access to drug abuse services: where are we and where do we go? J. Rural Health 23 (Suppl.), 79–83.

Buu, A., Dipiazza, C., Wang, J., Puttler, L.I., Fitzgerald, H.E., Zucker, R.A., 2009. Parent, family, and neighborhood effects on the development of child

substance use and other psychopathology from preschool to the start of adulthood. J. Stud. Alcohol Drugs 70 (4), 489–498.

Carlin, J.B., Galati, J.C., Royston, P., 2008. A new framework for managing and analyzing multiply imputed data in Stata. Stata J. 8 (1), 49–67.

Catalano, R.F., Hawkins, J.D., 1996. The social development model: a theory of antisocial behavior. In: Hawkins, J.D. (Ed.), Delinquency and Crime: Current Theories. Cambridge University Press., New York, NY, pp. 149–197.

Centers for Disease Control and Prevention, 2004. Surgeon General's Report: The Health Consequences of Smoking. Retrieved August 26, 2010, from ⟨http://www.surgeongeneral.gov/library/smokingconsequences/⟩.

Chassin, L., Presson, C.C., Montello, D., Sherman, S.J., Mcgrew, J., 1986. Changes in peer and parent influence during adolescence—longitudinal versus cross-sectional perspectives on smoking initiation. Dev. Psychol. 22 (3), 327–334.

Conger, R.D., 1997. The special nature of rural America. In: Robertson, E.B., Slboboda, Z., Boyd, G.M., Beatty, L., Kozel, N.J. (Eds.), Rural Substance Abuse: State of Knowledge and Issues. US Department of Health and Human Services, Rockville, MD, pp. 37–52.

Coomber, K., Toumbourou, J.W., Miller, P., Staiger, P.K., Hemphill, S., Catalano, R.F. Rural adolescent alcohol, tobacco and illicit drug use: a comparison of students in Victoria, Australia and Washington State, United States. J. Rural Health. doi:10.1111/j.1748-0361.2010.00360.x, in press.

Cronk, C.E., Sarvela, P.D., 1997. Alcohol, tobacco, and other drug use among rural/small town and urban youth: a secondary analysis of the monitoring the future data set. Am. J. Public Health 87 (5), 760–764.

Crum, R.M., Lillie-Blanton, M., Anthony, J.C., 1996. Neighborhood environment and opportunity to use cocaine and other drugs in late childhood and early adolescence. Drug Alcohol Depend 43 (3), 155–161.

DeVoe, J.E., Krois, L., Stenger, R., 2009. Do children in rural areas still have different access to health care? Results from a statewide survey of Oregon's food stamp population. J. Rural Health 25 (1), 1–7.

Donnermeyer, J.F., Scheer, S.D., 2001. An analysis of substance use among adolescents from smaller places. J. Rural Health 17 (2), 105–113.

Dornbusch, S.M., Erickson, K.G., Laird, J., Wong, C.A., 2001. The relation of family and school attachment to adolescent deviance in diverse groups and communities. J. Adolesc. Res. 16 (4), 396–422.

Eaton, D.K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., Hawkins, J., Harris, W.A., Lowry, R., McManus, T., Chyen, D., Lim, C., Whittle, L., Brener, N.D., Wechsler, H., 2010. Youth Risk Behavior Surveillance, 2009. Center for Disease Control and Prevention.

Fox, J.C., Blank, M., Berman, J., Rovnyak, V.G., 1999. Mental disorders and help seeking in a rural impoverished population. Int. J. Psychiatry Med. 29 (2), 181–195.

Fraser, C.E., Smith, K.B., Judd, F., Humphreys, J.S., Fragar, L.J., Henderson, A., 2005. Farming and mental health problems and mental illness. Int. J. Soc. Psychiatry 51 (4), 340–349.

Gfroerer, J.C., Larson, S.L., Colliver, J.D., 2007. Drug use patterns and trends in rural communities. J. Rural Health 23, 10–15.

Glaser, R.R., Van Horn, M.L., Arthur, M.W., Hawkins, J.D., Catalano, R.F., 2005. Measurement properties of the Communities That Care (R) Youth Survey across demographic groups. J. Quant. Criminol. 21 (1), 73–102.

Graham, J.W., 2009. Missing data analysis: making it work in the real world. Annu. Rev. Psychol. 60, 549–576.

Gregoire, A., 2002. The mental health of farmers. Occup. Med. (London) 52 (8), 471–476.

Guo, J., Hawkins, J.D., Hill, K.G., Abbott, R.D., 2001. Childhood and adolescent predictors of alcohol abuse and dependence in young adulthood. J. Stud. Alcohol 62 (6), 754–762.

Hanson, C.L., Novilla, M.L.L.B., Barnes, M.D., Eggett, D., McKell, c., Reichman, P., Havens, M., 2009. Using the rural-urban continuum to explore adolescent alcohol, tobacco, and other drug use in Montana. J. Child Adolesc. Subst. Abuse 18, 93–105.

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. Psychol. Bull. 112 (1), 64–105.

Hawkins, J.D., Graham, J.W., Maguin, E., Abbott, R., Hill, K.G., Catalano, R.F., 1997. Exploring the effects of age of alcohol use initiation and psychosocial risk factors on subsequent alcohol misuse. J. Stud. Alcohol 58 (3), 280–290.

Hawkins, J.D., Catalano, R.F., Arthur, M.W., Egan, E., Brown, E.C., Abbott, R.D., Murray, D.M., 2008. Testing communities that care: the rationale, design and behavioral baseline equivalence of the community youth development study. Prev. Sci. 9 (3), 178–190.

Hill, C.E., Fraser, G.J., 1995. Local knowledge and rural mental health reform. Community Ment. Health J. 31 (6), 553–568.

Hingson, R.W., Heeren, T., Winter, M.R., 2006. Age at drinking onset and alcohol dependence: age at onset, duration, and severity. Arch. Pediatr. Adolesc. Med. 160 (7), 739–746.

Hutchison, L., Blakely, C., 2003. Substance Abuse—Trends in Rural Areas: A Literature Review, Rural Healthy People 2010: A companion document to Healthy People 2010. The Texas A&M University System Health Science Center, School of Rural Public Health, Southwest Rural Health Research Center, College Station, TX.

Jacobson, J.O., 2004. Place and attrition from substance abuse treatment. J. Drug Issues 34 (1), 23–49.

Lambert, D., Gale, J.A., Hartley, D., 2008. Substance abuse by youth and young adults in rural America. J. Rural Health 24 (3), 221–228.

Maddahian, E., Newcomb, M.D., Bentler, P.M., 1988. Risk factors for substance use: ethnic differences among adolescents. J. Subst. Abuse 1 (1), 11–23.

Mason, W.A., Windle, M., 2001. Family, religious, school and peer influences on adolescent alcohol use: a longitudinal study. J. Stud. Alcohol 62 (1), 44–53.

McLafferty, S., 2008. Placing substance use. In: Thomas, Y.F., Richardson, D., Cheung, I. (Eds.), Geography and Drug Addiction. Springer, pp. 1–16.

National Center on Addiction and Substance Abuse at Columbia University, 2000. No Place to Hide: Substance Abuse in Mid-size Cities and Rural America New York: Author.

Newcomb, M.D., Maddahian, E., Bentler, P.M., 1986. Risk-factors for drug-use among adolescents—concurrent and longitudinal analyses. Am. J. Public Health 76 (5), 525–531.

O'Donnell, J., Hawkins, J.D., Abbott, R.D., 1995. Predicting serious delinquency and substance use among aggressive boys. J. Consult. Clin. Psychol. 63 (4), 529–537.

Oetting, E.R., Edwards, R.W., Kelly, K., Beauvais, F., 1997. Risk and protective factors for drug use among rural American youth. In: Robertson, E.B., Slboboda, Z., Boyd, G.M., Beatty, L., Kozel, N.J. (Eds.), Rural Substance Abuse: State of Knowledge and Issues.. US Department of Health and Human Services, Rockville, MD.

Peterson, P.L., Hawkins, J.D., Abbott, R.D., Catalano, R.F., 1994. Disentangling the effects of parental drinking, family management, and parental alcohol norms on current drinking by black and white adolescents. J. Res. Adolesc. 4, 203–227.

Philo, C., Parr, H., Burns, N., 2003. Rural madness: a geographical reading and critique of the rural mental health literature. J. Rural Stud. 19 (3), 259–281.

Quine, S., Bernard, D., Booth, M., Kang, M., Usherwood, T., Alperstein, G., Bennett, D., 2003. Health and access issues among Australian adolescents: a rural–urban comparison. Rural Remote Health 3 (3), 245.

Rubin, R., 1987. Multiple Imputation for Nonresponse in Surveys. John Wiley & Sons, New York, NY.

Sameroff, A.J., Seifer, R., Baldwin, A., Baldwin, C., 1993. Stability of intelligence from preschool to adolescence—the influence of social and family risk-factors. Child Dev. 64 (1), 80–97.

Sanne, B., Mykletun, A., Moen, B.E., Dahl, A.A., Tell, G.S., 2004. Farmers are at risk for anxiety and depression: the Hordaland Health Study. Occup. Med. (London) 54 (2), 92–100.

Scheier, L.M., Botvin, G.J., Diaz, T., Griffin, K.W., 1999. Social skills, competence, and drug refusal efficacy as predictors of adolescent alcohol use. J. Drug Educ. 29 (3), 251–278.

Sellstrom, E., O'Campo, P., Muntaner, C., Arnoldsson, G., Hjern, A. Hospital admissions of young persons for illicit drug use or abuse: does neighborhood of residence matter? Health Place. doi:10.1016/j.healthplace.2010.12.013, in press.

Snedker, K.A., Herting, J.R., Walton, E., 2009. Contextual effects and adolescent substance use: exploring the role of neighborhoods. Soc. Sci. Q. 90 (5), 1272–1297.

Song, E.Y., Reboussin, B.A., Foley, K.L., Kaltenbach, L.A., Wagoner, K.G., Wolfson, M., 2009. Selected community characteristics and underage drinking. Subst. Use Misuse 44 (2), 179–194.

Spoth, R., Goldberg, C., Neppl, T., Trudeau, L., Ramisetty-Mikler, S., 2001. Rural–urban differences in the distribution of parent-reported risk factors for substance use among young adolescents. J. Subst. Abuse 13 (4), 609–623.

Substance Abuse and Mental Health Services Administration—U.S. Department of Health and Human Services, 2007. Report to Congress: A Comprehensive Plan for Preventing and Reducing Underage Drinking. Retrieved August 25, 2010, from ⟨http://www.stopalcoholabuse.gov/media/underagedrinking/pdf/underagerpttocongress.pdf⟩.

Substance Abuse and Mental Health Services Administration, 2010. Results from the 2009 National Survey on Drug Use and Health: Volume I. Summary of National Findings. Office of Applied Studies, Rockville, MD.

The National Center on Addiction and Substance Abuse at Colubmia University, 2003. National Survey of American Attitudes on Substance Abuse VIII. Teens and Parents, New York, NY.

United States Department of Agriculture Economic Research Service, 2007. Rural Definitions: Data Documentation and Methods. Retrieved August 12, 2010, from ⟨http://www.ers.usda.gov/Data/Ruraldefinitions/Documentation.htm⟩.

Wainer, J., Chesters, J., 2000. Rural mental health: neither romanticism nor despair. Aust. J. Rural Health 8 (3), 141–147.

Wilson, J.M., Donnermeyer, J.F., 2006. Urbanity, rurality, and adolescent substance use. Crim. Justice Rev. 31 (4), 337–356.

Zuckerman, M., 1987. Biological connection between sensation seeking and drug abuse. In: Engel, J., Oreland, L. (Eds.), Brain Reward Systems and Abuse. Raven Press, New York, pp. 165–176.