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Community-Level Exposure to the Rural Mining Industry: The Potential Influence on Early Adolescent Alcohol and Tobacco Use

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Abstract

Purpose: Rural youth have higher rates of alcohol and tobacco use compared to their urban counterparts. However, the economic dependence of rural communities may differentially influence risk behaviors. While research has shown that adults working in mining have elevated rates of alcohol and tobacco use, the influence of living in a mining community on early adolescent substance use is unknown.

Methods: Using data from a representative sample of 4,535 middle school students in a state with heavy reliance on mining, we conducted weighted logistic regression to investigate whether community-level mining economic dependence influences rural-urban differences in adolescent alcohol and tobacco use. All models adjusted for sociodemographics, military family involvement, parental monitoring, and length of residence.

Findings: Over one quarter of the sampled students lived in rural counties and approximately half of these counties met the USDA mining economic typology. After stratifying rural counties by mining and nonmining economic dependence, students in rural mining counties had significantly higher odds of all measures of alcohol use (AORs ranged from 1.83 to 3.99) and tobacco use (AORs ranged from 1.61 to 5.05) compared to students in urban counties. Only use of smokeless tobacco was higher among students in rural nonmining counties.

Conclusions: Our findings demonstrate rural-urban disparities in adolescent substance use that are particularly pronounced among youth living in counties with economic dependence on mining. Future research on this subject should include a wider range of community-level factors that may have specific relevance in rural settings to inform the development of population-level interventions.

Key words adolescent, alcohol use, mining, rural, tobacco use.

Purpose

It is well documented that many risk behaviors, such as substance use, are adopted during early adolescence when the brain's risk evaluation and reward pathways are in the midst of development.[1,2] Initiation of substance use in early adolescence increases the risk of substance abuse disorders and other poor health and social outcomes that continue into adulthood.[3-8] From an interventional perspective the greatest opportunities for prevention may lie within programs targeting middle-school-aged youth, before risk behaviors are fully

established.[3,9,10] Therefore, identifying subpopulations of young adolescents at greatest risk for alcohol and tobacco use is essential for developing effective prevention programming.

Recent research has demonstrated that youth living in rural settings have higher rates of alcohol and tobacco use compared to their urban counterparts.[11-16] While such rural-urban differences have important implications for substance abuse prevention and treatment initiatives,[17,18] not all rural communities are the same and there have been recent calls to more closely explore health disparities that may exist among rural regions.[13,18-20] Research focusing on community-level factors associated with youth substance use has primarily focused on urban settings, limiting the ability to use such data to inform the development of ecologic prevention strategies in rural communities.[21,22]

There are many aspects of living in a rural community that may differentially influence health, including the economic dependence of a community on industries such as farming or mining.[20] Two studies have focused on the influence of living in farming communities on adolescent substance use. Donnermeyer and Scheer found that 12th graders living in farming communities were less likely to use alcohol, cigarettes, or marijuana than youth living in a town or in the country.[23] A more recent study found that high school students in farming communities reported higher prevalence of substance use, but no differences were found for middle school students other than a higher prevalence of smokeless tobacco use among farm-dwelling youth.[24] To our knowledge, studies have not explored the potential influence of economic dependence on other industries such as mining on youth substance use.

There is a small body of literature in the United States suggesting that adults employed by the mining industry are at a higher risk for alcohol and tobacco consumption than adults with other occupations. A recent analysis conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA) found that workers in the mining industry had the highest level of past month heavy alcohol use among 19 occupations studied. Using data collected from 2008 to 2012, SAMHSA found that 17.5% of workers in the mining industry reported heavy alcohol use in the past month compared to 16.5% in construction; 9.7% in manufacturing; 9.4% in agriculture, forestry, fishing, and hunting; and 8.8% in transportation and warehousing.[25] In addition, the prevalence of past month heavy alcohol use among workers in the mining industry appears to have increased from 2003 to 2012.[25] There is also recent research that identifies miners as having disproportionately high rates of tobacco use. One US study found that the prevalence of smokeless tobacco use and dual use of smokeless tobacco and cigarettes among mining workers (33.2% and 14.7%, respectively) was distinctly higher than the prevalence for nonmining industry workers (10.8% and 4.0%, respectively).[26]

More research assessing the influence of the mining occupation on substance use behaviors has been conducted in other countries. For example, a study conducted in Chile found that 28.1% of workers in the mining industry participate in hazardous alcohol consumption behavior compared to 21.6% in industry, 18.3% in agriculture, and 6.7% in services occupations.[27] Several studies in Australia have also found that mining industry workers are at significantly higher risk for heavy alcohol consumption and short-term alcohol-related harm when compared with workers in other industries.[28,29] Furthermore, a systematic review assessed the influence of living in proximity to mining in high-income countries and found that mining may contribute to work-family conflict.[30] However, the direct effects on youth risk behaviors were not assessed in any of the studies reviewed.

While previous research suggests that adults working in the mining industry are at increased risk for alcohol and tobacco use and mining may change the social environment in ways that could contribute to adolescent substance use, the influence of mining on adolescent substance use has not been directly assessed. To address this limitation, we investigated whether an ecologic indicator of economic reliance on mining was associated with substance use behaviors in a representative sample of 4,535 middle school students in a state with heavy dependence on mining.[31]

Methods

Participants and Sampling Procedures

The Youth Risk Behavior Survey (YRBS) is a national surveillance system that was established in 1991 by the Centers for Disease Control and Prevention (CDC) to monitor the prevalence of health risk behaviors among youth.[32] Nationally, the YRBS is conducted with high school students, but a few states elect to conduct a modified version of the survey with middle school students.

In 2015, a middle school YRBS was conducted in all regular public, charter, and alternative middle schools in Nevada. The sampling plan used a 2-stage, cluster sampling design to select a representative sample of 4,535 Nevada middle school students in grades 6-8.[33] The first stage of the sampling design placed all 17 school districts into 7 distinct regions that aligned with the state's substance abuse prevention coalition structure. This also

prevented the possibility of the identification of any individual school. In the second sampling stage, intact classes from each school were randomly selected based on the sample size required for each region.

Parental permission is required for YRBS participation. Nevada's school districts are a mix of active and passive forms of parental permission, with 8 being active and 9 being passive. In 2015, the overall response rate of the Nevada middle school YRBS was 69.5%.[33] After parental permission was obtained, the questionnaire was administered to students in all selected classes. Students could choose not to participate and could skip any questions they did not feel comfortable answering.

The study was approved by the University Institutional Review Board (IRB) and local school district IRB approval was obtained when required.

Exposure Variables

We used the US Census Bureau's rural-urban county classification definitions to categorize students as living in either a rural or an urban county. Counties with <50,000 people are classified as rural and counties with >50,000 people are classified as urban.[34,35] Only 3 of Nevada's 17 counties were classified as urban under this definition.[35] Of the 4,535 middle school participants, 1,194 (26.3%) lived in rural counties.

We combined the US Census Bureau's rural-urban county classification definitions and the 2015 USDA county economic typology definitions[34,36] to determine whether students were currently living in a rural mining county. Students from schools in rural counties where the mining industry accounted for at least 13% of the earnings, and/or 8% of employment averaged over a 3-year period,[36] were categorized as living in a rural mining county (7 counties). Students from the remaining rural counties were classified as living in a rural nonmining county (7 counties). None of the 3 urban counties met the required criteria to be considered a mining county. Of the 1,194 rural participants 566 (47.4%) lived in rural mining counties and 628 (52.6%) in rural nonmining counties.

Outcome Variables

All outcome measures were standardized and validated YRBS variables.[37]

Alcohol Use

Early initiation of alcohol use was assessed by asking students what age they had their first drink of alcohol. Students who reported drinking alcohol at age 11 or younger were categorized as "yes" for early initiation of alcohol, while all other answers were categorized as "no." To measure current alcohol use, students were asked how many days they had at least 1 drink of alcohol during the past 30 days, ranging from 0 to 30 days. Responses were categorized as 1 or more days "yes" versus 0 days "no." Current binge drinking was also assessed by asking students if they had had 5 or more drinks of alcohol in a row within a couple of hours, during the past 30 days; "yes" versus "no."

Cigarette Use

Early initiation of cigarette use was assessed by asking students what age they first smoked a whole cigarette for the first time. Students who reported having smoked a whole cigarette at age 11 or younger were categorized as "yes" and all other answers were categorized as "no." To assess current cigarette use, students were asked how many days they had smoked cigarettes during the past 30 days, ranging from 0 to 30 days. Responses were categorized as 1 or more days "yes" versus 0 days "no."

Other Tobacco Use

Current use of smokeless tobacco was assessed by asking students how many days they used chewing tobacco, snuff, or dip, such as Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, or Copenhagen during the past 30 days, with answers ranging from 0 to 30 days. Responses were categorized as 1 or more days "yes" versus 0 days "no." Current cigar use was assessed by asking students how many days they smoked cigars, cigarillos, or little cigars during the past 30 days with answers ranging from 0 to 30 days. Responses were categorized as 1 or more days "yes" versus 0 days "no."

Current use of electronic vapor (e-vapor) products was assessed by asking students how many days they had used an electronic vapor product such as blu, NJOY, or Starbuzz including e-cigarettes, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, and hookah pens during the past 30 days, with answers ranging from 0 to 30 days. Responses were categorized as 1 or more days "yes" versus 0 days "no."

Covariates

Demographic covariates included sex, age (range 10-16 years), and race/ethnicity. Race/ethnicity was grouped into 3 categories: Hispanic, non-Hispanic white, and non-Hispanic other. The non-Hispanic other category included students identifying as American Indian, Alaska Native, Asian, black, and Native Hawaiian or Pacific Islander.

Table 1 Characteristics of 4,535 Participating Middle School Students for Rural Mining, Rural Nonmining, and Urban Counties—Nevada, 2015

	Rural Mining n (%)	Rural Nonmining n (%)	Urban n (%)	
Total	566 (2.6)	628 (5.4)	3,341 (92.0)	*P* Value
Sex				
Female	247 (47.4)	302 (50.7)	1,845 (49.2)	
Male	315 (52.6)	323 (49.3)	1,487 (50.8)	
Age (range = 10-16 years)				
10-12 years	113 (26.3)	288 (44.9)	1,262 (45.2)	
13 years	217 (39.4)	222 (34.6)	1,295 (33.6)	
14-16 years	234 (34.3)	118 (20.5)	781 (21.2)	
Race/ethnicity				
Hispanic	186 (28.9)	175 (23.5)	1,496 (44.3)	$P < .001$
Non-Hispanic White	278 (60.9)	295 (64.7)	1,050 (30.8)	
Non-Hispanic Other	78 (10.2)	119 (11.8)	687 (24.9)	
Quality for free or reduced lunch				
Yes	161 (26.3)	238 (35.1)	1,495 (47.6)	$P < .001$
No	390 (73.7)	380 (64.9)	1,816 (52.4)	
Length of residence				
1+ years in the state	533 (95.6)	580 (94.4)	3,190 (95.6)	
<1 year in the state	28 (4.4)	32 (5.6)	127 (4.4)	
Military family				
Yes	96 (17.1)	142 (20.4)	558 (17.5)	
No	458 (82.9)	462 (79.6)	2,727 (82.5)	
Parental monitoring				
High	385 (71.0)	375 (66.0)	2,121 (65.1)	
Low/medium	164 (29.0)	225 (34.0)	1,040 (34.9)	

Table 2 Weighted Prevalence of Alcohol and Tobacco Use Behaviors Among 4,535 Participating Middle School Students in Rural-Mining, Rural Nonmining, and Urban Counties—Nevada, 2015

	Rural Mining n (%)	Rural Nonmining n (%)	Urban n (%)	*P* Value
Alcohol use				
Early initiation of alcohol	87 (15.5)	66 (10.6)	339 (11.2)	[a] [b]
Currently drink alcohol	101 (17.4)	49 (8.1)	354 (10.3)	[a] [b]
Currently binge drink alcohol	54 (9.9)	22 (3.2)	99 (2.4)	[a] [b]
Tobacco use				
Early initiation of cigarettes	28 (4.8)	35 (7.3)	94 (2.8)	[b] [c]
Currently smoke cigarettes	40 (6.5)	22 (3.1)	89 (2.2)	[a] [b]
Currently use smokeless tobacco	38 (6.3)	31 (7.0)	59 (1.6)	[b] [c]
Currently smoke cigars	30 (5.3)	29 (6.3)	97 (2.7)	[b]
Currently use e-vapor product	104 (17.4)	50 (8.4)	410 (11.3)	[a] [b]

[a]Rural mining versus rural nonmining ($P < .05$).
[b]Rural mining versus urban ($P < .05$).
[c]Rural nonmining versus urban ($P < .05$).

As a proxy for income we asked students whether they qualified for a free or reduced lunch, with responses dichotomized as "yes" versus "no." Students were also asked how long they had lived in Nevada. Responses were dichotomized as "less than 1 year" versus "1 or more years."

Research has demonstrated that youth from military households have greater substance use rates,[38,39] and parental monitoring is a strong protective factor against youth substance use.[40] Both variables were included as covariates in our study. We assessed whether students came from a household with adults serving on active duty

Table 3 Adjusted Odds Ratios for Alcohol Use Behaviors Among 4,535 Participating Middle School Students in Rural Mining, Rural Nonmining, and Urban Counties—Nevada, 2015

	Early Initiation of Alcohol AOR (95% CI)	Currently Drink Alcohol AOR (95% CI)	Currently Binge Drink Alcohol AOR (95% CI)
Location			
Rural mining	**1.88 (1.43-2.48)**	**1.83 (1.32-2.54)**	**3.99 (2.41-6.63)**
Rural nonmining	1.13 (0.77-1.65)	0.84 (0.54-1.31)	1.41 (0.65-3.05)
Urban	Ref	Ref	Ref
Sex			
Male	1.15 (0.85-1.54)	**0.69 (0.51-0.93)**	**0.45 (0.28-0.72)**
Female	Ref	Ref	Ref
Age			
11–12 years	1.15 (0.80-1.66)	**0.26 (0.18-0.39)**	**0.18 (0.09-0.36)**
13 years	1.07 (0.73-1.57)	**0.67 (0.48-0.94)**	0.67 (0.43-1.06)
≥14 years	Ref	Ref	Ref
Race ethnicity			
Hispanic	1.24 (0.88-1.73)	**1.55 (1.08-2.22)**	1.53 (0.82-2.84)
Non-Hispanic Other	1.24 (0.81-1.90)	0.99 (0.62-1.58)	0.87 (0.43-1.73)
Non-Hispanic White	Ref	Ref	Ref
Free/reduced lunch			
Yes	**1.81 (1.37-2.41)**	**1.36 (1.02-1.81)**	1.13 (0.69-1.86)
No	Ref	Ref	Ref
Length of residence			
<1 year in the state	0.97 (0.48-0.94)	1.04 (0.50-2.17)	1.53 (0.45-5.24)
1+ years in the state	Ref	Ref	Ref
Military family			
Yes	**1.48 (1.08-2.03)**	**1.81 (1.32-2.49)**	**2.27 (1.30-3.95)**
No	Ref	Ref	Ref
Parental monitoring			
Low/medium	**1.57 (1.14-2.16)**	**1.60 (1.21-2.13)**	1.56 (0.90-2.72)
High	Ref	Ref	Ref

Notes: All models adjusted for sex, age, race/ethnicity, free/reduced lunch, length of residence in the state, military family involvement, and parental monitoring. Significant AOR estimates are indicated in bold.

in the military. Responses were dichotomized as "yes" versus "no." We evaluated a student's level of parental monitoring by asking them how often parents or other adults in their home ask them where they are going or whom they will be with. Students who answered "Never," "Rarely," or "Sometimes" were categorized as having low/medium parental monitoring, while students who answered "Most of the time" or "Always" were categorized as having high parental monitoring.

Analysis

All analyses were weighted at the state and regional levels based on the sex, race/ethnicity, and grade level of students. The weighted chi-square test was used to assess locational differences (rural mining, rural nonmining, and urban) in sociodemographic characteristics and recent alcohol and tobacco use.

We used weighted logistic regression to account for the complex study design with a 3-level exposure variable: rural mining, rural nonmining, and urban. Using students from urban counties as the referent group, we calculated the Adjusted Odds Ratios (AOR) and their corresponding 95% Confidence Intervals (95% CI) for each of the alcohol and tobacco use behaviors among rural mining and rural nonmining students. In all of our models, we adjusted for sex, age, race/ethnicity, free/reduced lunch, length of residence in state, military family involvement, and parental monitoring.

Findings

As shown in Table 1, the distributions of most sociodemographic characteristics were similar between rural mining, rural nonmining, and urban students, with the exception of race/ethnicity and qualifying for a free or reduced lunch. There was a larger proportion of non-Hispanic white respondents in the both the rural mining and rural nonmining samples compared to the urban sample ($P < .001$). More students from the urban

Table 4 Adjusted Odds Ratios for Tobacco Use Behaviors Among 4,535 Participating Middle School Students in Rural Mining, Rural Nonmining, and Urban Counties—Nevada, 2015

	Early Initiation of Cigarettes AOR (95% CI)	Currently Smoke Cigarettes AOR (95% CI)	Currently Use Smokeless Tobacco AOR (95% CI)	Currently Smoke Cigars AOR (95% CI)	Current Use E-Vapor Product AOR (95% CI)
Location					
Rural mining	**1.93 (1.07-3.46)**	**2.92 (1.74-4.88)**	**5.05 (2.72-9.39)**	**2.41 (1.33-4.38)**	**1.61 (1.13-2.32)**
Rural nonmining	1.83 (0.97-3.45)	1.44 (0.78-2.63)	**2.06 (1.10-3.88)**	0.88 (0.43-1.81)	0.83 (0.47-1.48)
Urban	Ref	Ref	Ref	Ref	Ref
Sex					
Male	1.11 (0.65-1.89)	0.83 (0.49-1.39)	0.95 (0.54-1.68)	0.98 (0.58-1.68)	0.99 (0.73-1.35)
Female	Ref	Ref	Ref	Ref	Ref
Age					
11–12 years	0.68 (0.36-1.29)	**0.30 (0.15-0.61)**	0.48 (0.23-1.02)	**0.50 (0.26-0.98)**	**0.36 (0.27-0.49)**
13 years	**0.46 (0.24-0.89)**	0.70 (0.42-1.16)	0.82 (0.39-1.73)	0.96 (0.53-1.76)	**0.69 (0.51-0.92)**
≥14 years	Ref	Ref	Ref	Ref	Ref
Race ethnicity					
Hispanic	1.22 (0.69-2.15)	1.18 (0.66-2.10)	**2.06 (1.07-3.98)**	**2.86 (1.62-5.04)**	**1.65 (1.15-2.36)**
Non-Hispanic Other	**1.91 (1.00-3.68)**	1.37 (0.63-2.98)	**2.66 (1.28-5.53)**	**2.33 (1.14-4.80)**	0.99 (0.64-1.53)
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref
Free/reduced lunch					
Yes	1.25 (0.70-2.23)	1.10 (0.60-1.99)	0.99 (0.52-1.88)	0.97 (0.54-1.74)	1.21 (0.92-1.60)
No	Ref	Ref	Ref	Ref	Ref
Length of residence					
<1 year in the state	1.19 (0.37-3.86)	0.42 (0.15-1.22)	1.65 (0.45-6.05)	0.96 (0.21-4.41)	0.93 (0.45-1.92)
1+ years in the state	Ref	Ref	Ref	Ref	Ref
Military family					
Yes	1.72 (0.98-3.01)	1.38 (0.78-2.42)	1.49 (0.82-2.70)	1.65 (0.93-2.94)	**1.96 (1.47-2.61)**
No	Ref	Ref	Ref	Ref	Ref
Parental monitoring					
Low/medium	1.51 (0.89-2.56)	**2.23 (1.32-3.77)**	**3.86 (2.14-6.99)**	**2.15 (1.22-3.80)**	1.14 (0.85-1.53)
High	Ref	Ref	Ref	Ref	Ref

Notes: All models adjusted for sex, age, race/ethnicity, free/reduced lunch, length of residence in the state, military family involvement, and parental monitoring. Significant AOR estimates are indicated in bold.

counties qualified for a free or reduced lunch compared to students from rural mining and rural nonmining counties ($P < .001$).

In the unadjusted analyses (Table 2), middle school students from rural mining counties had a significantly higher prevalence of all 3 alcohol-use behaviors (early initiation of alcohol, current alcohol use, and current binge drinking) compared to students from rural nonmining counties and students from urban counties. Additionally, students from rural mining communities had a significantly higher prevalence of current cigarette and e-vapor product use compared to students from rural nonmining counties and a significantly higher prevalence of all 5 tobacco use behaviors compared to students from urban counties. Students from rural nonmining counties did not have significantly higher prevalence of any alcohol or tobacco use behaviors compared to students from rural mining counties, but they did have higher levels of early initiation of cigarette use and current smokeless tobacco use compared to students from urban counties.

The fully adjusted multiple regression models for alcohol use behaviors (Table 3) and tobacco use behaviors (Table 4) show that compared to students from urban counties, students from rural mining counties had significantly higher odds of engaging in all 8 of the alcohol and tobacco use behaviors (AORs ranged from 1.61 to 5.05). However, only current smokeless tobacco use was higher among students form rural nonmining counties compared to urban counties (Table 4).

In addition to our primary findings, we found that younger adolescents had lower odds of engaging in most types of alcohol and tobacco use, and males had lower odds of current alcohol use and binge drinking. We also found that the odds of many types of alcohol and tobacco use were higher among adolescents with military family involvement and lower levels of parental monitoring (Tables 3 and 4).

Conclusions

We found that prevalence of recent alcohol and tobacco use was consistently higher among students from rural counties with economic dependence on mining. Furthermore, in our fully adjusted models, students from rural mining counties had higher odds of engaging in all alcohol and tobacco use behaviors compared to urban students, while only recent use of smokeless tobacco was higher among rural students from nonmining counties. These findings suggest that rural-urban differences in adolescent substance use were largely driven by counties with economic dependence on mining and support the argument that there may be environmental and cultural factors unique to the economic typology of rural communities that influence risk behaviors.[20]

While we were not able to ascertain what is driving the higher rates of substance use among young adolescents in mining communities, the higher rates of alcohol and tobacco use behaviors among adults in the mining industry[25,27,30] may play a role. Research has demonstrated that adolescent substance is strongly influenced by parental and family substance use behaviors and attitudes toward substance use.[14,41,42] There are also several aspects of mining industry lifestyle and culture that are established risk factors for substance use in the general population, including isolation, irregular and extended working hours, difficult access to health care and interventional treatment, and working in a male dominated setting where alcohol and tobacco use is integrated into bonding aspects of the occupation.[43-45] A number of these risk factors may also influence social norms regarding substance use and decrease the amount of parental supervision of young adolescents, which could ultimately increase access to and use of alcohol and tobacco products.[42,46] It is also possible that counties with higher economic dependence on mining have a greater number of alcohol and tobacco retail locations, and research has shown that proximity to such retail increases youth substance use in rural and small town areas.[22]

There are several secondary findings from our research that may inform adolescent substance abuse prevention efforts in rural mining communities. Consistent with previous research, we found that substance use was more common among adolescents with lower levels of parental monitoring.[40] While there were no rural-urban differences in parental monitoring, it is important to consider parental monitoring given the extended working hours and shift work inherent in the mining occupation. We also found that alcohol use was consistently higher among adolescents with military family involvement, supporting previous research.[38,39] Military family involvement did not account for higher levels of substance use reported by youth living in rural mining counties; however, the military shares many similarities to the rural mining industry in terms of its male dominated culture and the potential influence that it can have on adolescent alcohol and tobacco use behaviors.[39] We also found that the prevalence of current drinking and binge drinking was higher for females than males. This finding supports recent national research which has shown that the sex gap in current drinking and binge drinking has closed among high school students in recent years,[47] and among 8th grade students, recent alcohol use and binge drinking is actually higher among females than males.[48]

To date, most studies looking at the impact of place on adolescent substance use have focused on urban environments.[20] However, the same factors related to place that influence population health in urban areas (culture, norms, built environment, access to services, and other community-level factors) may also influence population health in rural communities. When rural-urban differences in risk behaviors among adolescents are observed there may be a need to explore the context of "place" more closely. Our research found that there was variability in adolescent substance use in rural communities, and those living in economically mining-dependent rural counties were at increased risk. Other strengths of our study include the use of a large and representative sample of middle school students in a state with a large mining economy and the control for a number of potential confounding variables.

There are also several limitations to consider. As with all self-report data there may be recall bias, particularly of substance use behaviors. However, we do not believe that substance use reporting would differ based on geographic location or economic typology. Such nondifferential reporting would only bias our results toward the null. Second, while our sample is representative of middle-school-aged adolescents in Nevada, the results should not be generalized to other states. Third, the cross-sectional nature of the data limits our ability to assess temporality. Fourth, we relied on a single community-level measure of mining dependency and do not know how much direct exposure middle school students actually had to the mining industry or adults working in this industry. Furthermore, a single ecologic measure cannot capture the complex mechanisms by which community context influences youth risk behaviors.[21] There is a need for more research including a wider range of community-level factors that may have particular relevance in rural settings to inform the development of population-level interventions. Fifth, we did not have enough counties or the sample size to apply a metropolitan, micropolitan, and rural definition as well as categorization of economic

dependence on mining. As such, we are not able to distinguish differences that may exist between micropolitan and rural counties. Finally, there may be unmeasured confounding variables that are partially responsible for the association between living in rural mining counties and early adolescent substance use such as low socioeconomic status; however, it is interesting to note that the average household and family median income is substantially higher in Nevada counties with economic dependence on mining.[35] Future studies should continue to investigate how the economic dependence of a community influences adolescent alcohol and tobacco use behaviors and further explore factors such as community norms regarding substance use and youth access to alcohol and tobacco products.

Implications

Despite the limitations, our research suggests that middle school students living in communities with heavy economic dependence on mining are disproportionately at risk for early use of alcohol and tobacco products. Public health officials should consider locational influences when developing interventions aimed at reducing the prevalence of adolescent alcohol and tobacco use. Interventions that have a demonstrated success in rural communities, such as school-based programs,[49] computer-based screening and intervention techniques,[50] and prevention programs simultaneously targeting adolescents and their parents[9] could be more effective if tailored to the needs of families living in mining communities. Interventions directly targeting adults in the mining industry may also have indirect benefits to the children living in these rural communities. Given the similarities in mining and military occupational cultures and the elevated prevalence of substance use among adolescents in military households observed in our study and others,[38] substance abuse policies and programs adopted by the military[51] may be particularly relevant for addressing substance use among adults in mining occupations. However, the adaptation of such interventions will require robust qualitative research investigating the influence of male dominated culture, such as that found in mining and military occupations, on adolescent alcohol and tobacco use behaviors.[39] Due to the ecological nature of our findings, community-wide approaches to youth substance abuse prevention in mining communities should be employed. Working with local coalitions in rural mining communities may be an efficient way to address community norms and policies around alcohol and tobacco use at the population level[52] while implementing evidence-based school, family, and workplace interventions.

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