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Developmental Trajectories of Substance Use From Early to Late Adolescence: A Comparison of Rural and Urban Youth*

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Abstract

Objective—This study investigated differences in the development of heavy drinking and marijuana use among students in urban and rural areas and assessed whether any such differences can be accounted for by locality differences in racial/ethnic makeup, social disorganization/low social bonding, feelings of despondency and escapism, and the availability of drugs.

Method—Drawn from 62 South Dakota middle schools involved in a drug prevention field trial, participating students were assigned to a locality category based on the location of their seventh-grade school. Schools in metropolitan areas were distinguished from schools in nonmetropolitan areas. Schools in nonmetropolitan areas were further distinguished into those in micropolitan (medium and large towns) and noncore (rural areas without towns and with small towns) areas. We used latent growth curve analysis to model the influence of locality on the development of heavy drinking and marijuana use from ages 13 to 19 and to determine whether differences in development across locality were attributable to location-based differences in race/ethnicity, social disorganization/bonding, feelings of despondency and escapism, and alcohol and marijuana availability.

Results—Heavy drinking increased at a faster rate among youth living in micropolitan areas compared with youth living in metropolitan areas. Marijuana use increased at a faster rate among youth living in metropolitan and micropolitan areas compared with youth living in noncore areas. Differences in the rate of change in heavy drinking were attributable to differences in the racial/ethnic composition of metropolitan and micropolitan areas. Differences in the rate of change in marijuana use were attributable to differences in residential instability and marijuana availability.

Conclusions—This study underscores the diversity of drug use within rural communities, suggesting that living in a very rural area is protective against some forms of drug use but that living in a rural area that includes a medium or large town is not.

Although adolescent substance use was once perceived as primarily an urban problem, growing evidence suggests a relative convergence in rates of substance use between rural and urban youth (Cronk and Sarvela, 1997; Donnermeyer and Scheer, 2001; Edwards, 1997). In fact, recent data suggest that use rates for certain substances, such as methamphetamines and inhalants, are higher among rural youth than among urban youth (Cronk and Sarvela, 1997; Johnston et al., 2006). The upward trend in rural adolescent drug use, paralleled by a decline in use rates among urban youth (Johnston et al., 2006), has prompted questions about the availability of drugs, the effectiveness of prevention programs, and the erosion of social factors that may have previously suppressed rates of substance use

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in rural areas (Conger 1997; Conger and Elder, 1994; Donnermeyer, 1992; Oetting et al., 1998).

Although useful for tracking regional differences in substance use over time, trend data cannot tell us whether youth in rural and urban areas exhibit developmental differences in substance use. Studying developmental differences requires longitudinal data from a cohort of rural and urban youth as they age from early to late adolescence and into early adulthood. Such data can separate age-based differences from cohort-based differences in substance use and provide clues about the mechanisms underlying age-based differences. Although many studies have used longitudinal data to examine trajectories of substance use during adolescence and young adulthood (e.g., Colder et al., 2001; Ellickson et al., 2004; Li et al., 2000), no study has investigated rural and urban differences in those trajectories. To fill that gap, the current study examined developmental differences in substance use (heavy alcohol and marijuana use) among a cohort of rural and urban youth followed from early adolescence to young adulthood. Distinct trajectories of substance use among rural and urban youth could suggest a need for tailoring prevention and treatment efforts in those areas.

Why might substance use develop differently among rural and urban youth? Social disorganization theory (Sampson and Groves, 1989) posits that communities without strong social networks have limited capacity to discourage development of deviant norms and behaviors, including the initiation and maintenance of substance use. Social disorganization is thought to manifest itself through inadequate bonding of individuals to conventional social institutions (e.g., families, religion, school, and prosocial community organizations). Hence, urban communities, which have been characterized as encouraging greater involvement in deviant peer groups and weakened family control compared with rural communities, should display higher than average rates of substance use (Oetting et al., 1998; Weisheit et al., 1999; Wilson and Donnermeyer, 2006). Rural communities, in contrast, are often viewed as exhibiting less anonymity and greater solidarity, social control, family cohesion and prosocial peer groups than urban communities (Oetting et al., 1998; Weisheit et al., 1999; Wilson and Donnermeyer, 2006); by extension, they should exhibit lower than average rates of substance use.

However, several developments suggest that characteristics thought to foster the formation of strong social bonds (residential and familial stability, increased socioeconomic status, and limited population size) may no longer distinguish rural and urban areas. Economic problems resulting from the transformation of the American agricultural industry have threatened formerly protective rural family structures and social dynamics (Conger and Elder, 1994; Cronk and Sarvella, 1997; Dimitri et al., 2005). Compared with urban youth, rural youth are now more likely to be poor, to have younger and less educated parents, and to have repeated a grade in school (Rogers, 2005; National Center for Health Statistics, 2005). Lack of economic, educational, and social opportunities may create feelings of despondency among rural youth, making earlier and increased substance use appear to be attractive means of escape from their problems. Even geographic isolation, which historically limited availability of illicit drugs in rural areas (O'Dea et al., 1997), may not be the protective factor it once was. Although youth in the smallest rural communities continue to believe it would be harder for them to get illegal drugs than youth in urban communities (Edwards, 1997), recent data suggest that rural areas are providing new markets for the oversupply of drugs in metropolitan areas (O'Dea et al., 1997).

In this study, we used latent growth curve analysis (Curran, 2000) to examine differences in the development of heavy drinking and marijuana use among rural and urban adolescents, and to determine whether any such differences can be accounted for by locality differences in racial/ethnic composition, social disorganization and low social bonding, feelings of despondency and escapism, and availability of drugs. We examine rural-urban differences with and without controls for race/ethnicity to avoid confounding differences in development of substance use with differences in racial/ethnic makeup across communities. We focused on heavy drinking and marijuana use because they are common forms of substance use among youth (Johnston et al., 2007). We anticipated small differences in development across rural and urban areas for both substances, differences that we thought would be partially accounted for by location variations in racial/ethnic composition, social disorganization/bonding, and feelings of despondency and escapism. For marijuana, we also thought that developmental differences across localities would be partially accounted for by differences in the perceived availability of marijuana.

Method

Study design and sample

Participants in this study were students from 62 randomly assigned South Dakota middle schools that participated in a field trial to evaluate the effectiveness of a revised drug-use prevention program designed for middle school students (Project Alert; Ellickson et al., 2003) and a follow-up high school program (ALERT Plus). The baseline panel of 5,857 adolescents was approximately evenly distributed by gender and was primarily white (86%) or Native American (9%). Approximately 1 in 5 of these adolescents reported grades of C or below at baseline, and 68% were living in households with both biological parents present. Fifty percent of people living in South Dakota reside in rural areas, making it an ideal place to investigate rural-urban issues.

Study procedures

Participants completed paper-and-pencil surveys in school at Grades 7-11 (Waves 1-5) and by mail at age 19 (Wave 6). Trained staff administered the in-school surveys. Project staff conducted make-up survey sessions in school and mailed surveys to movers and chronic absentees to minimize attrition. Because sensitive data—such as use of alcohol and other substances—may be subject to reporting bias, we took several steps to enhance accurate reporting. These steps included obtaining a Certificate of Confidentiality from the Department of Health and Human Services and using data collectors whom the students did not know. Analyses of data consistency over time indicate that the vast majority of participants told the truth about alcohol and marijuana use. Fewer than 2% of participants gave inconsistent responses over time (Ellickson et al., 2003).

Measures

Locality—Students were assigned to a locality category based on the location of the school at which they attended seventh grade. In assigning locality categories, we distinguished schools in metropolitan areas from ones in nonmetropolitan areas. We divided nonmetropolitan areas into micropolitan and noncore areas because prior research has highlighted the need to go beyond the rural/urban dichotomy to fully understand the relationship between place of residence and substance use (Conger, 1997; D'Onofrio, 1997). South Dakota has population centers in three Metropolitan Statistical Areas based around a central urbanized area. These centers include (1) the urbanized areas or outlying counties of Sioux Falls (population: 207,918), (2) Sioux City Iowa (population: 142,571), and (3) Rapid City (population: 118,203). Twenty-seven middle schools, attended by 3,017 study participants (51% of the total sample), were located in one of these three metropolitan areas.

Nonmetropolitan areas are subdivided into two types: (1) micropolitan, that is, large rural areas that include a medium or large town with populations of 10,000-49,999 persons and their surrounding area, and (2) all remaining noncore counties. Although micropolitan areas do not have the economic or political importance of metropolitan cities, they are nevertheless considerable centers of population. In contrast, noncore counties, with no urban cluster of 10,000 or more persons, are areas of isolation *and* low population density that are likely to be at a significant economic disadvantage. Eighteen middle schools (attended by 2,091 [36%] of the study participants) were located in micropolitan areas, and 17 middle schools (attended by 749 [13%] of the study participants) were located in noncore areas.

Substance use

Heavy alcohol use was measured with one item that changed slightly over time to remain age appropriate. At ages 13-16, participants reported the number of days in the past month in which they had three or more alcoholic drinks on the same occasion (0 = none, 1 = 1 day, 2 = 2-4 days, 3 = 5-9 days, 4 = ≥9 days). At age 19, participants reported the number of days in the past month in which they had five or more drinks (0 = none, 1 = 1 day, 2 = 2-4 days, 3 = 5-9 days, 4 = ≥9 days). At each survey, participants reported whether they used marijuana in their lifetime, how often they used marijuana in the past year, and how often they used marijuana in the past month. Responses to these three items were used to create an 11-point index of marijuana use frequency (0 = never used to 10 = used ≥20 days in the past month).

Race/ethnicity

Participants self-identified as white, Native American, black, Asian American, Latino, or other race/ethnicity. Because only 5% of participants in total self-identified as black, Asian American, Latino, or other race/ethnicity, we grouped these participants into a single “other” category and created three dummy-coded vectors to compare white persons versus Native Americans and others. To create proxy indices of the racial/ethnic composition of students’ communities, we aggregated individual-level data on race/ethnicity to the school level and assigned each student his or her school's mean (i.e., the percentage of white persons, Native Americans, and others at his or her school).

Social disorganization/low social bonding

We measured all social disorganization/low social bonding variables at Grade 7. To create proxy indices of community-wide social disorganization/low social bonding, we aggregated students’ responses to the school level and assigned each student his or her school's mean. Measures of socioeconomic status included low parental education (1 = college graduate to 4 = high school dropout) and low household income (1 = ≥$70,000 to 5 = <$15,000). Our indicator of family disruption was whether participants lived with both biological parents. Our indicator of residential instability was the number of elementary schools participants attended. To measure low parental monitoring, we asked participants how often their parents know where they are when they are not home, how often their parents set a time to be home when they go out with their friends, and how much of their free time they spend with their parents (0 = all of the time or almost all of the time to 4 = none of the time or almost none of the time; α = .50). Low academic orientation was the average of two items (α = .56): (1) school grades (1 = mostly A's to 5 = mostly F's) and (2) the highest level of education participants planned to complete (1 = graduate/professional school to 5 = less than high school). Low religiosity was measured by two items (α = .84): (1) “Religion is very important in my life (1 = strongly agree to 4 = strongly disagree)” and (2) “How much do your religious beliefs influence the way you live your life? (1 = a great deal to 5 = not at all).” Finally, assuming that social disorganization is more likely in communities with larger versus smaller schools, we included among our measures of social disorganization the size of enrollment at students’ middle schools.

Feelings of despondency and escapism through substance use

To create proxy indices of community-wide despondency and escapism, we aggregated students' seventh grade responses to the school level and assigned each student his or her school's mean. We measured emotional distress with the five-item Mental Health Index (Stewart et al., 1988) that asked participants how often in the past month they felt (1) calm and peaceful, (2) nervous, (3) downhearted and blue, (4) happy, and (5) down in the dumps (0 = none of the time to 5 = all of the time). We scored these items so that higher numbers indicate greater emotional distress (α = .78). To measure self-derogation, we asked participants how often they "feel like a failure," "feel you are unimportant to others", and "feel like you are basically no good" (0 = never to 4 = almost always; α = .82). Short-term time perspective consisted of two items (α = .74): (1) "You do what feels good now rather than think about the future" and (2) "You focus on the short-run rather than the long-run (0 = strongly disagree to 4 = strongly agree)." Escapism via substance use contained three items (α = .80): "Drinking alcohol/smoking cigarettes/using marijuana help you get away from your problems (1 = strongly disagree to 4 = strongly agree)."

Availability of alcohol and marijuana

As proxies for the availability of alcohol in individuals' communities, we aggregated to the school level students' Grade 7 reports of how often the adult closest to them drinks alcohol (adult alcohol use; 0 = never to 3 = 4-7 days/week), how often they had been offered alcohol in their lifetime (alcohol offers; 0 = never to 4 = ≥5 times), and the percentage of seventh graders in their school who used alcohol. We then assigned each student his or her school's mean on each of these variables. As a proxy for marijuana availability, we aggregated to the school level students' Grade 9 reports of how easy or hard it would be for them to get marijuana if they wanted it (1 = very hard to 4 = very easy) and assigned each student his or her school's mean.

Missing data

Of the 5,857 students who participated at Grade 7, 91% participated at Grade 8, 87% at Grade 9, 83% at Grade 10, 84% at Grade 11, and 56% at age 19. We fit our models using maximum likelihood methods that assume data are missing at random (Little and Rubin, 2002). This approach uses all available data, including data from participants with partially observed outcomes to estimate model parameters. Missing at random assumes independence conditional on the observed data. This assumption is tenable in our models given that we controlled for differential rates of study dropout among identifiable groups by including in all models baseline covariates known to differ between completers and noncompleters (e.g., gender, ethnicity). In all models, covariance coverage ranged from .52 to 1.00, with an average of .82 per parameter.

Analytic approach

We used latent growth curve analysis (LGCA) to separately estimate models for growth in heavy drinking and marijuana use from ages 13 to 19. The LGCA used information on substance use from six waves of data collected over a 6-year period when participants were at average ages of 13 (Grade 7), 14 (Grade 8), 15 (Grade 9), 16 (Grade 10), 17 (Grade 11), and 19. The model assumes that a student's outcome at each wave is given by the sum of three terms: (1) a student-specific intercept, (2) the product of a student-specific rate of change and a wave-specific time term, and (3) a random error term. The wave-specific time terms do not vary across students. For Wave 1, the time term is set to 0, so that the intercept (initial status) describes level of use at age 13. For Wave 2, the time term is set to 1. For the remaining waves, the time terms are estimated as parameters of the model to capture the trajectory shape that best describes growth. The student-specific intercept and rate of change are modeled as functions of locality and, depending on the model, various subsets of the hypothesized school-level variables. The intercept and rate of change also depend on correlated student-specific error terms, one for the intercept and one for the rate of change, resulting in random growth curves per student.

Following Curran (2000), the parameters of the model were estimated using the structural equation modeling framework. In this framework, the intercept and rate of change are treated as unknown factors and the wave-specific time terms are factor loadings. The rate of change growth factor mean, estimated by the model, is the change in the outcome (heavy drinking or marijuana use) for a one-unit change in the time score. Because we set the Wave 1 and 2 time terms to 0 and 1, respectively, the rate of change growth factor mean corresponds to change in the outcome between ages 13 and 14. Because we allowed the model to estimate time values (to capture the shape of the growth curves) beyond age 14, the rate of change growth factor mean cannot be interpreted as a constant rate of change over all time points.

To assess the relationship between locality and the development of substance use, we created binary indicator variables from the locality index and regressed the initial status and rate of change factors on those indicators, varying the reference group so that all pairwise comparisons were made. In our initial models, the only predictor we included besides locality was treatment group status. Treatment group status was unrelated to growth in all models; therefore, we do not discuss it further. Based on the parameters from our initial models, we calculated substance use means for students in each locality at each time point and plotted them to depict developmental variation by locality. Next, we used univariate analysis of variance to compare metropolitan, micropolitan, and noncore areas on each hypothesized school-level explanatory variable. Then, we added to the initial growth models those variables that differed by location. We use school-level variables to explain geographic variation because location is a school-level variable and will be explained only by variation in other school-level variables. Variation among students within a school cannot explain difference among locations, because all students within a school are in the same location. Each school-level variable was specified as a predictor of the initial status and rate of change factors. If addition of a school-level variable to the model eliminated a difference in development between localities, that variable was said to account for the difference. For all conditional growth models, we varied the order of entry of the hypothesized explanatory variables to determine whether the results were robust to different orderings. In most cases, varying the entry order did not alter our substantive conclusions. The two cases in which order of entry did matter are explained in the results section of this article.

We conducted growth curve analyses in Mplus 4.0 (Muthén and Muthén, 2006) using full information maximum likelihood estimation. To ensure that inferences were robust to violations of the assumption of multivariate normality, we estimated standard errors using a sandwich estimator and tested the significance of coefficients with the Yuan-Bentler T2* test statistic (Yuan et al., 2002). All model-based standard errors were adjusted for random school cluster effects (Raudenbush and Bryk, 2002). Because some of the middle schools in our sample fed into a common high school, we accounted for the possibility that they might have correlated errors (given that they were part of the same community) when estimating standard errors. To evaluate overall model fit, we used the comparative fit index (CFI; Bentler, 1990) and the root mean square error of approximation (RMSEA; Steiger, 1998). A CFI value greater than .95 (Bentler, 1990) and RMSEA less than .05 (Browne and Cudeck, 1993) indicate good fit.

Results

Differences in the development of heavy alcohol use by locality

An unconditional LGCA of heavy alcohol use confirmed the presence of significant variation in the initial status (s^2 [SE] = 0.206 [0.031], $p < .001$) and rate of change (s^2 = 0.076 [0.013], $p < .001$) in heavy drinking among the total sample. The growth model that included treatment condition and locality as predictors of growth in heavy alcohol use fit the data well (CFI = .96, RMSEA = .03). In this model, locality was unassociated with variation in the initial status of heavy alcohol use (Table 1). Locality was, however, associated with rate of change in heavy alcohol use. Compared with youth in metropolitan areas, youth in micropolitan areas increased heavy alcohol use at a faster rate during adolescence. Youth from noncore areas were not reliably different from youth in either metropolitan or micropolitan areas. Figure 1 shows the difference in development of heavy alcohol use for metropolitan and micropolitan youth. Both groups start out with low levels of heavy alcohol use at Grade 7 and then increase use throughout adolescence. Although the rate of growth begins to decrease in both groups at about age 15, it decreases less for micropolitan youth. As the figure makes clear, the magnitude of the difference in rate of change is small.

Differences in the development of marijuana use by locality

An unconditional LGCA of marijuana use confirmed the presence of significant variation in the initial status (s^2 = 1.652 [0.386], $p < .001$) and rate of change (s^2 = 0.616 [0.114], $p < .001$) in marijuana use among the total sample. The model that included treatment condition and locality as predictors of growth in marijuana use fits the data well (CFI = .96, RMSEA = .03). As with heavy alcohol use, locality did not account for variation in the initial status of marijuana use (Table 2). Locality was, however, associated with rate of change in marijuana use. As Figure 2 shows, youth in all three localities start out with low levels of marijuana use at age 13, increase use through age 17, and then exhibit a downturn in use between ages 17 and 19. Compared with youth in metropolitan and micropolitan areas, youth in noncore areas increase use at a significantly slower rate through age 17 and exhibit somewhat less of a downturn thereafter.

Racial/ethnic differences by locality

Schools in noncore areas had a higher percentage of Native American students (17.6% on average) than did schools in metropolitan or micropolitan areas (5.5% and 6.8% on average, respectively) (F = 3.25, 2/48 df, $p < .05$). In addition, schools in metropolitan areas had a higher percentage of youth from racial/ethnic minority groups other than Native American (black, Asian American, and Latino; 7.4% on average) than did schools in micropolitan and noncore areas (2.5% and 2.3% on average, respectively) (F = 3.18, 2/48 df, $p < .05$).

Differences in social disorganization/low social bonding by locality

There were several differences in social disorganization and low social bonding by locality (Table 3). Students in metropolitan and noncore areas had less educated parents than did students in micropolitan areas. Compared with students in metropolitan and micropolitan areas, students in noncore areas lived in households with lower incomes. Students in metropolitan areas attended a greater number of elementary schools (our indicator of residential instability) than did students in noncore areas. Students in metropolitan and micropolitan areas attended larger elementary schools than did students in noncore areas. Finally, students in metropolitan and noncore areas had lower academic orientation than did students in micropolitan areas. The prevalence of disrupted families and aggregate levels of parental monitoring and religiosity did not differ by locality (all Fs < 1.65).

Differences in feelings of despondency and escapism by locality

There were no differences in feelings of despondency or escapism by location (all Fs < 1). Students in schools in metropolitan, micropolitan, and noncore area schools had comparable levels of emotional distress, were equally self-derogating, had similar time perspectives, and similarly endorsed the idea of substance use as a means of escape from one's problems.

Differences in perceived availability of alcohol and marijuana

Across localities, students did not differ in the number of alcohol offers received or the perceived prevalence of drinking among seventh graders at their schools (both Fs < 1). They did differ, though, in how often adults close to them drank alcohol ($F = 5.61$, 2/48 df, $p < .01$). In noncore areas (mean = 0.8 [0.04]), students reported less alcohol use by close adults than did students in metropolitan (mean = 1.0 [0.05]) and micropolitan (mean = 1.0 [0.04]) areas.

Perceived availability of marijuana differed by locality ($F = 4.67$, 2/48 df, $p < .05$). In metropolitan areas (mean = 3.7 [0.40]), marijuana was perceived to be more readily available than it was in noncore areas (mean = 3.2 [0.50]). Students in micropolitan areas (mean = 3.5 [0.42]) did not differ from students in metropolitan or noncore areas in this regard.

Accounting for locality differences in rate of change in heavy alcohol use

Accounting for differences in the racial/ethnic composition of schools by locality eliminated the difference between metropolitan and micropolitan area students in their rate of change in heavy alcohol use (CFI = .96, RMSEA = .03; Table 4, Data Column 2). To determine whether race/ethnicity acted as a proxy for one of our other hypothesized explanatory variables, we replaced race/ethnicity in the model with adult alcohol use and each of the social disorganization/low social bonding variables, assessing the effect of each replacement on the relationship between locality and rate of change. None of these other variables reduced the relationship. We also isolated the variance in race/ethnicity that is not shared with the other hypothesized explanatory variables by regressing race/ethnicity on all other variables and computing model-estimated residuals. We then added these residuals (i.e., the unique portion of race/ethnicity) to the model as predictors of growth. As Table 4 (Data Column 3) shows, adding the residuals as predictors had the same effect on the relationship between locality and rate of change as did adding the raw race/ethnicity variables. Thus, the effect of accounting for race/ethnicity on the relationship between locality and rate of change is not the result of variance in race/ethnicity that is shared with our other hypothesized explanatory variables.

Figure 3 shows the average trajectory of heavy alcohol use for the three racial/ethnic groups as estimated from a LGCA with race/ethnicity and treatment group status as predictors. A comparison of Figures 1 and 3 reveals that racial/ethnic differences in the development of heavy drinking are related to locality differences in the development of heavy drinking. Of greatest relevance is that the trajectory of non-Native American minorities (others) is the least steep of the three racial/ethnic groups. That non-Native American minorities are also most prevalent in metropolitan areas in part explains the difference in the development of heavy drinking between metropolitan and micropolitan areas.

Accounting for differences by locality in rate of change in marijuana use

As Table 5 shows, adding race/ethnicity, socioeconomic status, academic orientation, and elementary school size to the growth model did little to change the relationship between locality and rate of change in marijuana use (for all models, CFI > .96, RMSEA < .04). However, adding residential instability eliminated the difference between metropolitan and noncore youth; adding perceived availability eliminated the difference between micropolitan and noncore youth.

To determine whether residential instability on its own accounted for the difference between metropolitan and noncore youth in their rate of change in marijuana use, we tested a model that included only residential stability as a predictor of growth in marijuana use plus the location indicators. Although the beta coefficient for the difference between metropolitan and noncore youth was significantly smaller than in the initial model (*b* = -.12 [.06] vs *b* = -.23 [.07]), the difference was still statistically significant (*p* = .05). We then added each of the other predictors to the model along with residential instability to determine the combination of predictors that eliminated the difference between metropolitan and noncore youth. We found that adding *either* parental education or household income to a model that included residential instability eliminated the difference between metropolitan and noncore youth (but neither socioeconomic variable reduced that difference in the absence of residential instability). Including *both* parental education and household income, along with residential instability, did not further reduce the difference between metropolitan and noncore youth. Thus, a combination of residential instability and variance common to parental education and household income explains the difference between metropolitan and noncore youth.

We used a similar procedure to determine whether perceived availability on its own accounted for the difference between micropolitan and noncore youth in their rate of change in marijuana use. As we found for residential instability and its ability to explain the metropolitan-noncore difference, including only perceived availability as a predictor lessened but did not eliminate the difference between micropolitan and noncore youth (*b* = -.17 [.07] vs *b* = -.25 [.06]). As with residential instability, we found that either parental education or household income had to be accounted for to observe the explanatory value of perceived availability. Thus, it appears that a combination of community-level characteristics, residential instability and marijuana availability, and differing socioeconomic status between noncore and other regions explains geographic heterogeneity in the development of marijuana use.

Discussion

The primary aim of this study was to ascertain whether substance use develops differently among rural and urban adolescents. We found that heavy drinking increases at a faster rate during adolescence among youth living in micropolitan areas compared with youth living in metropolitan areas. We also found that marijuana use increases at a faster rate during adolescence among youth living in metropolitan and micropolitan areas than it does among youth living in noncore areas. These differences were small, however, suggesting that prevention efforts that succeed in one area are likely to succeed in other areas as well.

Differences in the rate of change in heavy drinking among metropolitan versus micropolitan youth were explained by differences in the racial/ethnic make-up of these areas. In particular, the larger percentage of non-Native American minorities (mainly black persons, Hispanics, and Asian Americans) in metropolitan areas versus micropolitan areas accounted for the slower increase in heavy drinking among metropolitan versus micropolitan youth. This finding is consistent with national data that show lower rates of heavy alcohol use occur among black persons, Hispanics, and Asian Americans versus white persons and Native Americans (Substance Abuse and Mental Health Services Administration, 2006). Importantly, we found that this developmental difference between racial/ethnic groups was not driven by differences in socioeconomic status, alcohol availability, or any of the social disorganization/bonding variables. To explain why rates of change are greater in micropolitan versus metropolitan areas, we need to pay closer attention to attitudinal, cultural, and genetic factors that may underlie the higher rates of heavy drinking among white and Native American youth (Galvan and Caetano, 2003). Comparing the development of substance use across reservation and nonreservation Native American youth might also illuminate these differences.

Differences in residential instability and marijuana availability were significant sources of the difference we observed among urban and rural youth in their rates of change in marijuana use. Consistent with social disorganization theory, greater residential instability in metropolitan areas accounted, in part, for the steeper increase in marijuana use among youth in these areas versus youth in noncore areas. We also found that greater availability of marijuana among youth in micropolitan areas accounted for their steeper increase in marijuana use versus youth in noncore areas, which highlights the need to examine population density and distance from urban areas along a gradient rather than as a dichotomy of rural versus urban (Conger, 1997; D'Onofrio, 1997). Although drug markets are expanding to nonmetropolitan areas at a substantial rate (O'Dea et al., 1997), it is likely that very rural places, which are isolated geographically, experience the impact of this growth to a lesser extent than do medium and large towns. In this sense, the greater geographic isolation of very rural places may offer protection against the use of illegal substances by youth. However, these community characteristics do not exist in isolation, and differences in socioeconomic status (parental education or family income) also account for some of the regional differences in the development of marijuana use, suggesting that efforts to control the accelerated use found in metropolitan and micropolitan areas need to be based on a better understanding of the relationship between socioeconomic status and substance use.

This study underscores the diversity of drug use within rural communities, suggesting that living in a very rural area is protective against some forms of drug use but that living in a rural area that includes a medium or large town is not. Future work is needed to determine if these distinctions replicate in other rural regions of the United States and to explore developmental differences among finer gradations of rural experience, for example, between youth who live on farms or ranches versus those who live in small towns. Because South Dakota's large metropolitan areas are smaller than those of many other states, research is also needed to assess whether the metropolitan/rural differences we observed hold elsewhere.

We also note that we used school-level measures as substitutes for community-level characteristics. Although schools are likely to be good proxies for the communities in which metropolitan and micropolitan youth live, the school community may encompass a larger geographic area than the home community for noncore youth who are bussed a great distance to school. Adolescents’ social networks are often based at school, however, and these networks influence attitudes toward drugs and access to them. Hence, school-level characteristics reflect the formative environment to which youth are exposed via teachers and peers.

Overall, our study provides needed information on the development of substance use among rural versus urban youth and identifies characteristics of rural and urban communities that are associated with increased risk for escalating substance use in adolescence. The greater availability of marijuana in rural areas that include a medium- to large-sized town compared with very rural areas suggests that prevention efforts in the former might benefit from paying greater attention to supply factors, as opposed to focusing largely on limiting demand for marijuana. Prevention efforts in metropolitan areas, on the other hand, might benefit by taking into account the greater vulnerability of youth who experience high rates of residential instability.

Although we found that living in a very rural area may offer protection against becoming a marijuana user, consequences of substance use in areas of geographic isolation and low population density may be particularly problematic. Because of limited access to specialized treatment and mental health services (Dempsey et al., 1999; Fortney and Booth, 2001; Hutchison and Blakely, 2003), rural people must not only battle the greater perceived social stigma of substance use treatment that exists in rural areas (Boyd, 1998) but also travel long distances to access the programs or care they need to remedy their substance use problems. Longer-term studies that follow rural and urban youth into adulthood are needed, therefore, to examine health disparities in the outcomes of adolescent substance use.

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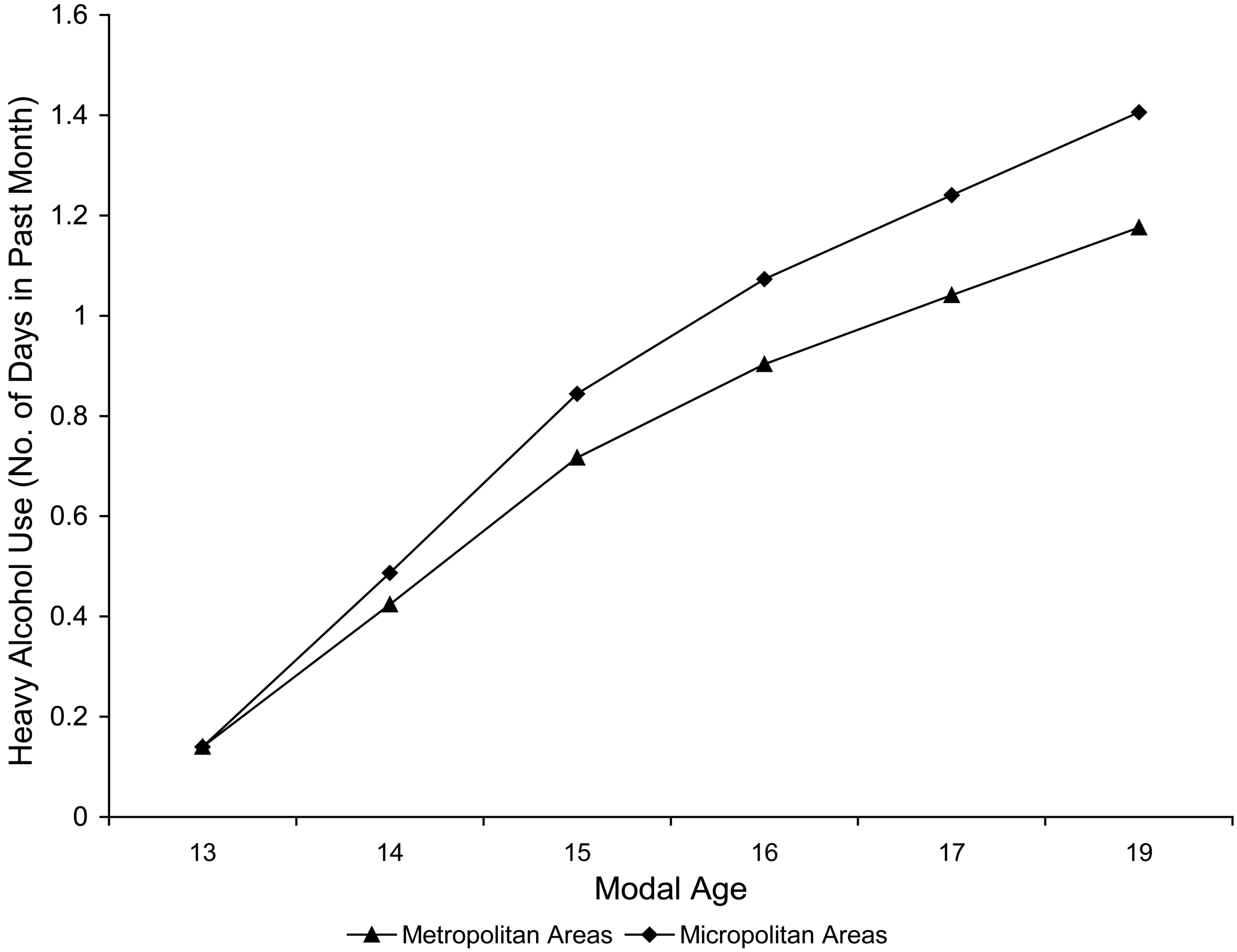

Figure 1.
Model-predicted trajectories of heavy alcohol use from ages 13 to 20 among youth in metropolitan versus micropolitan areas. The association between locality and the initial status factor was set to 0 before estimation of the means. The trajectory of heavy alcohol use among youth in noncore areas was not significantly different from that of youth in metropolitan or micropolitan areas and so is not shown.

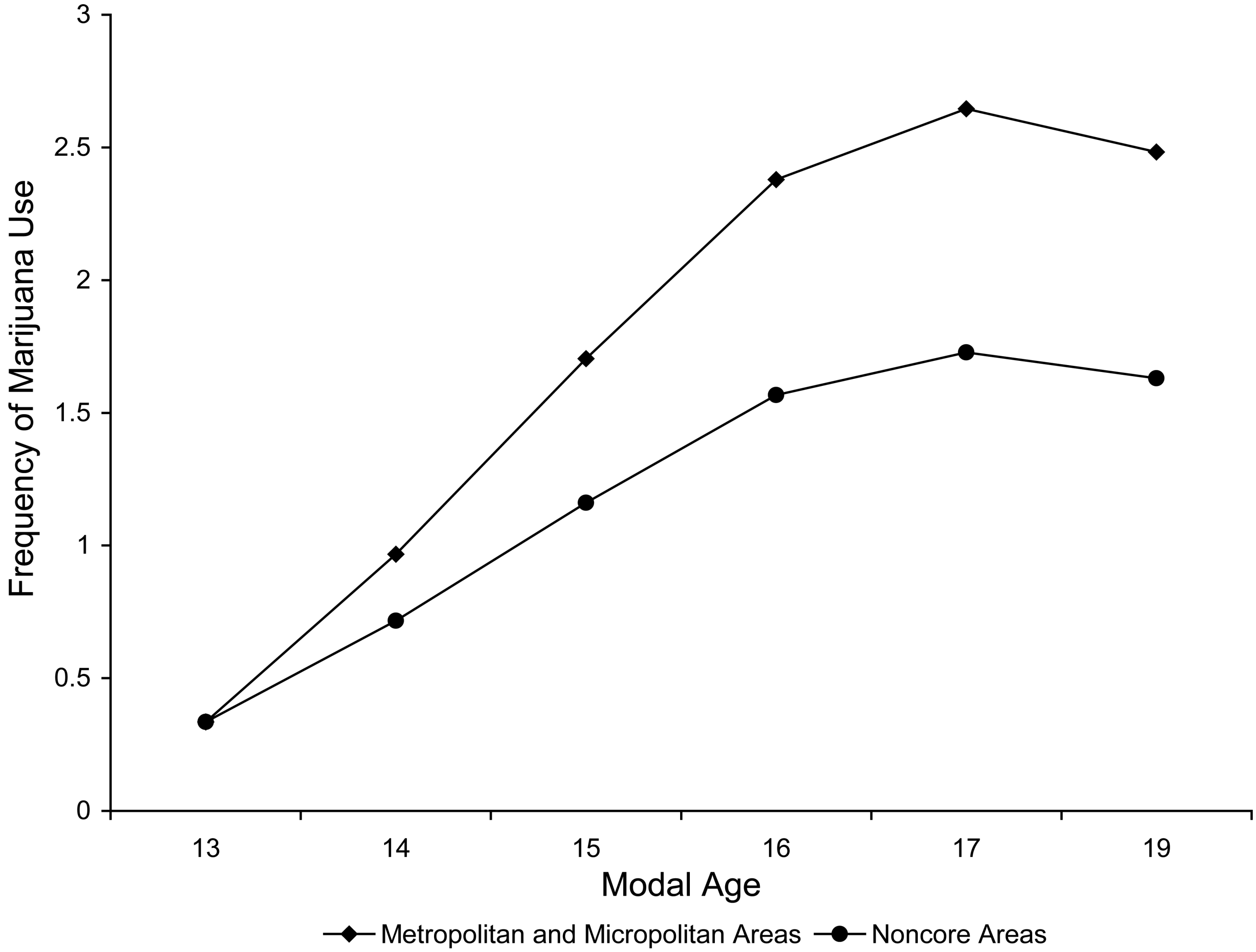

Figure 2.
Model-predicted trajectories of marijuana use from ages 13 to 20 among youth in metropolitan and micropolitan areas versus noncore areas. Frequency of marijuana use is measured on an 11-point scale, from 0 (no use) to 10 (≥20 days in the past month). On this scale, 1 = use in lifetime, 2 = one to two times in the past year, and 3 = one to two times in the past month. The association between locality and the initial status factor was set to 0 before estimation of the means. The trajectory of marijuana use among youth in metropolitan areas was not significantly different from that of youth in micropolitan areas.

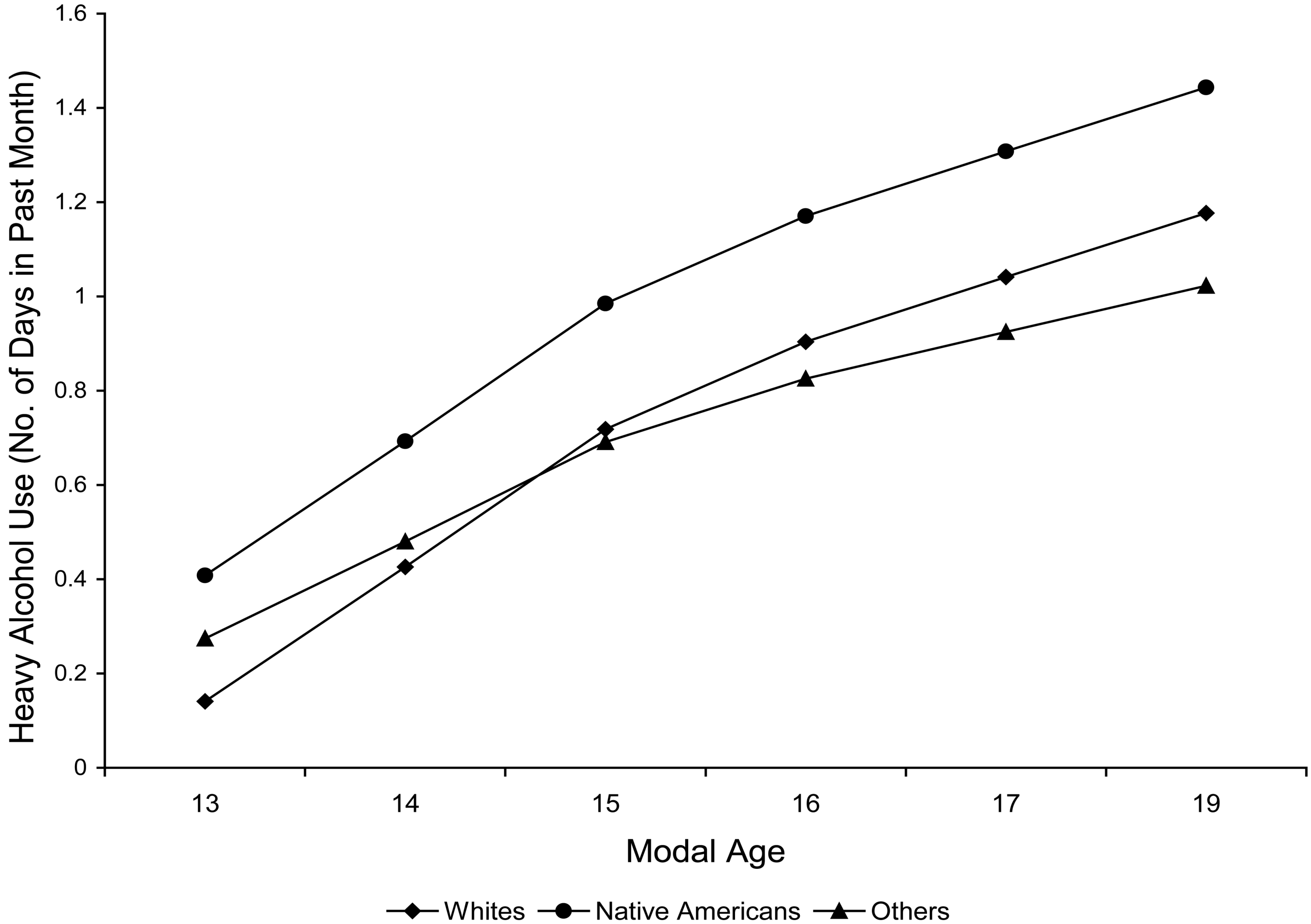

Figure 3.
Model-predicted trajectories of heavy alcohol use from ages 13 to 19 among white persons, Native Americans, and those of other racial/ethnic backgrounds (others). White students are most prevalent in micropolitan areas (90.7% vs 87.1% in micropolitan areas and 80.1% in noncore areas). Native American students are most prevalent in noncore areas (17.6% vs 5.5% in metropolitan areas and 6.8% in micropolitan areas). Students of other racial/ethnic backgrounds are most prevalent in metropolitan areas (7.4% vs 2.5% in micropolitan areas and 2.3% in noncore areas).

Table 1

Regression coefficients for the association between locality and the intercept and rate of change factors for heavy alcohol use (n = 5,857)

Variable	Initial status *b* (SE)	Rate of change *b* (SE)
Micropolitan vs *metropolitan*	-.03 (.03)	.06 (.02)‡
Noncore vs *metropolitan*	.09 (.07)	.01 (.04)
Noncore vs *micropolitan*	.13 (07)	-.06 (.04)

Note: Comparison (holdout) group is shown in *italics*.

$^{‡}p < .001$.

Table 2

Regression coefficients for the association between locality and the intercept and rate of change factors for marijuana use (*n* = 5,857)

Variable	Initial status *b* (SE)	Rate of change *b* (SE)
Micropolitan vs *metropolitan*	-.14 (.08)	.02 (.04)
Noncore vs *metropolitan*	.43 (.37)	-.23 (.07)‡
Noncore vs *micropolitan*	.47 (.37)	-.25 (.06)‡

Note: Comparison (holdout) group is shown in *italics*.

‡ $p < .001$.

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Table 3

Means and standard errors and percentages on social disorganization and low social bonding variables, by location

Variable	Metropolitan area schools (*n* = 27) Mean or % (SE)	Micropolitan area schools (*n* = 18) Mean or % (SE)	Noncore area schools (*n* = 17) Mean or % (SE)	Overall *F*
Parental education	1.97_a (0.07)	1.75_b (0.07)	1.99_a (0.07)	3.29^{*}
Household income	3.44_a (0.07)	3.31_a (0.07)	2.94_b (0.12)	$7.79^{\ddagger}$
% Two-parent households	64.55_a	71.79_a	67.77_a	<1
Elementary school enrollment	229.28_a (1.76)	214.85_a (1.97)	67.82_b (30.84)	$1{,}021.21^{\ddagger}$
Residential instability[§]	1.87_a (0.05)	$1.65_{a,b}$ (0.06)	1.53_b (0.04)	4.55^{*}
Low parental monitoring	1.21_a (0.05)	1.18_a (0.03)	1.16_a (0.04)	<1
Low academic orientation	2.07_a (0.06)	1.87_b (0.03)	2.09_a (0.06)	4.75^{*}
Low religiosity	2.40_a (0.08)	2.22_a (0.07)	2.37_a (0.06)	1.64

Notes: Means/percentages with the same subscript are not different from one at $p < .05$.

[§]Number of elementary schools attended.

[*]$p < .05$

[†]$p < .01$

[‡]$p < .001$.

Table 4

Effect of adding race/ethnicity to the LGCA model of heavy alcohol use on the association between locality and rate of change in use

Variable	Rate of change	Rate of change	Rate of change
Micropolitan vs *metropolitan*	.06 (.02)‡	.03 (.02)	.03 (.02)
Noncore vs *metropolitan*	.01 (.04)	.02 (.03)	.01 (.03)
Noncore vs *micropolitan*	-.06 (.04)	-.02 (.03)	-.03 (.03)
Native American vs *white*	–	-.20 (.05)‡	–
Other race/ethnicity vs *white*	–	-.77 (.33)†	–
Native American vs *white* (unique portion)	–	–	-.02 (.01)*
Other race/ethnicity vs *white* (unique portion)	–	–	-.02 (.01)*

Notes: Entries are unstandardized beta coefficients and their standard errors (in parentheses). Comparison (holdout) group is shown in *italics*. Associations between model covariates and the heavy alcohol use intercept factor were estimated but are not shown. Treatment status is controlled for in all models. The overall fit of all models was good: comparative fit index > .95 and root mean square error of approximation < .04 for all models. LGCA = latent growth curve analysis.

* $p < .05$

† $p < .01$

‡ $p < .001$.

Table 5

Effect of adding covariates to the LGCA model of marijuana use on the association between locality and rate of change in use

Variable	Rate of change	Rate of change	Rate of change	Rate of change	Rate of change	Rate of change	Rate of change
Micropolitan vs *metropolitan*	.02 (.04)	.03 (.04)	.08 (.05)	.03 (.05)	.02 (.05)	.05 (.05)	.03 (.05)
Noncore vs *metropolitan*	-.23 (.07)‡	-.27 (.07)‡	-.21 (.10)*	-.23 (.09)*	-.19 (.09)*	-.09 (.08)	-.09 (.07)
Noncore vs *micropolitan*	-.25 (.06)‡	-.30 (.07)‡	-.28 (.08)‡	-.26 (.08)‡	-.21 (.08)†	-.14 (.07)*	-.11 (.07)
Native American vs *white*	–	.32 (.16)*	.46 (.16)†	.47 (.18)†	.42 (.19)‡	.37 (.17)‡	.26 (.16)
Other race/ethnicity vs *white*	–	.29 (.53)	.52 (.52)	.40 (.53)	.04 (.51)	-.36 (.43)	-.55 (.37)
Low parental education	–	–	.12 (.10)	.19 (.10)‡	.13 (.11)	.09 (.10)	-.01 (.09)
Low household income	–	–	.17 (.10)	.10 (.11)	.06 (.11)	.12 (.10)	.04 (.09)
Low academic orientation	–	–	–	.34 (.13)†	.31 (.13)*	.22 (.14)	.23 (.13)
Elementary school enrollment[a]	–	–	–	–	.04 (.02)*	.02 (.02)	.01 (.02)
Residential instability[b]	–	–	–	–	–	.28 (.07)‡	.25 (.07)‡
Perceived availability	–	–	–	–	–	–	.15 (.07)*

Notes: Entries are unstandardized beta coefficients and their standard errors (in parentheses). Comparison (holdout) group is shown in *italics*. Associations between model covariates and the marijuana use intercept factor were estimated but are not shown. Treatment status is controlled for in all models. The overall fit of all models was good: Comparative fit index > .95 and root mean square error of approximation < .04 for all models. LGCA = latent growth curve analysis.

[a] Divided by 100

[b] number of elementary schools attended.

* $p < .05$

† $p < .01$

‡ $p < .001$.