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Social-ecological influences on patterns of substance use among non-metropolitan high school students¹

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Northeast Communities Against Substance Abuse (NECASA)

Abstract

Patterns of substance use are examined in a sample of over 1200 youth in a non-metropolitan region of New England. Self-reported history and frequency of alcohol, tobacco, marijuana, inhalants, pain medications, and other hard drug use was assessed for 9th and 10th grade students. Latent class analyses identified four patterns of substance use: non-users (22%), alcohol experimenters (38%), occasional polysubstance users (29%), and frequent polysubstance users (10%). Contextual risk and protective factors in the individual, family, peer, and community domains predicted substance use patterns. Youth report of peer substance use had the largest effects on substance use class membership. Other individual characteristics (e.g., gender, antisocial behavior, academic performance, perceived harm from use), family characteristics (e.g., parental drinking, parental disapproval of youth use), and community characteristics (e.g., availability of substances) demonstrated consistent effects on substance use classes. Implications for prevention are discussed from a social-ecological perspective.

Keywords

Adolescents; ATOD use; latent class analysis; risk and protective factors; non-metropolitan communities

Adolescence represents a period of increased experimentation and use of alcohol, tobacco, and other drugs (CDC, 2006). Despite the multifaceted-nature of adolescent substance use, a majority of studies rely on single indicators of substance use (e.g., frequency of drinking, history of marijuana use) and identification of population-level risk factors associated with

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use (Auerbach & Collins, 2006; Bates, 2000; Colder, Campbell, Ruel, Richardson, & Flay, 2002). While it is important to delineate the factors that contribute to adolescent use of substances independently, understanding individual patterns of use across substances may also enhance prevention efforts. Specifically, research that explicates the differential association of theoretically derived risk and protective factors to specific patterns of use could guide more effective tailoring of prevention approaches to meet the needs of adolescents engaged in dissimilar patterns of substance use.

Theoretical perspectives and empirical evidence support the notion that diverse patterns of substance use emerge in adolescence. Over 20 percent of high school youth in the *Monitoring the Future* surveys report they have not yet initiated substance use (Johnston, O'Malley, Bachman, & Schulenberg, 2006) and may constitute a separate class of non-users in adolescence. Kandel's (2002) research on the Gateway Hypothesis also suggests a progression in patterns of use from non-use to alcohol use, followed by use of an expanding array of licit and illicit substances. Person-centered cluster analytic approaches (e.g., latent class analyses; Lanza, Flaherty, & Collins, 2003) emphasize identification of homogeneous patterns of use within a heterogeneous population. Dierker and colleagues (2007), for example, identified five patterns of use among adolescents using nationally representative data: low users (55% of adolescents) engaged in no or minimal use of alcohol or other drugs; alcohol users (15% of adolescents); alcohol-marijuana users (8%), smokers (8%); and alcohol, tobacco, and marijuana users (14%) engaged in more frequent use of all three substances. Whitesell and colleagues (2006) identified four groups of lifetime use patterns among a different national sample (i.e., non-users, alcohol users, alcohol-marijuana users, and polydrug users) and three patterns of past-year use (i.e., non-users, alcohol users, alcohol and drug users). Similar findings have been reported in analyses of substance use patterns among Native American youth (Mitchell & Plunkett, 2000; Whitesell et al., 2006).

In addition to identifying distinct patterns of use, continued research is needed to shed light on factors within the adolescent's environment that increase likelihood of engaging in particular patterns of use across substances. Extensive research supports use of a social-ecological framework to understand adolescent substance use in which characteristics of the individual, as well as those of the family, peer, and community domains influence the likelihood of such involvement (e.g., Hawkins, Catalano, & Miller, 1992; Petraitis, Flay, & Miller, 1995; Scheier, 2001). The Theory of Triadic Influence (e.g., Flay & Petraitis, 1994; Flay, Petraitis, & Hu, 1999; Petraitis et al., 1995; Petraitis, Flay, Miller, Torpy, & Greiner, 1998) is based upon an extensive review of numerous theories of adolescent substance use (i.e., cognitive-affective, social-learning, conventional commitment/social attachment, intrapersonal, and integrative). This approach organizes influences based upon type (i.e., social, attitudinal, and intrapersonal) as well as level of influence (i.e., ultimate/contextual, distal/indirect, and proximal/direct). Drawing from these theoretical paradigms we identified factors that consistently have been shown to affect adolescent initiation and frequency or intensity of substance use across several ecological domains (i.e., individual, family, peer, and community). These influences are summarized below.

Individual domain

Sociodemographic and individual characteristics of adolescents play an important role in shaping individual decisions to engage in substance use (Petraitis et al., 1995). Numerous reviews of risk factors associated with adolescent substance use highlight the influence of demographic differences such as gender and age (e.g., Hawkins et al., 1992; Johnston et al., 2006; Scheier, 2001). Males generally report higher rates of alcohol and illicit substance use than females, though national data suggests that gender differences have decreased over time among youth entering high school (Wallace et al., 2003). Adolescent depressive symptoms,

behavior problems, and academic ability are important intrapersonal influences on use. Adolescent depressive symptoms have demonstrated a consistent positive and prospective relationship to initiation and frequency of adolescent substance use, in general (Armstrong & Costello, 2002; Way, Stauber, Nakkula, & London, 1994), and with cigarette and marijuana use in particular (McGee, Williams, Poulton, & Moffitt, 2000; Windle & Windle, 2001). Involvement in delinquent or antisocial behavior increases the likelihood of substance use during adolescence (Farrell, Sullivan, Esposito, Meyer, & Valois, 2005; Mason & Windle, 2002). Academic achievement has consistently been shown to reduce risk of substance use involvement in both cross-sectional and prospective research (Bryant, Schulenberg, O'Malley, Bachman, & Johnston, 2003; Dryfoos, 1990; Fothergill & Ensminger, 2006).

In addition to these intrapersonal influences, attitudinal influences (i.e., personal values and beliefs that influence attitudes toward substance use) are important to understand within the context of adolescent substance use (Petraitis et al., 1998). At the proximal level, youth who perceive substance use as more harmful to their health are less likely to initiate use (Kilmer, Hunt, Lee, & Neighbors, 2007; Resnicow, Smith, Harrison, & Drucker, 1999). At a more distal level, youth attachment to normative institutions (e.g., the school/education system) may influence patterns of use. Youth reporting greater commitment to school, for example, are less likely to engage in substance use than those with lesser commitment (Bryant, Schulenberg, Bachman, O'Malley, & Johnston, 2000; Najaka, Gottfredson, & Wilson, 2001).

Family domain

The social influences of the family domain are among the most frequently studied risk or protective factors associated with adolescent substance use (Petraitis et al., 1995). Perceived parental disapproval of adolescent substance use is an important proximal influence within the family domain (Nash, McQueen, & Bray, 2005). Distal social influences that increase risk of adolescent substance use include the substance-related attitudes and behaviors of parents and other family members such as a history of parental substance use or abuse (Abdelrahman, Rodriguez, Ryan, French, & Weinbaum, 1998; Hawkins et al., 1992; Su, Hoffmann, Gerstein, & Johnson, 1997).

A number of reviews highlight parental monitoring as an important contextual influence on initiation and rates of substance use (e.g., Hawkins et al., 1992; Scaramella & Keyes, 2001). Supervision has been shown to reduce association with negative peer influences and indirectly reduce the likelihood of adolescent substance use (Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2006; Dishion, Capaldi, Spracklen, & Li, 1995; Duncan, Duncan, Biglan, & Ary, 1998). Relatedly, youth reporting greater time spent in unstructured activities or without an adult present are more likely to engage in a range of problem behaviors including substance use (Osgood, Anderson, & Shaffer, 2005) compared to youth involved in structured extracurricular activities (Borden, Donnermeyer, & Scheer, 2001).

Peer domain

As with the family domain, peer interactions and perceptions of peer behaviors and attitudes play an important role in shaping adolescent substance use attitudes and behaviors (Petraitis et al., 1995). Perceived peer disapproval is a potential proximal influence on adolescent substance use, though perceived use of substances by peers is among the most robust risk factors for adolescent substance use (Duncan et al., 1998; Jessor, Turbin, & Costa, 1998; Olds & Thombs, 2001; Windle, 2000). Dinges and Oetting (1993) observed that 90 percent of adolescents who engaged in drug use also report having friends who use the same drugs.

Community domain

Finally, aspects of the contextual environment (i.e., neighborhood or community) influence adolescent attitudes and behaviors regarding substance use. Many theoretical perspectives emphasize the role of adolescent perceptions of community disorganization, high rates of substance use, and the ready availability of substances within their community as a risk factor for engaging in substance use. Research has shown that such community-level characteristics are associated with substance use or related problem behaviors among adolescents (Bond, Toumbourou, Thomas, Catalano, & Patton, 2005; Jessor et al., 2003; Jessor, Van Den Bos, Vanderryn, Costa, & Turbin, 1995).

The purpose of the present study is to identify substance use patterns and their associated predictors within a sample of non-metropolitan youth in New England. As indicated, recent advances in quantitative methods such as latent class analysis identify distinct patterns of behavior and the factors associated with class membership (Lanza et al., 2003). Many studies of substance use employing these methods have focused on analysis of multiple indicators of use for a particular substance such as alcohol (e.g., Reboussin, Song, Shrestha, Lohman, & Wolfson, 2006), indicators of lifetime prevalence across multiple substances (e.g., Sneed, Morisky, Rotheram-Borus, Lee, & Ebin, 2004), or indicators of frequency of use during specified periods of time (e.g., R. L. Collins, Ellickson, & Bell, 1999). We have adopted a combined approach that incorporates indicators of both lifetime and recent use for a range of substances. This approach facilitates a clearer understanding of concurrent use of substances in a given month, while also highlighting youth with a history of use for given substances who may not have used recently.

Based upon prior research and patterns of initiation of substance use during adolescence, we hypothesized that a number of distinct classes of adolescent substance use would be found including: non-users, alcohol users, and those engaged in a broader array of polysubstance use (i.e., those indicating recent use of a wider variety of substances). Because alcohol use is the most prevalent “drug of choice” among high school students we expected an alcohol user class to be most prevalent, with a polysubstance user class to be the least prevalent. Finally, based upon prior research we hypothesized that individual, family, peer, and community factors would differentiate among classes of substance use, with peer and family characteristics acting as particularly salient predictors of substance use risk.

In addition to our incorporation of lifetime and frequency indicators of use across a range of substances, another uncommon feature of this study is the focus on a non-metropolitan sample of adolescents. Prior research indicated that urban adolescents were at greater risk for substance use than their rural and suburban counterparts. Recently, however, rural, suburban, and urban rates of substance use have converged, with adolescents in rural areas engaging in substance use at rates comparable to urban adolescents (Johnston et al., 2006; Scheer, Borden, & Donnermeyer, 2000). Research on identification of substance use patterns within less urban settings may provide some insight into the specific prevention needs for youth in such communities.

Methods

Site

Northeast Communities Against Substance Abuse (NECASA) is a community-based coalition representing the 21 towns and municipalities in northeast Connecticut. NECASA began in 1990 with State funding to support planning and development of substance abuse prevention- and treatment-related services for the region. The region comprises approximately 171,000 people and covers an area of approximately 740 square miles. With

an average population density of approximately 231 individuals per square mile, the region is among the least populated areas of the state, though it includes both suburban and rural locales. Many towns in the region have fewer than 5,000 inhabitants. The ethnic and racial make-up of the community is 94.5% Caucasian, 1.2% African-American and 1.1% Asian American, and 3.1 % Hispanic. The median household income in the region is \$58,199, with 6.4% of the population below the poverty line.

Participants

Participants in the survey represented 9th and 10th grade students from the 10 public/non-vocational high schools serving the region. A total of 1,236 completed the survey. Over half of respondents (57%) were in the 9th grade, and the average age of respondents was 14.6 years ($SD = 0.7$ years). Fifty-three percent of respondents were female, and the racial and ethnic composition was as follows: 89% Caucasian, 4% Hispanic/Latino, 1% African American, 1% Asian/Pacific Islander, 1% Native American, and 3% Other. Nearly all respondents indicated that English (95%) or a combination of English and Spanish (2%) were primarily spoken at home. The racial and ethnic composition and language information mirrored regional student composition. School-level profile information for the survey period indicated that 89% of students in participating schools were Caucasian and 3% did not speak English in their homes.

Procedures

NECASA staff members administered surveys to 9th and 10th grade students within the region's 10 public high schools over a four-year period from the spring of 2000 to the fall of 2003. Surveys were administered in a group format, with most schools administering the survey in health education classes and one school conducting the survey in two large-group sessions. Passive consent procedures were approved by school boards, and a letter was sent home to parents indicating that they could elect to have their child excused from the survey. Youth also provided active assent at the time of survey administration and were informed that they did not need to participate in the anonymous survey. Less than one percent of parents indicated they did not want their child to participate in the school survey, and less than two percent of students declined participation. Surveys were self-administered with youth reading the survey and marking responses on forms that included no identifying information to ensure confidentiality and anonymity of responses. Surveys were checked for consistency of responding, and a small number of surveys (0% to 9% at each school) were discarded following administration. Data were coded and entered by NECASA staff members and subsequently transferred to the lead author for analyses.

Measures

The NECASA School Survey was based on the Connecticut Governor's Prevention Initiative for Youth's, *Youth and Program Survey* (Ungemack, Cook, & Damon, 2001). This self-report instrument was designed to assess lifetime prevalence and specify recent (i.e., past 30 days) substance use, as well as a wide range of antecedent risk and protective factors associated with use among adolescents. In addition to the specific subscales used in the present analyses (described below), youth provided basic demographic information including age, gender, and race/ethnicity.

Substance use—Lifetime history of use and frequency of use during the past 30 days was collected for 16 substances including: alcohol, tobacco, marijuana, pain and other prescription medications (e.g., sedatives, sleeping pills, barbiturates, codeine, tranquilizers; used without a doctor's prescription), inhalants, and several illicit substances (e.g., cocaine, crack, heroin, and MDMA/ecstasy). Frequency of use during the past 30-day period was

assessed on an 8-point scale ranging from “no use” (0) to “daily use” (7). Lifetime and past 30-day use for alcohol, tobacco, and marijuana were collapsed into single items to reflect the following scale: (0) no history of use, (1) no history of use past 30 days, (2) use 1–5 days, (3) use 6 or more days.

Given the limited responses to individual hard drugs, we collapsed affirmative responses among these substances into a single response category representing any hard drug use using the following scale: (0) no history of use, (1) no history of use past 30 days, (2) use during past 30 days. Finally, inhalant and prescription medication use (without a doctor’s prescription) were modeled on the following scale: (0) no history of use, (1) history of use.

Individual-level risk and protective factors—Self-reported unstructured weekly time, mental health, antisocial behavior involvement, academic grades, school commitment, and perceived harm from occasional substance use were assessed. Unstructured weekly time was assessed by summing responses to questions regarding the amount of time spent on a weekly basis for eight items (e.g., watching TV, hanging out with friends at your or their home, talking on the telephone) using a 7-point Likert scale (0 = none to 6 = 20 or more hours per week; $\alpha = 0.86$). Mental health was assessed by computing the mean ratings for 17 items consistent with depressive mood or symptoms (e.g., I feel lonely; all in all, I am glad I am me; I have trouble concentrating). Items were rated on a 5-point Likert scale reflecting the degree to which respondents agreed or disagreed with each statement; higher scores reflected fewer depressive feelings or symptoms, and the items demonstrated strong internal consistency ($\alpha = 0.86$). Involvement in antisocial behaviors was assessed using a 15-item scale in which youth indicated the frequency of involvement in a range of behaviors (e.g., threatening to hurt someone, cheating on a test, stealing items worth less than \$50, selling illegal drugs) during the past 12 months. A total score was produced by summing the number of behaviors with an affirmative response. Academic grades were measured using a 9-point scale ranging from “mostly A’s” to “mostly F’s”, which was converted to a score from 0–4 reflecting approximate GPA. Youth commitment to school and education was assessed using a five-item scale indicating the degree to which youth felt an attitude or behavior was indicative of themselves (e.g., I try hard to do go work at school, I want very much to get more education after high school). Items were rated on a four-point scale (“definitely not true” to “definitely true”) with higher scores indicative of stronger commitment to education ($\alpha = 0.78$). Finally, perception of harm from occasional substance use was assessed by averaging responses from four items reflecting the degree to which respondents thought people harmed themselves from occasional alcohol, tobacco, and marijuana use, and drunkenness (“no harm” to “a lot of harm”) with good internal consistency ($\alpha = 0.79$).

Family risk and protective factors—Youth report of perceived parental disapproval of substance use, parental smoking, parental drinking, family history of problem drug use, and parental monitoring and supervision practices were used to assess family characteristics associated with substance use. Perceived parental disapproval was assessed by computing the mean for three items reflecting the degree to which youth perceived their parents felt it was wrong to use alcohol, cigarettes, or marijuana on a four-point scale (“not at all wrong” to “very wrong”); items demonstrated good internal consistency ($\alpha = 0.79$). Youth report of parental smoking and drinking were coded as 0 (“no”) or 1 (“yes”). Family history of problem drug use was assessed with three items reflecting the extent of problem involvement with alcohol, marijuana, or other illegal drugs; items were rated on a three-point scale indicating “no history”, “prior history”, and “current history” of problem use ($\alpha = 0.84$). Finally, parental monitoring and supervision was assessed with four questions reflecting the extent to which parents provided monitoring and supervision and enforced

rules. Items were rated on a four-point scale (“definitely not true” to “definitely true”) and had acceptable internal consistency ($\alpha = 0.64$).

Peer risk and protective factors—Youth report of perceived peer disapproval of substance use, peer substance use, and peer antisocial behavior were used to assess peer characteristics associated with substance use. Perceived peer disapproval of substance use was assessed by computing the mean for three items reflecting the degree to which youth perceived their close friends felt it was wrong to use alcohol, cigarettes, or marijuana on a four-point scale (“not at all wrong” to “very wrong”); items demonstrated good internal consistency ($\alpha = 0.87$). Peer substance use was computed by taking the mean for five items in which respondents indicated they number of close friends that used alcohol, tobacco, and other drugs. Items were scored on a four-point scale (“none” to “most”) and had good internal consistency ($\alpha = 0.84$). Peer antisocial behavior was assessed summing affirmative responses to items reflecting whether any of the respondents close friends had engaged in six antisocial activities in the past year (e.g., been suspended from school, sold illegal drugs, stolen or tried to steal a motor vehicle).

Community risk and protective factors—The community domain was assessed using two scales, including perceived availability of substances in one’s community and perceived drug use in the community. Perceived availability of drugs was assessed using 4 items reflecting ease of access to substances on a 4-point scale with options ranging from “very easy” to “very hard” to access. Perceived drug use in the community was assessed using a three-item scale reflecting perceived truth of statements regarding use of marijuana and other drugs within the neighborhood on a four-point scale (“definitely not true” to “definitely true”). Both scales have excellent internal consistency ($\alpha = 0.84$ and 0.87 , respectively).

Data Analysis

Latent class analysis (LCA; Lubke & Muthén, 2005; McCutcheon, 1987) with Mplus 5.0 (Muthén & Muthén, 2006) was used to test study hypotheses. LCA is used to detect unobserved heterogeneity in a given population, identify meaningful groups (i.e., classes) based upon similarity of responses to measured variables, and identify covariates that differentiate membership across classes (Nylund, Asparouhov, & Muthén, 2007). The primary advantage of LCA over alternative approaches (e.g., cluster analysis or a priori assignment based upon observed data) is the reliance on a model-based method for estimating population characteristics derived from sample data, adjustment of estimates for measurement error, formal statistical procedures for determining the number of classes, use of probabilities as the basis for interpretation of results, and flexible treatment of variance among classes (Magidson & Vermunt, 2002; Muthén & Muthén, 2006; Nylund et al., 2007).

LCA provides estimates of class membership probabilities (e.g., substance use classes), and behavioral probability estimates within class (e.g., class-specific patterns of ATOD use; Auerbach & Collins, 2006; Lanza et al., 2003). The relationship of covariates to class membership are determined through simultaneously estimated multinomial logistic regression with corresponding odds ratios estimated to indicate the effect of a given level of the covariate on probability of class membership relative to a reference class. Mplus 5.1 provides alternative parameterization solutions for multinomial logistic models to facilitate comparison of effects based upon alternative reference classes – for the present analyses we initially used the non-user class as the reference class in multinomial logistic analyses; re-parameterized models facilitated comparison among substance using classes. Missing data was addressed via full information maximum likelihood methods.

We conducted a series of models, beginning with a one class model and incorporating additional classes, and compared fit indices to determine the optimal solution. Covariates were included in analyses for all but the one-class model. For models with more than one class, we tested a series of unrestricted models in which class substance use probabilities were freely estimated as well as a series of restricted models that imposed a zero-use class (i.e., a “non-user” class). Based upon existing research recommendations (Muthén & Muthén, 2006; Nylund et al., 2007), model fit was compared using multiple indices (i.e., Adjusted BIC, Lo-Mendell-Rubin Likelihood Ratio Test, and model entropy).

Because these data were clustered within a limited number of schools (i.e., 10 schools), multilevel modeling to assess school-level random effects was precluded (Maas & Hox, 2004, 2005). An additional model was run in which school setting was treated as a fixed effect to determine whether there were any significant setting effects related to class membership. Analyses provided nearly identical results to the model without these fixed effects in terms of both the number of classes identified and the effects of risk and protective factors on class membership. Further, of the 27 school-level identifier effects tested in the multinomial regression model in which non-users served as the reference group, only one effect was statistically significant – indicating a lower risk of membership in a particular substance use class (frequent polysubstance users) for one of the ten schools relative to an arbitrarily chosen reference school. Because the focus of this study was not on school-level effects on substance use class membership, and for the sake of parsimony, the results of the analyses without inclusion of school-level fixed effects are reported.

Results

Results of successive LCA models are presented in Table 1. Both four-class models demonstrated better fit to the data than other models, with no clear advantage between the two models in terms of adjusted BIC or entropy. Given nearly equivalent indicators of model fit, the restricted four-class model was selected on the basis of parsimony (i.e., fewer parameters were estimated) and consistency with expectations of a non-user class based upon prior research and theory. The basic structure of the classes across both four-class solutions was comparable, with some variation in prevalence of identified classes across the two models. Average individual posterior assignment probabilities for the four-class restricted solution indicated relatively high values along the diagonal and low values off the diagonal, providing further indication that the four-class solution was appropriate.

Conditional probabilities of substance use by class provide an indication of the patterns of substance use exhibited by members of each class (see Table 2). Class 1 accounted for 22 percent of the sample and was restricted to those youth with no history of substance use (“non-users”). Class 2 (“alcohol experimenters”) accounted for 38 percent of the sample; the conditional probability of any history of alcohol use was 0.64, though most had not used in the past month (probability = 0.47). Class 3 (“occasional polysubstance users”) accounted for 29 percent of the sample and exhibited a higher probability of use for each of the substance categories than either Class 1 or Class 2. Nearly all youth in this class reported a history of alcohol use, and a majority indicated a history of tobacco and marijuana use. Probabilities of frequent past month alcohol, tobacco, and marijuana use were relatively low for this class – ranging from 0.11 to 0.27. Finally, Class 4 (“frequent polysubstance users”) accounted for 10 percent of the sample. Youth in this class endorsed the highest probability of initiation for each of the substances assessed, and past month use in excess of 6 or more days was high for alcohol, tobacco, and marijuana (approximately two thirds to three quarters of youth in this group). The probability of lifetime hard drug, inhalant, and prescription drug use without a doctor’s prescription was highest for this group.

Multinomial logistic regression analyses examined the association between class membership and hypothesized individual, family, peer, and community domains. The odds ratios (OR) resulting from these analyses with Class 1 (non-users) treated as the reference category are presented in Table 3, and alternative parameterizations of the results permitting comparisons among use groups are presented in Table 4.

Within the individual-level domain, a number of characteristics significantly differentiated the non-user class from each of the substance user classes, as well as amongst user classes. Controlling for other factors, males were at decreased odds for being identified as an alcohol experimenter, occasional polysubstance user, or frequent polysubstance user relative to non-users; and also were at decreased odds for being identified as a frequent polysubstance user relative to an alcohol experimenter and occasional polysubstance user. Higher rates of reported antisocial behavior were associated with increased odds of being identified as an alcohol experimenter, occasional polysubstance user, or frequent polysubstance user compared to the non-user class; and also with increased odds for identification in classes with higher rates of use amongst substance using classes. Both higher academic grades and perceived harm from occasional substance use were associated with decreased odds of occasional and frequent polysubstance use compared to non-users and alcohol experimenters. Finally, significant effects also were observed with respect to child mental health and time spent in unstructured activities each week, though these effects were less consistent than other individual-level influences.

Among family characteristics, youth report of parental drinking was associated with increased odds of being identified as an alcohol experimenter, occasional polysubstance user, or frequent polysubstance user compared to non-users. Greater perceived parental disapproval of substance use was associated with decreased odds of being identified as a frequent polysubstance user compared to each of the other classes. Additionally, higher ratings of parental monitoring decreased odds of being identified as an occasional polysubstance user compared to a non-user.

The largest effects with respect to class membership were observed among youth reports of peer characteristics, specifically reports of peer substance use. Higher levels of peer use increased odds of being identified as an alcohol experimenter, occasional polysubstance user, or frequent polysubstance user relative to non-users; and also of being identified with classes reporting higher rates of use amongst substance using classes. Higher perceived peer disapproval of use was associated with decreased odds of being identified as an occasional polysubstance user compared to a non-user or alcohol experimenter, and higher ratings of peer antisocial behavior increased odds of identification as an occasional polysubstance user compared to an alcohol experimenter.

Finally, at the community-level perceived availability of substances increased odds of membership in each of the polysubstance use classes compared to both non-users and alcohol experimenters, and also with increased odds of identification as a frequent, compared to occasional, polysubstance user.

Discussion

The present study examined adolescent patterns of substance use, across a range of licit and illicit substances, within a non-metropolitan region comprised of rural and suburban communities. Multiple indicators of substance use, comprising both lifetime history and frequency of past-month use, were examined using latent class analysis within a theoretically derived model of social-ecological influences on class membership. Our results provided strong support for study hypotheses regarding distinct patterns of adolescent

substance use. We identified four classes of substance use, consistent with previous research (e.g., Dierker et al., 2007; Whitesell et al., 2006) and expectations based upon stage-sequential theories of substance use (e.g., L. M. Collins, 2002; Kandel, 2002). The first two classes were comprised of youth who had not yet initiated use or who had begun to experiment with alcohol and had limited prior history of tobacco use. The final two classes both included youth who had expanded to a broader range of polysubstance use. Thus, about 60 percent of youth engaged in relatively low-risk patterns of use (i.e., non-use or relatively infrequent alcohol use), while 30 percent of youth have initiated a more risky pattern of use, and 10 percent of youth engaged in a pattern of use that poses significant risk to their physical, social and mental health as they transition to later adolescence and young adulthood.

Consistent with our hypotheses and the basic premise of the Theory of Triadic Influence (e.g., Petraitis et al., 1995; Petraitis et al., 1998), risk factors across the individual, family, peer, and community domains encompassing intrapersonal, attitudinal, and social influences were associated with substance use class membership. It is telling that these risk factors appear consistent with the literature based upon variable-centered analysis of individual substances (e.g. alcohol use) or on latent class models for single substances (e.g., patterns of alcohol use). This may suggest that risk and protective factors are not unique to specific substances. Alternatively, it may be that classes represent a general progression in intensity and expansion of use that emerges during adolescence – with risk and protective factors associated with this more general progression. Longitudinal research on transitions across patterns of use based upon multiple substances as well as transitions for specific substance use classes (e.g., classes based upon multiple indicators of alcohol use) would help to clarify this relationship further.

Individual and peer factors appeared to have the most consistent effects, differentiating non-users from each use class and also differentiating amongst use classes. The most robust effects on class membership were observed for perceived peer substance use. Follow-up analyses to investigate this relationship in greater detail revealed a strong social dynamic at play. Two-thirds (66%) of youth identified as non-users reported that none of their close friends engaged in any of the five substances assessed, compared to 18% of alcohol experimenters, 2% of occasional polysubstance users, and 1% of frequent polysubstance users. This pattern of findings also provides context to the substantial effect sizes observed with respect to peer use and substance use class membership, particularly when non-users served as the reference.

Within the individual domain, the findings with respect to gender were somewhat unanticipated. Examination of posterior class probabilities revealed that males were significantly over-represented among non-users (53%) and significantly under-represented among the alcohol experimenter and frequent polysubstance user classes (43% and 40%, respectively). Females appear to be at particular risk of engaging in alcohol experimentation (57%), while males who engage in similar levels of alcohol use are likely to do so within the context of occasional polysubstance use. The relation of gender to frequent polysubstance use is a bit more complex and may be attributable, in part, to the greater prevalence of prescription medication use without a doctor's prescription among females (27% vs. 21% in males) – a unique feature of the frequent user class.

These findings suggest the need to tailor prevention efforts to meet the specific needs of adolescents in a number of ways. For the majority of youth prevention efforts should seek to maintain the supports that have facilitated non-use or limited alcohol use, while also providing appropriate skills to resist initiation of a broader array of substances (e.g., tobacco and marijuana). For youth who have begun to engage in occasional polysubstance use,

prevention efforts should focus on shaping attitudes and providing appropriate supports to assist youth in reducing their frequency of alcohol, tobacco, and marijuana use (e.g., harm reduction models; Graham, Patterson, Roberts, & Johnston, 2004; McBride, Farrington, Midford, Meuleners, & Phillips, 2004). Finally, youth engaged in a pattern of frequent polysubstance use require more targeted or intensive intervention aimed at significantly reducing their substance use behavior.

The regression findings provide additional support to the need for substance use prevention efforts to incorporate a broad social-ecological perspective that focuses on individual-level influences as well as broader contextual influences (e.g., peer and family member attitudes and behaviors). It is imperative that prevention efforts continue to target basic intrapersonal influences such as basic knowledge of harmful effects and skill-building behaviors (e.g., refusal skills, decision making). In addition, peer influences have a salient effect on youth substance use behaviors that should be incorporated into prevention efforts, whether this effect is the result of peer pressures to initiate use or the tendency of youth to associate with peers engaging in similar patterns of risk behavior (e.g., substance use, antisocial behavior, etc.). A number of evidence-based programs have been developed to address multiple contextual influences on adolescent problem behavior such as the Strengthening Families Program (Kumpfer, Molgaard, & Spoth, 1996) and the Guiding Good Choices program (formerly Preparing for the Drug Free Years; Park et al., 2000; Spoth, Randall, Shin, & Redmond, 2005). This latter program, in particular, has demonstrated specific reductions in polysubstance use among rural adolescents (Mason, Kosterman, Hawkins, Haggerty, & Spoth, 2003).

Findings from this study also should be considered in light of potential limitations. First, the results of the analyses are based upon adolescent self-report of sensitive behaviors (i.e., substance use), raising questions about the validity of such reports. Available evidence indicates that adolescents generally provide accurate reports of substance use (Harrison, Haaga, & Richards, 1993; Needle, Jou, & Su, 1989), and similar youth surveys (e.g., the *Monitoring the Future* and *Communities that Care* surveys) have been shown to provide valid epidemiological estimates of prevalence of adolescent substance use associated risk and protective factors (Arthur, Hawkins, Pollard, Catalano, & Baglioni, 2002; Johnston et al., 2006). Further, youth perceptions of contextual influences are a central feature of the Theory of Triadic Influence model, though more objective indicators of risk, or those rated by other observers, would strengthen the model we tested. A second limitation is the use of cross-sectional data which limits our ability to draw causal influences between risk and protective factors (e.g., association with substance using peers) and substance use class membership. It is possible that the associations observed in our findings result from alternative temporal sequences (e.g., youth who engage in frequent polysubstance use are more likely to subsequently gravitate to similar peers). Prior longitudinal research has generally supported the hypotheses we have tested, though it is likely that substance use behaviors on the part of the adolescent also influence characteristics of the youth's intrapersonal, attitudinal, and social environment. Additional research, using longitudinal data, would permit for additional testing to determine the causal relation of risk and protective factors to class membership and would permit additional analyses of changes in class membership over time. Finally, our sample was relatively homogeneous in terms of demographic diversity. The extent to which these results would generalize to non-metropolitan settings representing a broader range of minority youth, or to non-school-based populations, is unclear. It might be expected, for example, that a broader range of substance use patterns or different prevalence rates for such patterns may emerge in a more broadly diverse settings or regions.

Despite these limitations, the present study provides valuable empirical evidence for differential patterns of substance use among a non-metropolitan high school population and the relation of hypothesized social-ecological risk and protective factors to these patterns of use. Future research, employing multilevel modeling within more diverse community and school settings, is needed to facilitate our understanding of how school and community contexts serve as potential moderators of substance use patterns and effects of risk and protective factors. In addition, longitudinal research is needed to better understand individual trajectories across substance use patterns and the extent to which they change over time.

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Table 1

Fit statistic comparisons of exploratory LCA models with covariates.

Model	Description	Adjusted BIC	LMR LRT p-value	Entropy
1	One-class (no covariates)	11976.10	–	–
2	Two-class, unrestricted	8725.16	< 0.001	0.88
3	Two-class, restricted ^a	9644.57	< 0.001	0.97
4	Three-class, unrestricted	8215.53	< 0.001	0.87
5	Three-class, restricted ^a	8403.98	< 0.001	0.87
6	Four-class, unrestricted	8138.76	0.03	0.83
7	Four-class, restricted ^a	8140.35	<0.001	0.83
8	Five-class, unrestricted	8108.85	0.27	0.84
9	Five-class, restricted ^a	8096.73	0.60	0.86

Notes: BIC – Bayesian Information Criterion. LMR LRT – Lo-Mendell-Rubin Likelihood Ratio Test p-value for (K-1)-classes. A significant p-value indicates that the (K-1)-class model should be rejected in favor of a model with at least K-classes.

^aRestricted one class to no history of use across all substance use variables.

Table 2

Four-class restricted LCA model of conditional probabilities of substance use by class.

Class Prevalence	Class 1: Non-users 21.8%	Class 2: Alcohol Experimenters 38.4%	Class 3: Occasional Polysubstance Users 29.3%	Class 4: Frequent Polysubstance Users 10.5%
<u>Alcohol Use</u>				
Never	1.000	0.358	0.022	0.000
No Past Month Use	0.000	0.467	0.327	0.089
One to five days	0.000	0.163	0.382	0.247
Six or more days	0.000	0.012	0.269	0.664
<u>Tobacco Use</u>				
Never	1.000	0.783	0.266	0.000
No Past Month Use	0.000	0.197	0.424	0.133
One to five days	0.000	0.018	0.197	0.205
Six or more days	0.000	0.002	0.113	0.662
<u>Marijuana Use</u>				
Never	1.000	0.941	0.298	0.062
No Past Month Use	0.000	0.053	0.302	0.095
One to five days	0.000	0.006	0.215	0.096
Six or more days	0.000	0.000	0.185	0.747
<u>Hard Drug Use</u>				
Never	1.000	0.985	0.892	0.139
No Past Month Use	0.000	0.006	0.058	0.177
Past 30 day Use	0.000	0.009	0.050	0.684
<u>Inhalant Use</u>				
Never	1.000	0.968	0.827	0.366
Past Use	0.000	0.032	0.173	0.634
<u>Prescription medication Use without a Doctor's Prescription</u>				
Never	1.000	0.865	0.668	0.132
Past Use	0.000	0.135	0.332	0.868

Table 3

Odds ratio results from latent multinomial logistic regression models: Covariate effects on latent class membership with abstainers as reference group.

	Alc. Exp. vs. Non-Users OR (95% CI)	Occ. Poly Users vs. Non-Users OR (95% CI)	Freq. Poly Users vs. Non-Users OR (95% CI)
Age	1.04 (0.47–2.30)	1.02 (0.41–2.52)	0.87 (0.25–3.00)
Gender: Male	0.42* (0.27–0.82)	0.33* (0.11–0.98)	0.10** (0.03–0.33)
Unstructured Time	1.03 (0.96–1.10)	1.12** (1.03–1.21)	1.08 (0.98–1.19)
Child Mental Health	0.86 (0.44–1.67)	1.78 (0.79–3.98)	1.26 (0.48–3.30)
Child Antisocial Behavior	1.90* (1.16–3.09)	2.90** (1.54–5.47)	4.51** (2.35–8.64)
Academic Grades	0.51 (0.26–1.00)	0.21** (0.09–0.49)	0.20** (0.07–0.52)
School Commitment	1.64 (0.56–4.82)	2.84 (0.79–10.25)	1.71 (0.42–6.89)
Perceived Harm from Use	0.48 (0.22–1.05)	0.18** (0.07–0.45)	0.12** (0.04–0.34)
Parental Disapproval of Use	0.54 (0.18–1.63)	0.53 (0.16–1.78)	0.16** (0.05–0.56)
Parental Smoking	1.45 (0.72–2.93)	1.90 (0.77–4.72)	2.20 (0.73–6.63)
Parental Drinking	2.42** (1.26–4.67)	3.51* (1.33–9.29)	3.61* (1.05–12.50)
Family Drug Problem History	0.70 (0.25–2.02)	1.04 (0.33–3.26)	1.32 (0.36–4.78)
Parental Monitoring	0.31 (0.09–1.00)	0.17* (0.03–0.92)	0.27 (0.04–1.63)
Peer Disapproval of Use	.57 (0.26–1.29)	0.32* (0.13–0.80)	0.53 (0.17–1.63)
Peer Substance Use	8.41** (1.97–35.78)	26.13** (5.66–120.52)	85.63** (16.38–447.75)
Peer Antisocial Behavior	1.04 (0.65–1.67)	1.39 (0.85–2.26)	1.17 (0.65–2.10)
Community Availability	1.52 (0.98–2.36)	2.31** (1.35–3.94)	5.50** (2.30–13.19)
Community Substance Use	1.13 (0.74–1.73)	1.33 (0.81–2.20)	1.76 (0.94–3.30)

*
p < 0.05,

**
p < 0.01

Table 4

Odds ratio results from alternative parameterization of latent multinomial logistic regression models.

	Occ. Poly Users vs. Alc. Exp. OR (95% CI)	Freq. Poly Users vs. Alc. Exp. OR (95% CI)	Freq. Poly Users vs. Occ. Poly Users OR (95% CI)
Age	0.98 (0.55–1.75)	0.84 (0.33–2.13)	0.86 (0.37–2.01)
Gender: Male	0.78 (0.33–1.83)	0.23** (0.08–0.64)	0.29** (0.13–0.67)
Unstructured Time	1.09** (1.03–1.16)	1.05 (0.97–1.13)	0.96 (0.90–1.03)
Child Mental Health	2.07** (1.21–3.56)	1.47 (0.69–3.13)	0.71 (0.39–1.28)
Child Antisocial Behavior	1.53** (1.11–2.09)	2.38** (1.65–3.42)	1.56** (1.24–1.96)
Academic Grades	0.42** (0.26–0.69)	0.38** (0.19–0.75)	0.91 (0.57–1.45)
School Commitment	1.74 (0.78–3.89)	1.04 (0.41–2.68)	0.60 (0.31–1.16)
Perceived Harm from Use	0.38** (0.24–0.61)	0.25** (0.13–0.49)	0.66 (0.38–1.15)
Parental Disapproval of Use	0.99 (0.59–1.68)	0.30** (0.16–0.57)	0.30** (0.19–0.49)
Parental Smoking	1.31 (0.71–2.43)	1.52 (0.64–3.62)	1.16 (0.58–2.31)
Parental Drinking	1.45 (0.70–2.98)	1.49 (0.52–4.30)	1.03 (0.42–2.52)
Family Drug Problem History	1.48 (0.88–2.50)	1.87 (0.84–4.16)	1.27 (0.60–2.65)
Parental Monitoring	0.57 (0.23–1.41)	0.88 (0.29–2.70)	1.55 (0.77–3.12)
Peer Disapproval of Use	0.56** (0.38–0.83)	0.92 (0.46–1.82)	1.64 (0.92–2.93)
Peer Substance Use	3.11** (1.59–6.06)	10.19** (4.24–24.46)	3.28** (1.74–6.18)
Peer Antisocial Behavior	1.33** (1.08–1.64)	1.12 (0.75–1.67)	0.84 (0.60–1.20)
Community Availability	1.52* (1.08–2.14)	3.63** (1.70–7.73)	2.38* (1.17–4.85)
Community Substance Use	1.18 (0.86–1.61)	1.56 (0.96–2.55)	1.32 (0.85–2.06)

*
p < 0.05,**
p < 0.01