EFFECTS OF ALCOHOL USE INITIATION PATTERNS ON HIGH-RISK BEHAVIORS AMONG URBAN, LOW-INCOME, YOUNG ADOLESCENTS

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Abstract

This study examined associations between patterns of alcohol use initiation and progression from age 12 to 14 years and recent cigarette and marijuana use, and violent and delinquent behavior at age 14. The study sample (n=2,193) was predominantly African American or Hispanic (43% and 37%, respectively) and low-income (68% receiving free, or reduced price, lunch). They completed classroom-based surveys when in 6th–8th grades. Multilevel latent class analyses were used to identify the heterogeneous alcohol use trajectories. Linear and logistic mixed-effects regression was then used to examine the association between these patterns and high-risk behaviors in 8th grade. Five alcohol use trajectories were identified: (1) No Use (63.3%), (2) Onset of Consistently Infrequent Use at Age < 12 (13.3%), (3) Onset of Monthly Use at Age 14 (9.9%), (4) Onset of Monthly Use at Age 13 to Heavy Use at Age 14 (6.6%), and (5) Onset of Consistently Heavy Use at Age 12 (6.9%). Relative to non-users, membership in any of the alcohol use trajectory classes was significantly associated with greater past month cigarette and marijuana use, as well as violent behaviors in 8th grade. Higher levels of delinquent behaviors were significantly associated with membership in all but one of the alcohol use trajectory classes relative to the "no use" class. Results suggest that any use of alcohol in early adolescence is associated with other high-risk behaviors and support the critical need for efforts to prevent early initiation and progression of alcohol use among youth as a key component to prevent future high-risk behaviors.

Keywords

alcohol use; high-risk behaviors; adolescent; trajectory classes

INTRODUCTION

Alcohol is the most commonly used substance among American youth (Johnston, O'Malley, Bachman, & Schulenberg, 2008), and for many, initiation of use occurs prior to age 13 (Kosterman, Hawkins, Guo, Catalano, & Abbott, 2000; National Center for Chronic Disease Prevention and Health Promotion, 2008). Results from the 2007 Youth Risk Behavior Survey

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(National Center for Chronic Disease Prevention and Health Promotion, 2008) suggest that nearly one-quarter of youth begin drinking alcohol before age 13. Such early onset of use has been associated with a number of deleterious health and social problems, including alcohol abuse and dependence, alcohol-related violence and injuries, drinking and driving, truancy, traffic crashes, risky sexual behavior, and other drug use throughout adolescence and into adulthood (Grant & Dawson, 1998; Grant, Stinson, & Harford, 2001; Gruber, DiClemente, Anderson, & Lodico, 1996; Hingson, Heeren, Levenson, Jamanka, & Voas, 2002; Hingson, Heeren, Winter, & Wechsler, 2003; Hingson, Heeren, & Zakocs, 2001; Hingson, Heeren, Zakocs, Winter, & Wechsler, 2003; Hingson, Heeren, & Winter, 2006). Although these studies have been fundamentally important in understanding the consequences of early onset of alcohol use, they have two important limitations. First, most rely on retrospective recall of age of onset of alcohol use and such recall could be confounded by current use and/or alcohol-related problems. Second, most of these studies have used a simple dichotomy of use/no use, therefore providing few details regarding differential initiation and progression patterns and how these may affect alcohol-related consequences.

In addition, until recently, most of the literature describing the relationships between alcohol use initiation and health and social outcomes has employed a variable-centered approach (Hill, White, Chung, Hawkins, & Catalano, 2000). This approach assumes data come from a homogenous population and describes the average behavior of the sample. This assumption fails to adequately describe higher-risk or lower-risk individuals (Hill et al., 2000) and does not provide a nuanced analysis (Duncan, Duncan, & Strycker, 2006), as there may be several heterogeneous patterns of alcohol use which may differentially affect outcomes.

In contrast, a person-centered approach allows identification of heterogeneous patterns of alcohol use and examination of effects by these sample subgroups. Several recent studies have utilized this approach to examine different patterns, or trajectories, of alcohol use and their effects on social and behavioral outcomes (Chassin, Flora, & King, 2004; Chassin, Pitts, & Prost, 2002; Colder, Campbell, Ruel, Richardson, & Flay, 2002; Flory, Lynam, Milich, Leukefeld, & Clayton, 2004; Hill et al., 2000; Tucker, Ellickson, Orlando, Martino, & Klein, 2005). These studies have identified three to six distinct patterns of use and differential effects across outcomes for the various patterns. For example, Hill and colleagues (2000) identified four trajectories of binge drinking among their sample of 808 predominantly White youth aged 10 to 21 years: (1) early high prevalence of binging, (2) increasing binge drinking, (3) late onset of binging, and (4) non-bingers. They found that compared to non-bingers, youth in the more advanced binge categories reported significantly more crime, alcohol abuse and dependence, drug abuse and dependence, and high school dropout. Additionally, Flory and colleagues (2004) identified three classes of alcohol and marijuana use (early onset, late onset, nonuser) among 481 predominantly White youth aged 11 to 16 years. Compared to nonusers, early onset and late onset youth reported significantly more antisocial personality characteristics, arrests, and alcohol and marijuana abuse and dependence. These studies, and others like them, illustrate the benefits of a person-centered approach to understanding adolescent drinking and subsequent social and behavioral outcomes.

The present study contributes to the literature on trajectories of alcohol use among youth and extends it in two important ways. First, we identify the distinct trajectories of alcohol use initiation and progression among a large, predominantly African American and Hispanic sample of urban youth and describe the associations between these trajectories and several high-risk behaviors. Consistent with problem behavior theory (Jessor, 1991), we anticipate that more advanced, risky, patterns of alcohol use will be associated with increased maladaptive behaviors, such as violence, delinquency and other drug use. Few studies have examined heterogeneous patterns of alcohol use and subsequent effects on behavior among ethnic minority youth residing in urban areas. This is an important lacuna in the literature, as African

American and Hispanic youth are among the fastest growing segments of the U.S. population (U.S. Census Bureau, 2007), they are disproportionately residents of metropolitan cities (U.S. Census Bureau, 2000), and significant disparities exist for alcohol-related problems (Caetano, 2003). Second, our data were collected throughout early adolescence (age 12 to 14 years), the developmental stage where alcohol use onset rates peak (Kosterman et al., 2000) and many alcohol-related problems first appear (National Research Council & Institute of Medicine, 2004). Understanding the different patterns of alcohol use initiation and progression among young adolescents and the type and severity of associated consequences may suggest appropriate prevention strategies and help prioritize limited resources to those groups most at risk.

The present study integrated variable- and person-centered approaches to examine the associations between patterns of alcohol use initiation and progression from age 12 to 14 years and high-risk behaviors at age 14. Specifically, we examined the predictive utility of five classes of early adolescent alcohol use for recent cigarette and marijuana use, and violent and delinquent behaviors. We hypothesized that trajectory of alcohol use will be positively associated with these other high-risk behaviors. We also explored if there were differences in associations between trajectory of alcohol use and other high-risk behaviors by ethnic and gender subgroups.

METHODS

Study Design and Participants

The sample for the present study included young, multi-ethnic, urban adolescents who participated in a longitudinal alcohol preventive intervention trial [Project Northland Chicago (PNC); see Komro et al. 2004; 2008 for a complete description of the project's research design, participant recruitment and outcomes]. A cohort of youth in 61 public schools in Chicago participated in the trial. Schools were selected from a list of all Chicago Public Schools (CPS) that included grades 5–8, had relatively low mobility rates (less than 25%) and were larger schools (30 or more students per grade). Study schools were similar to those throughout Chicago with respect to race (84% ethnic minority youth in PNC schools, 85% in CPS) and the percentage of students at, or above, test score norms for math (49% in PNC schools, 43% in CPS) and reading (42% in PNC schools, 43% in CPS). Repeated, cross-sectional, self-report surveys were conducted in each study school at four time points when the students were in the 6th, 7th and 8th grades (ages 12 to 14). Response rates ranged from 91% to 96% each year (defined as students who completed a survey as a proportion of students enrolled in the relevant grade each year).

The subsample for the present study comprised 2,193 African American, Hispanic and White students who completed surveys in the beginning of 6th (age 12) and end of 8th (age 14) grades. Students were predominantly African American or Hispanic (43% and 37%, respectively); had a relatively equal gender distribution (49% male); lived in two-parent households (56%); and were low-income (68% receiving free, or reduced price, lunch).

Survey Protocol

Surveys were administered in study schools during the fall of 2002, spring of 2003, spring of 2004 and spring of 2005, when the students were in the 6th, 7th and 8th grades. Surveys were administered by three-person teams of trained university-based research staff interviewers using standardized protocols. Prior to survey administration, parents and students were given the opportunity to refuse participation. Parent consent, student assent, and PNC data collection protocols were approved by the University of Minnesota Institutional Review Board for the

Protection of Human Subjects, with secondary data analyses approved by the University of Florida Institutional Review Board.

Measures

Alcohol Use—Alcohol use was assessed longitudinally with five items from the Monitoring the Future study (Johnston, O'Malley, Bachman, & Schulenberg, 2007): "During the last 12 months, on how many occasions, or times, have you had alcoholic beverages to drink?"; "During the last 30 days, on how many occasions, or times, have you had alcoholic beverages to drink?"; "During the last 7 days, on how many occasions, or times, have you had alcoholic beverages to drink?"; "Think back over the last two weeks, how many times have you had five or more alcoholic drinks in a row?"; and "Have you ever gotten really drunk from drinking alcoholic beverages, so you fell down or got sick?". Response options were dichotomized to reflect "0 occasions" versus "1 or more occasions."

Past Month High-risk Behaviors

<u>Cigarette use:</u> Cigarette use was assessed with one item: "During the last month, have you smoked a cigarette?" Response options were 0 = "No" and 1 = "Yes."

<u>Marijuana use:</u> One item assessed marijuana use: "During the last 30 days, on how many occasions, or times, if any, have you used marijuana?" Response options were dichotomized to reflect "0 occasions" versus "1 or more occasions."

<u>Violent behavior:</u> A six item scale was used to assess violent behavior: "During the last month, how many times have you …" (1) "… damaged property on purpose, for example, broken windows or furniture, put paint on walls or signs, put scratches or dents in a car?"; (2) "… called someone a bad name to their face?"; (3) "… told someone you were going to hit or beat them up?"; (4) "… pushed, shoved, pulled someone's hair, or grabbed someone?"; (5) "… kicked, hit, or beat up another person?"; and (6) "… taken part in a fight where a group of your friends were against another group?". Response options were 1 = "Never," 2 = "1–3 times," and 3 = "4 or more times." A higher score on this scale indicated more violent behavior (Range: 6–18, Cronbach's alpha: 0.84).

<u>Delinquent behavior:</u> Delinquent behavior was assessed with a six item scale: "During the last month, how often have you …" (1) "… stolen something from the store?"; (2) "… cut or skipped school?"; (3) "… been in trouble for not following school rules?"; (4) "… been sent to the principal's office for doing something wrong or had detention?"; (5) "… gotten into serious trouble with your parent or guardian?"; and (6) "… gotten into trouble with the police?". Response options were 1 = "Never," 2 = "1–3 times," and 3 = "4 or more times." A higher score on this scale indicated more delinquent behavior (Range: 6–18, Cronbach's alpha: 0.71).

Covariates—Baseline measures of age, gender, family composition, and race/ethnicity were selected for inclusion as covariates in the analyses. Family composition was dichotomized such that "mother and father together" was compared to "other" ("mother and father equally, at separate homes," "mother mostly," "father mostly," "grandparent," "other relative," "foster parents," "other"). Race/ethnicity was coded such that Whites and Hispanics were compared separately to African Americans. In addition, treatment status was included as a covariate in the analyses.

Analytical Strategy—Analyses proceeded through two phases where (1) the number of heterogeneous patterns of alcohol use initiation were identified, and (2) the relationship between these patterns and high-risk behaviors were examined. First, multilevel latent class analysis in Mplus (Muthén & Muthén, 2008) was used to identify the number and

characteristics of latent classes that best described the heterogeneous trajectories of alcohol use. Competing models (i.e., models with 1-through *n*-class solutions) were estimated and compared to determine the number of classes necessary to represent the heterogeneity in responses to the five alcohol use items over time. Selection of the appropriate number of classes was aided by the Bayesian Information Criterion (BIC; Raftery, 1986) and Akaike Information Criterion (AIC; Akaike, 1973), which provide relative measures of model fit, and guided by substantive theory. School was specified as a cluster variable to account for the dependency of observations among participants within each school and a minimum of 500 sets of starting values was specified to ensure replication of the best loglikelihood and recovery of the most robust solution.

We then tested for measurement invariance across racial/ethnic and gender subgroups (i.e., African American boys and girls, Hispanic boys and girls, White boys and girls) using SAS PROC LCA (Lanza, Collins, Lemmon, & Schafer, 2007) by incorporating them as a grouping variable in the analyses. We replicated the solution recovered in Mplus and used a likelihood ratio difference test to compare nested models where the item-response probabilities were first estimated freely and then held equal across subgroups. The difference in likelihood ratios, or ΔG^2, is asymptotically chi-square with degrees of freedom equal to the difference in degrees of freedom between the two models. A statistically significant ΔG^2 suggests that the null hypothesis of measurement invariance should be rejected (Lanza et al., 2007).

Once the appropriate latent class solution was identified, the samples' class membership was determined using maximum rule assignment, where the class assigned reflected that for which their posterior probability was the highest. Nagin (1999; 2005; 2001) suggested that an average posterior probability for each class of 0.80 indicates adequate assignment. Here, the average posterior probability for each class ranged from 0.77 to 0.89.

In phase 2 of the analyses, linear and logistic mixed-effects regression was used to examine the relationship between patterns of alcohol use from 6th to 8th grade (i.e., alcohol trajectory class membership) and high-risk behaviors in 8th grade. Analyses were conducted using PROC MIXED and PROC GLIMMIX (SAS Institute, 2004), procedures in SAS designed to handle dependent variables that are both Gaussian and non-Gaussian, respectively. PROC MIXED was used for the normally-distributed violent and delinquent behaviors scales. Given the bimodal distribution of the cigarette and marijuana items, we recoded them to a binary response and applied a logit model with a binomial variance function using PROC GLIMMIX. Schools were specified as a nested random effect in both procedures to appropriately account for the study design.

Each of the dependent variables was regressed on participants' baseline measure of the dependent variable, age, gender, family composition, race/ethnicity, treatment status, and alcohol use trajectory class membership. Two- and three-way interaction effects between race/ethnicity, gender, and trajectory class membership were analyzed for inclusion in the final models for each outcome. A partial test approach was used, where estimates do not depend on the order of variables in the model and represent the impact of each predictor while controlling for all others.

Lastly, odds ratios, Pearson's *r*, and corresponding confidence intervals were calculated for each alcohol use trajectory class across the binary and continuous dependent variables, respectively. These measures provide an indication of the strength of the association between membership in each class and outcome relative to the "no use" class when controlling for covariates, and allow for comparison of effects across outcomes. In the present study, odds ratios are interpreted as the increase in odds of the respective high-risk behavior related to membership in each alcohol use trajectory class relative to non-users and the *r* estimates

represent the amount of change in standard deviation units in the respective high-risk behavior related to membership in each alcohol trajectory class relative to non-users.

Missing Data—Youth in the PNC cohort who were present and completed surveys at the beginning of 6th and end of 8th grade were eligible for inclusion in analyses ($n = 2{,}193$). The analysis sample included 2,133–2,139 students, as a result of missing values. There were no statistically significant differences between the analysis sample and those who completed surveys only at the beginning of 6th grade ($n = 3{,}631$) across genders and baseline levels of violent and delinquent behaviors. However, the analysis sample had significantly more dual-parent households ($\chi^2 (1) = 37.26, p < 0.001$), and Hispanic and White youth relative to African American youth ($\chi^2 (1) = 21.66, p < 0.001$ and $\chi^2 (1) = 12.89, p < 0.001$, respectively) than those who only completed surveys in 6th grade. Additionally, fewer youth in the analysis sample reported past month cigarette ($\chi^2 (1) = 17.47, p < 0.001$) and marijuana ($\chi^2 (1) = 23.59$, $p < 0.001$) use in 6th grade compared to those lost to follow-up.

RESULTS

Alcohol Use Trajectory Class Model Selection

We examined the relative fit of models with one- through six-class solutions (Table 1). A model with five classes best described the heterogeneity in alcohol use trajectories among the sample (AIC = 42084.40; BIC = 42776.82). While the BIC continued to decrease with more complex solutions, albeit incrementally less so, we did not observe improvements in the substantive interpretations of the classes beyond the 5-class solution (i.e., an additional class had the same interpretation as a previous class); therefore, a 5-class solution was selected. The likelihood ratio difference test for measurement invariance across racial/ethnic and gender subgroups (i.e., African American boys and girls, Hispanic boys and girls, and White boys and girls) was statistically significant ($\chi^2 (500) = 772.19, p < 0.001$), indicating that there may be differences in the number and interpretations of the classes across the subgroups; however, after examining the interpretation of the item response probabilities for each racial/ethnic and gender subgroup, we determined the number and interpretations of the classes did not differ substantively. Therefore, these were constrained to be equal.

Class Interpretation

To interpret the five trajectory classes, we examined the response probabilities for each item conditional on membership in each class (Table 2). Youth in class 1 (63.3% of the sample), labeled "no use," had very low probabilities of reporting any alcohol use from baseline (beginning of 6th grade) through the end of 8th grade. Class 2 (13.3%), "onset of consistently infrequent use at age <12," was characterized by high probabilities of reporting alcohol use in the past year for all time points ($\rho = 0.605, 0.646, 0.629$, and 0.593 for baseline, 6th, 7th and 8th grade, respectively) but, very low probabilities of responding "yes" to any of the other alcohol use items throughout the study period. Youth in class 3 (9.9%), "onset of monthly use at age 14," had very low probabilities of reporting any alcohol use until they reached 8th grade, where they had very high probabilities of reporting alcohol use in the past year ($\rho = 0.981$) and past month ($\rho = 0.841$). Class 4 (6.6%), "onset of monthly use at age 13 to heavy use at age 14," was characterized by high probabilities of alcohol use in the past year and month beginning in 7th grade ($\rho = 0.987$ and $\rho = 0.920$, respectively) and high probabilities of past year and month alcohol use ($\rho = 0.848$ and $\rho = 0.543$, respectively) as well as having ever been drunk ($\rho = 0.472$) in 8th grade. Youth in class 5 (6.9%), "onset of consistently heavy use at age 12," had very high probabilities of reporting alcohol use in the past year and month and having ever been drunk beginning in 6th grade ($\rho = 0.921$, $\rho = 0.770$, and $\rho = 0.602$, respectively) that were sustained in 7th grade and escalated to include high probabilities of past week and heavy episodic alcohol use in 8th grade ($\rho = 0.657$ and $\rho = 0.580$, respectively).

Interaction Effects

We explored interactions among race and gender and alcohol use trajectory class membership across the other high-risk behavior outcomes. Of the 12 potential interaction effects (three per outcome variable), only one was statistically significant: trajectory class membership × race/ethnicity × gender for delinquent behavior. White girls in the "onset of monthly use at age 13 to heavy use at age 14" class has less delinquent behavior than youth in the other racial/ethnic × gender × trajectory class subgroups. While this interaction was statistically significant, the magnitude of differences was small and not substantively relevant. Therefore, it was excluded from the final model.

Covariates

Results from the linear and logistic mixed-effects regressions are presented in Table 3, including the covariates in the model. Boys, compared with girls, had significantly higher rates of past month cigarette and marijuana use, as well as higher levels of violent and delinquent behaviors. White youth had a higher rate of past month cigarette use than African American youth. African American youth had a higher rate of past month marijuana use, violent and delinquent behaviors than Hispanic youth and higher rates of past month marijuana use and violent behaviors than White youth. Youth living in two parent households had a significantly lower rate of delinquent behaviors.

Alcohol Use Trajectories and High-risk Behaviors

The main outcomes of interest in this paper, the association between alcohol use trajectories from age 12 to 14 and other high-risk behaviors at age 14 are presented in Table 3. Relative to the "no use" class, membership in any of the alcohol use trajectory classes was significantly associated with greater past month cigarette (OR: 2.5–22.6) and marijuana use (OR: 3.3–22.2), as well as violent (Pearson's r: 0.03–0.18) and delinquent (Pearson's r: 0.03–0.17) behaviors in 8th grade (Figures 1 and 2).

DISCUSSION

Among this sample of low-income, multi-ethnic, urban young adolescents five classes best described the heterogeneity in alcohol use initiation and progression patterns: (1) No Use (63.3%), (2) Onset of Consistently Infrequent Use at Age < 12 (13.3%), (3) Onset of Monthly Use at Age 14 (9.9%), (4) Onset of Monthly Use at Age 13 to Heavy Use at Age 14 (6.6%), and (5) Onset of Consistently Heavy Use at Age 12 (6.9%). Relative to non-users, youth in any of the alcohol-using trajectory classes were at significantly greater risk for monthly cigarette and marijuana use and violent and delinquent behaviors in 8th grade (age 14). There appears to be a dose-response relationship between escalation of alcohol use over time and past month cigarette and marijuana use in 8th grade. As the intensity of drinking increases, so does the risk of cigarette and marijuana use in 8th grade. This dose response relationship was less clear with violent and delinquent behaviors. Rather, there seems to be an important cut point of risk; those youth who were consistent infrequent users did not have increased risk for violent and delinquent behaviors compared to nonusers. However, youth in all other drinking initiation and progression patterns, ranging from onset of monthly use age at 14 to onset of consistently heavy use before age 12, were at increased risk for violent and delinquent behaviors in 8th grade (age 14). Overall, these results are consistent with problem behavior theory (Jessor, 1991) and suggest that alcohol use during early adolescence (ages 12 to 14) is associated with increased risk across any drinking initiation and progression pattern. However, for early onset infrequent users, the risk is less than that of the more advanced patterns of use albeit still significantly more risky than no alcohol use.

The results from this study contribute to the literature in several important ways. First, we provide a more detailed examination of alcohol use initiation and progression patterns during early adolescence rather than relying simply on age of onset of any level of alcohol use (Grant & Dawson, 1998; Grant et al., 2001; Gruber et al., 1996; Hingson et al., 2002; Hingson, Heeren, Winter et al., 2003; Hingson et al., 2001; Hingson, Heeren, Zakocs et al., 2003; Hingson et al., 2006). Second, we used a person-centered analytic approach to better describe the heterogeneity of initiation and progression patterns rather than a variable-centered approach which assumes a homogeneous pattern of onset. Third, we assessed alcohol use over time rather than relying on retrospective recall (Grant & Dawson, 1998; Grant et al., 2001; Gruber et al., 1996; Hingson et al., 2002; Hingson, Heeren, Winter et al., 2003; Hingson et al., 2001; Hingson, Heeren, Zakocs et al., 2003; Hingson et al., 2006). Fourth, our sample included a large number of low-income, multi-ethnic, urban youth during the peak years of alcohol onset, contributing important information regarding the risk of alcohol use among this vulnerable population.

The results of the present study may be generalizable to youth living in other large, diverse cities in the U.S. given similarities in alcohol use rates among urban youth across cities. According to the 2007 Youth Risk Behavior Survey, Chicago high school students reported similar rates of lifetime, current and heavy episodic use compared to high school students in Los Angeles, Miami and three of the five boroughs of New York City, three other large cities in the U.S. (National Center for Chronic Disease Prevention and Health Promotion, 2008).

The results of this study are similar to previous reports that early onset of alcohol use is associated with a number of deleterious health and social problems (Grant & Dawson, 1998; Grant et al., 2001; Gruber et al., 1996; Hingson et al., 2002; Hingson, Heeren, Winter et al., 2003; Hingson et al., 2001; Hingson, Heeren, Zakocs et al., 2003; Hingson et al., 2006). However, this study supports the conclusion that any use in early adolescence appears to be risky in terms of other problem behaviors. The cumulation of evidence supports the critical need for efforts to prevent early initiation and progression of alcohol use among youth as a key component to prevent future high-risk behaviors.

Acknowledgments

References

Akaike, H. Information theory and an extension of the maximum likelihood principle. In: Petrov, BN.; Csaki, F., editors. Second International Symposium on Information Theory. Budapest: Akademiai Kaido; 1973. p. 267-281.

Caetano R. Alcohol-related health disparities and treatment-related epidemiological findings among whites, blacks, and Hispanics in the United States. Alcoholism-Clinical and Experimental Research 2003;27:1337–1339.

Chassin L, Flora DB, King KM. Trajectories of alcohol and drug use and dependence from adolescence to adulthood: The effects of familial alcoholism and personality. Journal of Abnormal Psychology 2004;113:483–498. [PubMed: 15535782]

Chassin L, Pitts SC, Prost J. Binge drinking trajectories from adolescence to emerging adulthood in a high-risk sample: Predictors and substance abuse outcomes. Journal of Consulting and Clinical Psychology 2002;70:67–78. [PubMed: 11860058]

Duncan, TE.; Duncan, SC.; Strycker, LA. An introduction to latent variable growth curve modeling: Concepts, issues and applications. Mahway, NJ: Lawrence Erlbaum Associates; 2006.

Flory K, Lynam D, Milich R, Leukefeld C, Clayton R. Early adolescent through young adult alcohol and marijuana use trajectories: Early predictors, young adult outcomes, and predictive utility. Development and Psychopathology 2004;16:193–213. [PubMed: 15115071]

Grant BF, Dawson DA. Age of onset of drug use and its association with DSM-IV drug abuse and dependence: Results from the National Longitudinal Alcohol Epidemiologic Survey. Journal of Substance Abuse 1998;10:163–173. [PubMed: 9854701]

Grant BF, Stinson FS, Harford T. Age at onset of alcohol use and DSM-IV alcohol abuse and dependence: A 12-year follow-up. Journal of Substance Abuse 2001;13:493–504. [PubMed: 11775078]

Gruber E, DiClemente RJ, Anderson MM, Lodico M. Early drinking onset and its association with alcohol use and problem behavior in late adolescence. Preventive Medicine 1996;25:293–300. [PubMed: 8781007]

Hill KG, White HR, Chung IJ, Hawkins JD, Catalano RF. Early adult outcomes of adolescent binge drinking: Person- and variable-centered analyses of binge drinking trajectories. Alcoholism-Clinical and Experimental Research 2000;24:892–901.

Hingson R, Heeren T, Levenson S, Jamanka A, Voas R. Age of drinking onset, driving after drinking, and involvement in alcohol related motor-vehicle crashes. Accident Analysis and Prevention 2002;34:85–92. [PubMed: 11789578]

Hingson R, Heeren T, Winter MR, Wechsler H. Early age of first drunkenness as a factor in college students' unplanned and unprotected sex attributable to drinking. Pediatrics 2003;111:34–41. [PubMed: 12509551]

Hingson R, Heeren T, Zakocs R. Age of drinking onset and involvement in physical fights after drinking. Pediatrics 2001;108:872–877. [PubMed: 11581438]

Hingson R, Heeren T, Zakocs R, Winter M, Wechsler H. Age of first intoxication, heavy drinking, driving after drinking and risk of unintentional injury among US college students. Journal of Studies on Alcohol 2003;64:23–31. [PubMed: 12608480]

Hingson RW, Heeren T, Winter MR. Age at drinking onset and alcohol dependence - Age at onset, duration, and severity. Archives of Pediatrics & Adolescent Medicine 2006;160:739–746. [PubMed: 16818840]

Jessor R. Risk behavior in adolescence: A psychosocial framework for understanding and action. Journal of Adolescent Health 1991;12:597–605. [PubMed: 1799569]

Johnston, LD.; O'Malley, P.; Bachman, JG.; Schulenberg, J. Monitoring the Future national results on adolescent drug use: Overview of key findings, 2007. Bethesda, MD: National Institute on Drug Abuse; 2008.

Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future national survey results on drug use, 1975–2006: Volume 1, Secondary school students. Bethesda, MD: National Institute on Drug Abuse; 2007.

Komro KA, Perry CL, Veblen-Mortenson S, Bosma LM, Dudovitz BS, Williams CL, et al. Brief report: the adaptation of Project Northland for urban youth. Journal of Pediatric Psychology 2004;29:457–466. [PubMed: 15277588]

Komro KA, Perry CL, Veblen-Mortenson S, Farbakhsh K, Toomey TL, Stigler MH, et al. Outcomes for a randomized controlled trial of a multi-component alcohol use preventive intervention for urban youth: Project Northland Chicago. Addiction 2008;103:606–618. [PubMed: 18261193]

Kosterman R, Hawkins JD, Guo J, Catalano RF, Abbott RD. The dynamics of alcohol and marijuana initiation: Patterns and predictors of first use in adolescence. American Journal of Public Health 2000;90:360–366. [PubMed: 10705852]

Lanza ST, Collins LM, Lemmon DR, Schafer JL. PROC LCA: A SAS procedure for latent class analysis. Structural Equation Modeling 2007;14:671–694. [PubMed: 19953201]

Muthén, LK.; Muthén, B. Mplus Version 5.2. Los Angeles, CA: Muthén & Muthén; 2008.

Nagin DS. Analyzing developmental trajectories: Semi-parametric, group-based approach. Psychological Methods 1999;4:39–177.

Nagin, DS. Group-Based Modeling of Development. Cambridge, MA: Harvard University Press; 2005.

Nagin DS, Tremblay RE. Analyzing developmental trajectories of distinct but related behaviors: A group-based method. Psychological Methods 2001;6:18–34. [PubMed: 11285809]

National Center for Chronic Disease Prevention and Health Promotion. YRBSS Youth online: Comprehensive results. 2008. Retrieved September 12, 2008 from http://apps.nccd.cdc.gov/yrbss/

National Research Council, & Institute of Medicine. Reducing Underage Drinking: A Collective Responsibility. Washington, D.C: The National Academies Press; 2004.

Raftery AE. A note on Bayes factors for log-linear contingency table models with vague prior information. Journal of the Royal Statistical Society Series B (Methodological) 1986;48:249–250.

SAS Institute. SAS/STAT 9.1 User's Guide. Cary, NC: SAS Institute, Inc; 2004.

Tucker JS, Ellickson PL, Orlando M, Martino SC, Klein DJ. Substance use trajectories from early adolescence to emerging adulthood: A comparison of smoking, binge drinking, and marijuana use. Journal of Drug Issues 2005;35:307–331.

U.S. Census Bureau. United States Census 2000. Washington, D.C: U.S. Department of Commerce; 2000.

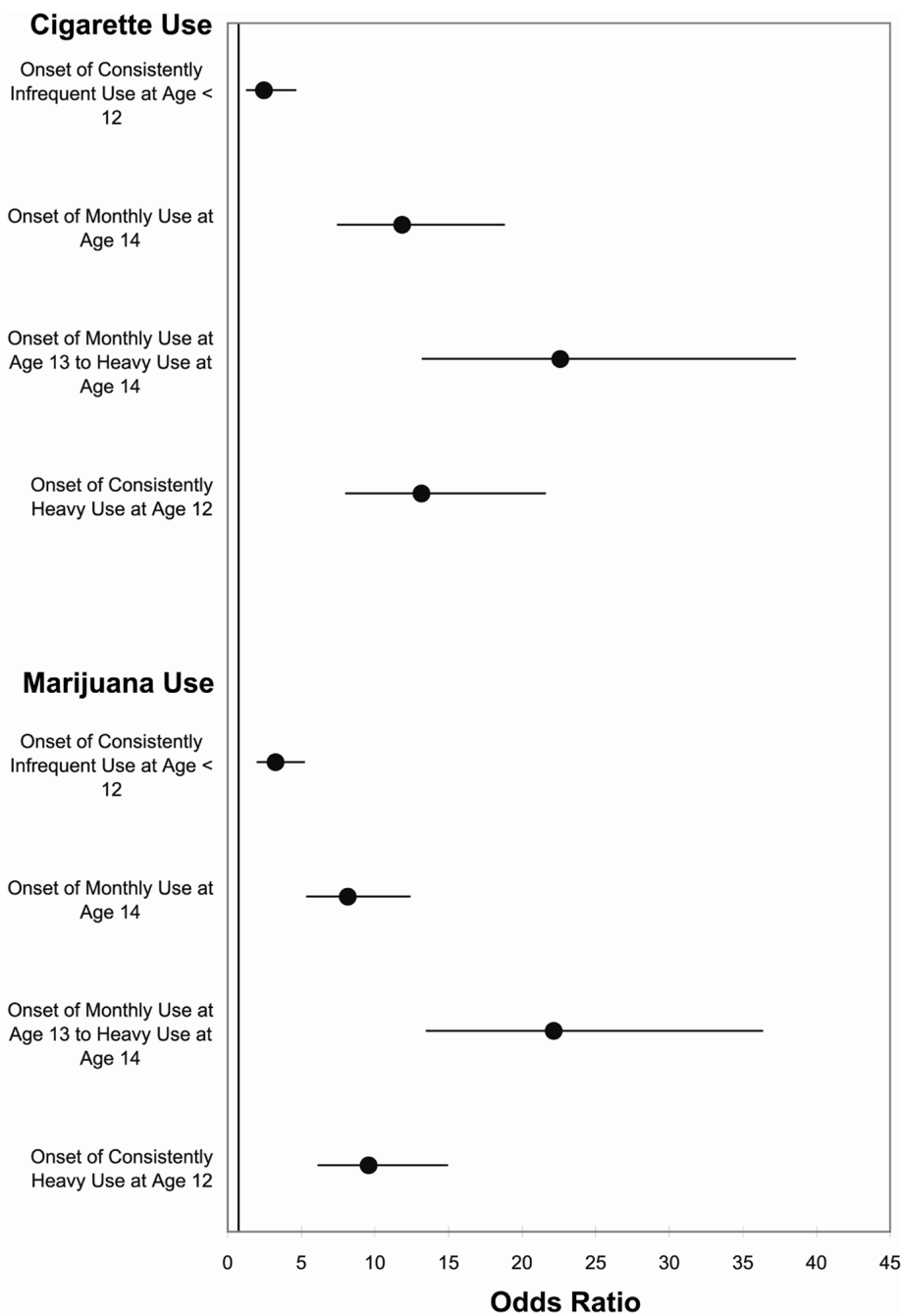U.S. Census Bureau. Population estimates. 2007. Retrieved January 4, 2008, from www.census.gov/poptest/estimates.php

Figure 1.
Odds of past month high-risk behaviors in 8th grade (age 14) for each alcohol use trajectory class relative to the "no use" class.
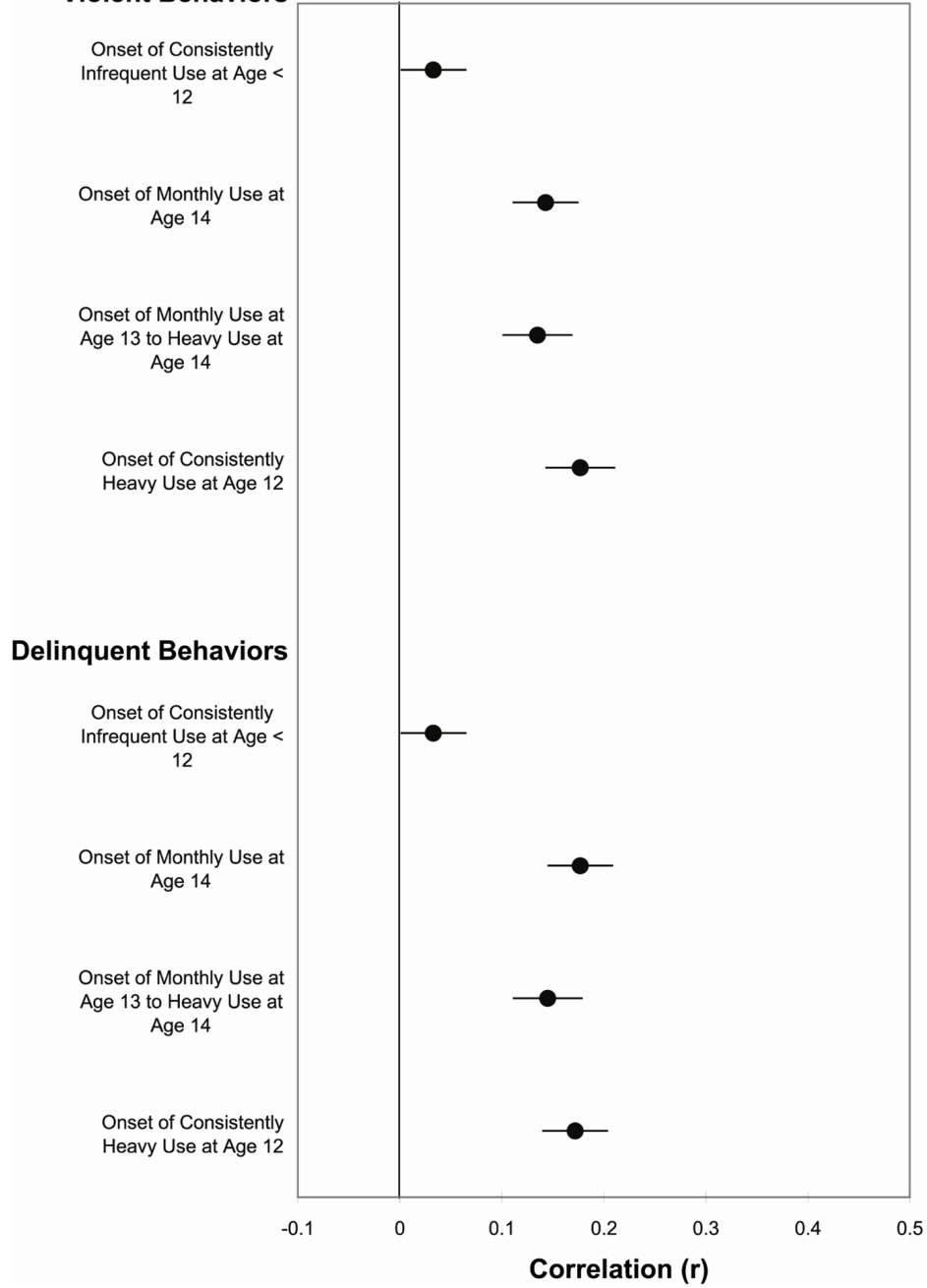
Figure 2.
Effect of alcohol use trajectory class membership on past month violent and delinquent
behaviors in 8th grade (age 14) relative to the "no use" class.

Table 1

Model selection indices

	Number of Classes					
	1	**2**	**3**	**4**	**5**	**6**
Loglikelihood	−28384.44	−22731.54	−21841.13	−21329.89	−20938.20	−20739.88
AIC	56808.88	45545.09	43806.26	42825.78	42084.40	41729.77
BIC	56942.04	45818.06	44219.05	43378.38	42776.82	42562.00

Table 2

Item response probabilities for each alcohol use trajectory class.

	Item response probabilities[a]																					
	Baseline, Mean Age = 11.84					6th Grade, Mean Age = 12.33					7th Grade, Mean Age = 13.29					8th Grade, Mean Age = 14.27						
Class	Past Year	Past Month	Past Week	Ever Drunk	Heavy Episodic	Past Year	Past Month	Past Week	Ever Drunk	Heavy Episodic	Past Year	Past Month	Past Week	Ever Drunk	Heavy Episodic	Past Year	Past Month	Past Week	Ever Drunk	Heavy Episodic	Label	%[b]
1	0.036	0.002	0.000	0.003	0.002	0.038	0.003	0.000	0.004	0.003	0.096	0.013	0.001	0.005	0.003	0.135	0.003	0.004	0.015	0.003	No Use	63.3
2	**0.605**	0.287	0.120	0.165	0.151	**0.646**	0.232	0.102	0.209	0.088	**0.629**	0.183	0.043	0.186	0.044	**0.593**	0.110	0.006	0.201	0.022	Onset of Consistently Infrequent Use at Age < 12	13.3
3	0.144	0.017	0.007	0.016	0.023	0.268	0.069	0.021	0.040	0.026	0.381	0.023	0.000	0.059	0.000	**0.981**	**0.841**	0.383	0.431	0.242	Onset of Monthly Use at Age14	9.9
4	0.112	0.010	0.010	0.008	0.000	0.303	0.067	0.018	0.043	0.025	**0.848**	**0.920**	0.473	0.379	0.333	**0.848**	**0.543**	0.308	**0.472**	0.267	Onset of Monthly Use at Age13 to Heavy Use at Age 14	6.6
5	**0.679**	0.454	0.259	0.370	0.331	**0.921**	**0.770**	0.490	**0.602**	0.521	**0.905**	**0.721**	0.409	**0.662**	0.454	**0.969**	**0.849**	**0.657**	**0.770**	**0.580**	Onset of Consistently Heavy Use at Age 12	6.9

[a] Probability of responding "yes" to each alcohol use item conditional on alcohol trajectory class membership.

[b] Prevalence of each alcohol trajectory class among the sample.

Table 3

Effects of alcohol use trajectory class on past month high-risk behaviors in 8th grade (age 14).

	Cigarette Use				Marijuana Use				Violent Behavior				Delinquent Behavior			
	Slope	SE	F-value	P-value	Slope	SE	F-value	P-value	Slope	SE	F-value	P-value	Slope	SE	F-value	P-value
Intercept	-3.773	0.270	195.44	<.0001	-2.908	0.227	163.58	<.0001	8.263	0.294	792.42	<.0001	4.828	0.236	420.25	<.0001
Baseline	-0.419	0.690	0.37	0.5436	0.333	0.440	0.57	0.4492	0.304	0.023	175.84	<.0001	0.374	0.026	202.26	<.0001
Age	0.113	0.168	0.45	0.5014	0.290	0.151	3.69	0.0549	-0.252	0.133	3.57	0.0588	-0.124	0.090	1.89	0.1691
Treatment[1]	0.022	0.221	0.01	0.9220	-0.136	0.206	0.43	0.5108	0.055	0.204	0.07	0.7894	-0.037	0.135	0.07	0.7844
Alcohol Use Trajectory Class																
No Use[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Onset of Consistently Infrequent Use at Age < 12	0.902	0.317	8.07	0.0045	1.180	0.238	24.56	<.0001	0.419	0.206	4.12	0.0425	0.248	0.137	3.28	0.0703
Onset of Monthly Use at Age 14	2.473	0.234	112.12	<.0001	2.101	0.211	98.90	<.0001	2.043	0.196	108.45	<.0001	1.369	0.133	106.52	<.0001
Onset of Monthly Use at Age 13 to Heavy Use at Age 14	3.118	0.272	131.37	<.0001	3.098	0.252	151.53	<.0001	2.253	0.283	63.40	<.0001	1.686	0.189	79.28	<.0001
Onset of Consistently Heavy Use at Age 12	2.578	0.251	105.50	<.0001	2.261	0.225	100.89	<.0001	1.868	0.219	72.79	<.0001	1.515	0.147	106.23	<.0001
Covariates																
Family Composition[3]	-0.248	0.177	1.95	0.1622	-0.222	0.161	1.90	0.1682	-0.220	0.135	2.68	0.1019	-0.219	0.091	5.75	0.0166
Gender[4]	0.338	0.167	4.09	0.0432	0.597	0.153	15.23	<.0001	0.454	0.126	12.96	0.0003	0.337	0.086	15.49	<.0001
Hispanic[5]	-0.189	0.231	0.67	0.4127	-0.903	0.213	17.91	<.0001	-1.371	0.184	55.82	<.0001	-0.365	0.122	8.96	0.0028
White[5]	0.615	0.256	5.79	0.0162	-0.555	0.252	4.87	0.0275	-1.101	0.213	26.64	<.0001	-0.305	0.142	4.58	0.0325

[1] The control group is the reference group.

[2] "No Use" is the referent class.

[3] "Mother & Father Together" compared to "Other"

[4] Females are the reference group.

[5] African Americans are the reference group.