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A latent class analysis of underage problem drinking: Evidence from a community sample of 16–20 year olds

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Abstract

The aim of this paper is to shed light on the nature of underage problem drinking by using an empirically based method to characterize the variation in patterns of drinking in a community sample of underage drinkers. A total of 4056 16–20-year-old current drinkers from 212 communities in the US were surveyed by telephone as part of the National Evaluation of the Enforcing Underage Drinking Laws (EUDL) Program. Latent class models were used to create homogenous groups of drinkers with similar drinking patterns defined by multiple indicators of drinking behaviors and alcohol-related problems. Two types of underage problem drinkers were identified; risky drinkers (30%) and regular drinkers (27%). The most prominent behaviors among both types of underage problem drinkers were binge drinking and getting drunk. Being male, other drug use, early onset drinking and beliefs about friends drinking and getting drunk were all associated with an increased risk of being a problem drinker after adjustment for other factors. Beliefs that most friends drink and current marijuana use were the strongest predictors of both risky problem drinking (OR = 4.0; 95% CI = 3.1, 5.1 and OR = 4.0; 95% CI = 2.8, 5.6, respectively) and regular problem drinking (OR = 10.8; 95% CI = 7.0, 16.7 and OR = 10.2; 95% CI = 6.9, 15.2). Young adulthood (ages 18–20) was significantly associated with regular problem drinking but not risky problem drinking. The belief that most friends get drunk weekly was the strongest discriminator of risky and regular problem drinking patterns (OR = 5.3; 95% CI = 3.9, 7.1). These findings suggest that underage problem drinking is most strongly characterized by heavy drinking behaviors which can emerge in late adolescence and underscores its association with perceptions regarding friends drinking behaviors and illicit drug use.

Keywords

Adolescent; Alcohol; Drinking patterns; Epidemiology; Latent class analysis; Problem drinking

1. Introduction

Underage drinking is a long-standing major public health problem in the United States. Although underage drinking decreased following changes in the minimum purchase age in the mid-1980s, prevalence rates have remained relatively stable over the past decade (Faden and

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Fay, 2004). In 2003, an estimated 10.9 million youth aged 12–20 reported drinking in the past month (SAMHSA, 2004). This is an alarmingly high number given the widespread individual and social consequences of underage drinking; both acute and long-term. Alcohol use by persons under age 21 is associated with an increased likelihood of death from motor-vehicle crashes, other unintentional injuries, homicide and suicide; the four leading causes of death among 10–24 year olds (CDCP, 2004). Numerous studies have found that adolescent drinkers are at an increased risk for engaging in other health-risk behaviors such as violence and aggression (DuRant et al., 1997; Grunbaum et al., 1998; White et al., 1999; Swahn et al., 2004), unsafe sexual practices (Duncan et al., 1999; Cooper, 2002) and the use of illicit drugs (Wagner and Anthony, 2002; Ellickson et al., 2003). Moreover, underage drinking is often cited as a risk factor for sexual victimization among adolescent females (Kreiter et al., 1999; Champion et al., 2004). In addition to the proximal consequences of underage drinking, there is evidence to suggest that adolescent alcohol use is associated with an increased risk in young adulthood of alcohol abuse and dependence (Robins and Przybeck, 1985; Anthony and Petronis, 1995; Grant et al., 2001) as well as other health problems like obesity and high blood pressure (Oesterle et al., 2004).

Given the continued pervasiveness of underage drinking, recent efforts have focused on understanding the nature of underage problem drinking rather than abstinence. This is consistent with studies in other countries, such as Britain, where the emphasis tends to be on health promotion (sensible drinking) rather than primary prevention (non-drinking) (Foxcroft et al., 1997). The term ‘problem drinking’ is most often used by researchers in the alcohol field to describe individuals who are not alcohol dependent but who consume enough alcohol to be at risk for a variety of alcohol-related problems; a definition consistent with the Institute of Medicine report issued by the National Academy of Sciences (IOM, 1990). Evidence suggests, however, that one-dimensional consumption measures commonly used to study problem drinking in adult populations fail to identify underage drinkers suffering alcohol-related problems (Ellickson et al., 1996; Stewart and Power, 2002; Townshend and Duka, 2002). For example, Ellickson et al. (1996) found that definitions of problem drinking based solely on how much or how often a teenager drinks failed to identify as many as half of those suffering alcohol-related problems. Other studies have documented that in contrast to adults, adolescents in the United States tend to be infrequent but heavy drinkers (Deas et al., 2000; Wechsler et al., 2000), suggesting that quantity and frequency measures should be used in concert when studying adolescent drinkers. Recent data from the Monitoring the Future Survey supports this characterization of adolescent drinking, estimating that while approximately 30% of high school seniors binged in the past 2 weeks and 60% have ever been drunk, less than 3% drink daily (Johnston et al., 2004). In addition, many youth who experience harmful consequences as a result of drinking do not meet the clinical definition of dependence (Chung et al., 2000, 2002). In the study by Ellickson et al. (1996), less than 4% of high school seniors reported an inability to stop drinking, compared to 24% who reported passing out from drinking. Chung et al. (2002) found that a low reporting of withdrawal symptoms accounted for a large proportion of subthreshold cases of dependence among adolescents. Chung et al. (2002) also noted variability in the types of abuse symptoms experienced, specifically a high reporting of drinking in hazardous situations and a low reporting of legal problems.

Evidence of differences in the drinking behaviors and alcohol-related problems of adolescents and adults, as well as the failure of both unidimensional measures and clinical dependence criteria to capture underage problem drinking, underscores the importance of identifying patterns of drinking in adolescents that are associated with alcohol-related problems. In this paper, we use an empirically based multivariate statistical technique to examine the structure underlying a set of co-occurring drinking behaviors and alcohol-related problems among underage drinkers. In contrast to applying diagnostic decision rules or arbitrary cut-off scores to identify underage problem drinkers, we use latent class analysis (LCA) to create subgroups

of drinkers with similar drinking patterns. The aims of this paper are to (1) use empirical data to characterize problem drinking in a large community sample of 16–20-year-old underage drinkers in the United States, and (2) to better understand the variation in drinking patterns with a focus on individual, peer and family factors. A similar approach was taken by Fergusson et al. (1995) in an attempt to identify among a cohort of 16 year olds in New Zealand those who abuse alcohol or engage in hazardous drinking. In this paper, we will study the drinking patterns in a more recent and broad sample of underage drinkers aged 16–20 living in communities in the United States surveyed between 1999 and 2004 as part of the National Evaluation of the Enforcing Underage Drinking Laws (EUDL) Program. We will also use recently developed latent class regression methods (Reboussin and Anthony, 2001) that model the probability of being an LCA-derived problem drinker as a function of suspected determinants. This new approach accounts for the potential misclassification inherent in two-step strategies that assign individuals to classes based on modal posterior probabilities of group membership, and then fit regression models to the grouped data.

2. Methods

2.1. Population and sample

The EUDL Program is a national program, funded by the United States Office of Juvenile Justice and Delinquency Prevention (OJJDP), intended to increase enforcement of underage drinking laws and reduce underage drinking. Each year since 1998, each of the 50 states was awarded a block grant to support and enhance state and local efforts to prohibit the sale and consumption of alcoholic beverages to and by minors. In addition, each year since the program began discretionary grants were awarded on a competitive basis to a subset of the states to expand the number of communities taking a comprehensive approach to enforcement. States were free to establish criteria for deciding which communities would receive funding in their state under the discretionary grant program. These criteria included “need”, “readiness”, “infrastructure”, “regional diversity”, and varied across the states (see Wolfson et al., 2001 for details). The national evaluation, also funded by OJJDP, was designed to compare a sample of communities from states receiving discretionary grants with matched comparison communities not receiving such intense interventions. Propensity scores were used to identify comparison communities within each state using community-level indicators in order to select communities that, as a group, were as similar as possible to the group of intervention communities (D’Agostino, 1988; Preisser et al., 2003).

Data are from a repeated cross-sectional telephone survey of 16–20 year olds conducted annually as part of the national evaluation of the EUDL Program. The survey included questions on the perceived availability of alcohol to youth, sources of alcohol, underage alcohol use, and problems related to underage alcohol use. Random digit dialing (RDD) was used to obtain a sample of at least 15 youth from each community receiving discretionary funds (intervention communities) and matching sites that did not receive funds (comparison communities). This resulted in approximately equal numbers of participants from intervention and comparison communities. All protocols for the study were approved by the Wake Forest University School of Medicine Institutional Review Board and informed verbal consent was obtained by the interviewers prior to proceeding with the survey. The survey took an average of 20 min to complete and participants were not compensated. Across the 6 years the survey was implemented, the refusal rate averaged 7.34%.

The first discretionary round began in 1999 with 55 intervention and 55 comparison communities in 10 states included. The second round used in the evaluation began in 2000 with 17 intervention and 17 comparison communities in seven states. The final round began in 2002 with 34 intervention and 34 comparison communities in eight states. States receiving discretionary grants included California, Connecticut, Georgia, Illinois, Louisiana, Maine,

Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Jersey, North Carolina, New Mexico, New York, Ohio, Pennsylvania, Virginia, Washington and Wisconsin. Data were collected pre-intervention (or early in the intervention period), and 1 and 2 years following each discretionary round. A total of 11,174 youth from 212 communities were surveyed of which 4387 were current drinkers. A total of 4056 had complete data for the analyses reported.

2.2. Assessment of drinking behaviors

To identify current underage drinkers, the interviewers asked adolescents “When was the last time you drank any alcohol?” A response of “Sometime in the last 7 days” or “Sometime in the last 30 days” classified an adolescent as a current drinker. Alcohol included any beer, wine coolers, wine, liquor, and mixed drinks. Drinking alcohol meant drinking more than a single sip at any one occasion. Among current drinkers, drinking behaviors were measured by the following survey items:

1. Regular drinking. “On how many occasions have you had alcohol to drink in the last 30 days?” A number was recorded and if necessary probed using categories “1–2, 3–5, 6–9, 10–19, 20–39, 40 or more.” Respondents were characterized as regular drinkers if they reported drinking on six or more occasions in the past 30 days. On average, underage drinkers drink 5 days per month compared to adults who drink 9 days per month (USDHHS, 2004). Our rationale was to capture more than the weekend underage drinker while not requiring the same frequency of drinking found in adult populations.
2. Binge drinking. “Think back over the last 2 weeks. How many times have you had five or more drinks in a row? A drink is a glass of wine, a bottle of beer, a shot glass of liquor, a mixed drink or wine cooler.” Respondents who reported binge drinking one or more times in the past 2 weeks were contrasted to respondents who did not report binge drinking in the past 2 weeks.
3. Drunkenness. “Over the past 12 months, on how many days have you gotten drunk or “very, very high” on alcohol? Would you say ... every day or almost every day, 3–5 days a week, 1 or 2 days a week, 2 or 3 days a month, once a month or less, 1 or 2 days in the past 12 months, never.” Respondents who reported getting drunk at least 2 or 3 days a month were contrasted with all others.

2.3. Assessment of alcohol-related problems

(1) Driving after drinking. “During the last 30 days, how many times (if any) have you driven after drinking two or more drinks in an hour or less?” Respondents who reported driving at least once after drinking in the past 30 days were contrasted to all others.

Respondents were then asked, “Have you had any of the following experiences after you had been drinking?” For each problem, adolescents who reported experiencing a problem during the past 12 months were contrasted to all others.

(2) Physical problems from drinking:

- a. Have you passed out?
- b. Were you unable to remember what happened while drinking?
- c. Have you had a headache or hangover?

(3) Social consequences from drinking:

- a. Were you cited or arrested for drinking, possessing or trying to buy alcohol?
- b. Have you missed any school due to drinking?

- c. Were you warned by a friend about your drinking?
- d. Did you break or damage something?
- e. Were you punished by your parents or guardian?

2.4. Suspected determinants of underage problem drinking

Individual, peer and family factors were examined as potential determinants of underage drinking on the basis of prior analysis of this dataset and reviews of the literature indicating their possible association with underage problem drinking (Hawkins et al., 1992, 1997; Fergusson et al., 1995; Kosterman et al., 2000; Guo et al., 2002; Wagner and Anthony, 2002; Beyers et al., 2004; Callas et al., 2004; Foley et al., 2004; Wood et al., 2004).

2.4.1. Individual factors

1. Gender. This was coded 1 if the adolescent was male and 0 if the adolescent was female.
2. Age. This was coded 1 if the adolescent was aged 18–20 to capture young adulthood and 0 if the adolescent was aged 16–17 for late adolescence.
3. Early onset alcohol use. Adolescents who first tried alcohol by age 14 were classified as early onset (Kandel and Logan, 1984; Anthony and Petronis, 1995; DeWit et al., 2000).
4. Current marijuana use. “In the past 30 days, have you smoked marijuana?” Adolescents who responded “yes” were contrasted to all others.
5. Current cigarette use. “In the past 30 days, have you smoked cigarettes?” Adolescents who responded “yes” were contrasted to all others.

2.4.2. Peer factors

1. Perception that people your age in your community drink. “In your community, how many people your age do you think have had any alcohol to drink in the past 30 days? Would you say ... none, a few, some, most or all” Adolescents responding “most, or all” were compared to adolescents responding “none, a few, or some”.
2. Perception that friends drink. “How many of your friends do you think have had any alcohol to drink in the last 30 days? Would you say ... none, a few, some, most, or all” Adolescents responding “most, or all” were compared to adolescents responding “none, a few, or some”.
3. Perception that friends get drunk. “How many of your friends would you estimate get drunk at least once a week? Would you say ... none, a few, some, most, or all” Adolescents responding “most, or all” were compared to adolescents responding “none, a few, or some”.

2.4.3. Family factors—(1) Parental consequences. “If your parent(s) (or guardian) caught you after you had been drinking, what do you think they would do? Nothing, they would tell you to be careful with alcohol, they would tell you not to drink, they would yell at you, they would take away some of your privileges, they would ground you for a week or less, they would ground you for several weeks, other.” Adolescents responding with yell at you, taking away privileges or other consequences were compared to adolescents who reported nothing would happen or parents would tell them to be careful or not drink alcohol.

2.5. Statistical analyses

Latent class analysis (LCA) was applied to examine the structure underlying the set of 12 co-occurring drinking behaviors and alcohol-related problems. Information about the underlying class structure is conveyed through two sets of parameters; the proportion of underage drinkers in each class (latent class prevalences) and the probability of reporting a drinking behavior or alcohol-related problem within a particular underage drinking class (response probabilities). The hallmark of LCA is the assumption that the co-occurrence of behaviors and alcohol-related problems is due to an underlying class structure. In a statistical sense this means that within a latent class, behaviors and alcohol-related problems are independent (sometimes termed locally independent) (Lazarsfeld, 1950; McCutcheon, 1987). For our application, this means that the associations among drinking behaviors and alcohol-related problems can be explained by an underlying subclassification of underage drinkers. The desired result from making such an assumption is a set of homogeneous classes different from one another, within which drinking patterns are presumed to differ only due to random measurement error (McCutcheon, 1987; Magidson and Vermunt, 2000).

In an effort to understand underage problem drinking, a series of latent class models were fit to the data. We started with the most parsimonious one-class model ("all drinkers the same") and fit successive models with an increasing number of latent classes in order to determine the most parsimonious model that provided an adequate fit to the data. Because models with different numbers of latent classes are not nested, precluding the use of a difference likelihood-ratio test, we must rely on measures of fit such as the Akaike Information Criterion (AIC), a global fit index which combines goodness of fit and parsimony. In comparing different models with the same set of data, models with lower values are preferred. The validity of the local independence assumption is evaluated by comparing the observed log odds ratio and the expected log odds ratios predicted by the model for pairs of observed drinking behaviors and alcohol-related problems. Larger differences indicate stronger evidence for local dependence (Garrett and Zeger, 2000). The quality of the latent classifications were evaluated in terms of the separation of classes or how well they could predict the classes to which individuals belong given their drinking profile by estimating the proportion of classification error (Magidson and Vermunt, 2000). Following the work of Bandeen-Roche et al. (1997), we infer the number of classes ignoring covariates to reduce the complexity of the problem.

Once determining the appropriate number of latent classes, we fit a baseline-category logistic regression model for the latent class prevalences that allowed us to describe the association between the LCA-derived problem drinkers and their suspected determinants (Reboussin and Anthony, 2001). The overwhelming prevalence of a Caucasian sample (88.7%) precluded our ability to obtain stable parameter estimates; therefore, race was not included in the models. The results of the analyses are presented in the form of odds ratios which can be interpreted, for example, as the odds of being an LCA-derived problem drinker for males versus the corresponding odds for females.

Because community populations represent intact social groups, youths within a community are likely to be more like one another than they are to be like youths in other communities (Murray and Short, 1995, 1996). Failure to account for this correlation among youths within a community in the above regression analyses could result in inflated type I error rates and invalid conclusions (Donner et al., 1981). For this reason, we estimate the latent class model parameters using a generalized estimating equations (GEE) approach for correlated binary responses originally developed by Zeger and Liang (1986) for generalized linear models with repeated measures. The GEE approach was extended by Reboussin and Anthony (2001) for latent class models incorporating the additional source of correlation among the binary items that comprise the response profiles, in this case the pattern of responses to the drinking behaviors and alcohol-related problems. We extend this approach to account for the within-

community correlation of responses expected in the present community trial design. We report 95% confidence intervals and *p*-values as an aid to interpretation, with variance estimators based upon the GEE working correlation structure and robust specification of variance estimation.

3. Results

Table 1 shows characteristics of the 4056 respondents who qualified as current drinkers. Among these drinkers, about half were younger than 18 years at the assessment and most were non-Hispanic whites. The male–female ratio was almost 1:1. Among current drinkers, about 40% had initiated drinking by age 14, half were current smokers and about one-quarter had used marijuana in the past 30 days. The majority believe that most peers in their community and friends drink while only 20% think their friends get drunk on a weekly basis. Half of the sample believe their parents will yell or punish them if they are caught drinking.

Table 2 shows the prevalence of each drinking behavior and alcohol-related problem among current underage drinkers. Binge drinking in the past 2 weeks was reported by approximately 40% of the sample while almost half get drunk at least 2–3 days a month. Despite this high level of consumption, only 19% reported drinking at least 6 days in the past month. Driving after drinking was reported by approximately 12% of the sample. The most common alcohol-related problem was having a headache or hangover (55%) followed by physical problems such as being unable to remember what happened (25%) or passing out (22%). Alcohol-related social consequences were uncommon with prevalences ranging from 5 to 11%.

Latent class models were fit to the data on drinking behaviors and alcohol-related problems, starting with a most parsimonious one-class model (“underage drinkers all the same”) with progression to a less parsimonious model with five classes of underage drinkers. Based on exploratory analyses, the five alcohol-related social consequences were combined into a single indicator of any alcohol-related social consequence because of their low prevalence and lack of discriminatory power. The joint item prevalence was 28.8%. There was also a strong local dependency between reporting passing out from drinking and being unable to remember what happened. Rather than increase the complexity of the model by introducing additional classes to account for this dependency, which is likely caused by the fact that both questions are measuring closely related traits (odds ratio (OR) = 7.2; 95% CI = 6.1, 8.5), we applied the joint item method similar to the above whereby the two items are replaced by a single item which is positive if the response to either question is positive. The prevalence of this joint item was 33.8%.

The AIC suggested a best-fitting model based on three classes of underage drinkers. Large differences between the observed and expected log odds ratios between pairs of behaviors and alcohol-related problems under a two class model also supported the introduction of a third class to adequately describe the associations among the drinking behaviors and alcohol-related problems despite the increase in the proportion of classification error (6% for two class model; 16% for three class model). The median absolute percent difference between observed and expected log odds ratios was 15.7% (range 0.2–58.5%) under the two class model. This was reduced to 6.6% (range 0.7–25.2%) for a three class model. Although the introduction of a fourth class improved the local independence assumption slightly (median absolute percent difference 3.6%; range 0.1–15.8%), the classes were no longer well separated (classification error = 21%), leading us to accept a more parsimonious three class model of underage drinking.

The estimated probability of reporting drinking behaviors and alcohol-related problems in each class is provided in Table 3 and displayed graphically in Fig. 1. Underage drinkers in Class 1, which comprise an estimated 43% of our sample, report little alcohol consumption or alcohol-

related problems (<12%) except having a headache or hangover (23%); an experience present in 55% of our sample. We will refer to underage drinkers in this class as '*non-problem drinkers*' since their patterns of behavior are not associated with alcohol-related problems. Among underage drinkers in Class 2, the estimated prevalence of binge drinking in the past 2 weeks was 35% and the estimated prevalence of getting drunk at least 2–3 days per month during the past year was 52%. Drinking at least 6 days during the past month was uncommon among underage drinkers in this class (6.6%). However, more than half of underage drinkers in Class 2 were likely to experience physical problems from drinking and approximately 40% have experienced alcohol-related social consequences. We will refer to underage drinkers in this class as '*risky problem drinkers*'; the estimated prevalence of Class 2 is 30%. Class 3 with an estimated prevalence of 27% is characterized by underage drinkers that are significantly more likely to exhibit risky drinking behaviors like binge drinking in the past 2 weeks (98%), getting drunk at least 2–3 days a month during the past year (96%), and driving after drinking (34%) than underage drinkers in Class 2. However, more than half of underage drinkers in Class 3 (61%) drank at least 6 days in the past month. Underage drinkers in Class 3 also have an even greater likelihood of reporting physical and social problems from drinking. Given this pattern of behavior, this class of underage drinkers will be referred to as '*regular problem drinkers*'.

We would expect that if classes reflect increasing severity in underage drinking behaviors and alcohol-related problems, then the probability of reporting each behavior and alcohol-related problem should increase monotonically across classes (Eaves et al., 1993) as seen in Table 3. However, heterogeneity in the distribution of response probabilities across classes can occur in the presence of monotonicity, and, when observed, would provide evidence for qualitative differences between underage drinkers. As shown at the bottom of Table 3, Class 1 reported a total of 0.6 behaviors and alcohol-related problems on average, followed by Class 2 reporting on average 2.7, and Class 3 reporting 4.9. While supporting the notion of classes reflecting increasing levels of severity, we see that the mean number of reported alcohol-related problems is essentially the same in Classes 2 and 3 (1.8 and 2.3, respectively), but the mean number of drinking behaviors increases from 0.9 in Class 2 to 2.5 in Class 3. This provides additional evidence that we have identified two types of underage drinkers at risk of experiencing problems from drinking, specifically risky problem drinkers (Class 2) and regular problem drinkers (Class 3). Fig. 1 demonstrates the qualitative aspect of the latent structure, specifically the unique divergence in the probability of regular drinking between classes 1 and 2 versus class 3.

To learn more about our two LCA-derived types of underage problem drinkers, latent class multinomial logistic regression analyses (Reboussin and Anthony, 2001) were completed to estimate associations with individual, peer and family factors. The results are presented in Table 4 in the form of unadjusted and adjusted odds ratios with Class 1 (non-problem drinkers) treated as the reference group. Among individual factors, being male (OR = 2.3; 95% CI = 1.8, 2.9 and OR = 3.5; 95% CI = 2.5, 5.0), current use of cigarettes (OR = 2.8; 95% CI = 2.2, 3.6 and OR = 3.2; 95% CI = 2.3, 4.6), current use of marijuana (OR = 4.0; 95% CI = 2.8, 5.6 and OR = 10.2; 95% CI = 6.9, 15.2), and early onset drinking (OR = 2.2; 95% CI = 1.7, 2.8 and OR = 4.2; 95% CI = 3.0, 5.8) are consistent with an increased risk of being both a risky problem drinker (Class 2) and regular problem drinker (Class 3), respectively, after controlling for all other factors. Underage drinkers between the ages of 18 and 20 were twice as likely as 16–17 year olds to be regular problem drinkers relative to non-problem drinkers (OR = 2.2; 95% CI = 1.6, 3.2). There was no difference in risk between these two groups for being risky problem drinkers relative to non-problem drinkers after adjusting for other factors. Perceptions that most friends drink (OR = 4.0; 95% CI = 3.1, 5.1 and OR = 10.8; 95% CI = 7.0, 16.7) and most friends get drunk weekly (OR = 2.0; 95% CI = 1.3, 3.1 and OR = 10.6; 95% CI = 6.9, 16.2) signaled an increased risk of being a risky problem drinker and regular problem drinker, respectively

even after adjustment for individual and family factors. Beliefs that most peers in the community drink was associated with both types of problem drinkers in unadjusted models but was no longer significant after adjusting for beliefs about friends drinking as well as individual and family factors. Beliefs that parents will yell or punish you if they caught you drinking were significantly associated with a decreased risk of being a regular problem drinker (OR = 0.5; 95% CI = 0.4, 0.6) and an increased risk of being a risky problem drinker (OR = 1.7; 95% CI = 1.2, 2.4), however, after adjusting for individual and peer factors, perceptions of parental consequences were no longer predictive of underage problem drinking.

In order to understand differences between the two types of underage problem drinkers, we present unadjusted and adjusted odds ratios in Table 5 that contrast the odds of being a regular problem drinker relative to a risky problem drinker. Being male (OR = 1.5; 95% CI = 1.1, 2.1), a young adult aged 18–20 (OR = 1.9; 95% CI = 1.4, 2.5), current marijuana use (OR = 2.6; 95% CI = 1.9, 3.4), early onset drinking (OR = 1.9; 95% CI = 1.4, 2.5), beliefs that most friends drink (OR = 2.7; 95% CI = 1.7, 4.3), and beliefs that most friends get drunk weekly (OR = 5.3; 95% CI = 3.9, 7.1) were predictive of being a regular problem drinker relative to a risky problem drinker. Current cigarette use, beliefs that most peers in the community drink, and beliefs about parental consequences did not discriminate between the two types of underage problem drinkers after adjusting for other factors.

4. Discussion

We found evidence for two types of underage problem drinkers: risky problem drinkers and regular problem drinkers. Both types of problem drinkers are at an increased risk of experiencing problems from drinking such as having a headache or hangover, passing out, and being unable to remember what happened as well as less common problems like driving after drinking, being cited or arrested for drinking, missing school, breaking or damaging something, being punished by parents or being warned by friends about drinking. Based on these response patterns detected by latent class analysis (LCA), an estimated 57% of underage drinkers are classified as problem drinkers. If a priori we required regular drinking to be present to indicate problem drinking as in adult populations, only an estimated 27% of adolescents (Class 3) would have been classified as problem drinkers; failing to identify approximately half of underage problem drinkers in our sample. The three class model of underage problem drinking suggests that problem drinking among youth is most strongly characterized by heavy drinking behaviors (i.e. binge drinking and getting drunk) regardless of regularity, lending support to the idea that the majority of alcohol-related harm can be attributed to quantity of drinking among adolescents. This is consistent with the findings of Fergusson et al. (1995) in which the class that conformed most closely to the general conceptual definition of alcohol abuse was characterized by heavy drinking (71% reported drinking at least 90 ml of pure alcohol on a typical occasion and 85% reported drinking at least 180 ml of pure alcohol on one occasion in the last 3 months). Approximately half of the members in this class reported drinking at least once per week, also consistent with our estimated prevalence of 61% in Class 3 reporting drinking at least 6 days in the past month.

It is also worth pointing out that for a class of underage drinkers in which only approximately 35% have binged in the past 2 weeks and half have gotten drunk at least 2–3 days a month during the past year (Class 2), alcohol-related problems are relatively common. In fact, despite that fact that underage drinkers in Class 3 are almost three times more likely to binge and twice as likely to get drunk at least 2–3 days a month then underage drinkers in Class 2, the mean number of alcohol-related problems between these two groups is practically the same (mean = 1.8 for Class 2 and 2.3 for Class 3). This suggests that even among a group with a moderate prevalence of heavy drinking, the risk of alcohol-related problems should not be ignored. It is interesting that despite the same average number of alcohol-related problems between the two

classes, underage drinkers in Class 3 are almost five times more likely to drive after drinking (6.4% versus 34.2%); a consequence perhaps of more regular drinking.

The estimated prevalence of problem drinking in the New Zealand sample (Fergusson et al., 1995) was approximately 10%; a rate much lower than even our most problematic drinking class (Class 3). However, the New Zealand rate was not restricted to current drinkers. Given that 75% of the New Zealand sample reported consuming alcohol during the past 3 months, we can roughly estimate that the rate of problem drinking among current drinkers in the New Zealand sample is approximately 13% ($=0.10/0.75$); a rate still much lower than the rate in our sample. However, whereas the New Zealand sample surveyed 16 year olds in 1993, the EUDL sample spans ages 16–20 with data collected between 1999 and 2004. We know based on results from the 2003 National Household Survey on Drug Use and Health that the highest prevalence of heavy drinking is among those aged 18–25, with the peak rate of both measures occurring at age 21 (SAMHSA, 2004). There is also evidence that the number of college students reporting heavy drinking and drunkenness has increased from 1993 to 1999 (Wechsler et al., 2000). Both of these factors offer possible explanations for the much higher rates of problem drinking in our sample.

In 2000, the U.S. Surgeon General and the U.S. Department of Health and Human Services recognized binge drinking among college students as a major public health problem (USDHHS, 2000). Alarming, only a mere one-third of our sample had a low probability (<11%) of reporting heavy drinking behaviors (Class 1). In our sample, there was no difference in risk for being a risky problem drinker for late adolescents (ages 16–17) and young adults (ages 18–20) suggesting that at least some of our late adolescent drinkers are manifesting risky drinking behavior profiles at the same rate as young adults. We did find evidence that young adulthood confers an increased risk of being a more regular drinker (Class 3) underscoring the need to recognize that patterns of risky drinking can develop in late adolescence and the window of opportunity for preventing more problematic drinking, i.e. regular drinking, might occur earlier than previously thought.

Similar to others, we found that physical problems from drinking were more prominent than social consequences among underage problem drinkers (Ellickson et al., 1996). The physical problems surveyed in this study were acute consequences, e.g. passing out, being unable to remember what happened and having a headache or hangover, whereas social consequences may be long-term manifestations of ongoing drinking that causes concerns by friends, parents or law enforcement. In addition, risky drinking is more likely to occur on weekends among this age group and so consequences such as missing school are less probable. Further, if heavy drinking is occurring in the context of college campuses, then social acceptability of drinking as well as less monitoring by parents and law enforcement may make social consequences less likely. The social consequences assessed in this study also fail to include some of the more common social problems among this age group such as fighting with friends, losing a boyfriend/girlfriend or risky sexual behavior which may be reflected in the lower rates.

The study findings also include an assessment of variation in the risk of being a problem drinker based on peer and parental influences. One of the strongest influences on the risk of being a problem drinker was the belief that most friends drink weekly, even after adjustment for other important influences like demographics, current cigarette use and parental consequences for drinking. This result is also consistent with Fergusson et al. (1995) who found that affiliation with substance using peers was one of only three factors predictive of problem drinking after adjustment for social, family and individual factors. Our findings also provide support for the hypothesis that perceptions of friends drinking behavior is associated with underage drinking behavior and is consistent with prior findings that perceptions of friend's use is a better predictor than actual use (Wilks et al., 1989; Iannotti and Bush, 1992). It also fits well within the

framework of cognitive development theory (Inhelder and Piaget, 1958), which suggests that the actual environment is not as important as one's perception or understanding of the environment in shaping behavior. Additionally, others have found that youth tend to overestimate drug use by peers, thereby providing support for a greater impact of perceived use over actual use. We also found that beliefs that most peers in the community drink had little influence once beliefs about friends drinking was included in the models suggesting a greater influence of the immediate social network of friends over normative expectations in the community, as previously reported by others (Baer et al., 1991; Barnes et al., 1994). Individual factors such as gender, age, early onset drinking and other drug use signaled an increased risk of problem drinking but the magnitudes of the effects were not as great as they were for peer factors with the exception of current marijuana use. Current marijuana users were ten times more likely to be regular drinkers and four times more likely to be risky drinkers relative to non-problem drinkers. Marijuana use was also a strong discriminator of risky and regular problem drinking. This finding is consistent with other studies supporting the stepping stone hypothesis that alcohol use signals an increased risk of marijuana initiation (Wagner and Anthony, 2002).

We were also interested in the relative influence of perceived parental consequences once perceptions of friend's and peer's drinking was controlled in the models. We found that the belief that parents would yell or punish you if they caught you drinking had a significant protective effect on regular drinking, but was no longer influential once individual and peer factors were controlled in analyses. The protective effect for regular drinking but not risky drinking in unadjusted models is consistent with some studies that have found that parents have greater influence over more serious drug use (Kandel, 1985; Kandel and Andrews, 1987). The failure of this result to be maintained in the presence of individual factors and peer influences support prior findings that, while family bonding is important early, peers have greatest influence later (Coleman, 1980; Guo et al., 2002).

Several limitations should be noted. There are, of course, limitations inherent in the study methodology. We acknowledge that our inferences are only valid for the population from which we sampled. Although block grants were awarded in all 50 states, discretionary grants were awarded on a competitive basis to a subset of states. In addition, as is typical of telephone surveys, nonwhites and lower SES individuals were underrep-resented in the sample. Older adolescents (i.e. 19 and 20 year olds) are harder to reach in telephone surveys using random digit dialing (RDD) and were also underrepresented in our sample. Nonetheless, despite the lack of a nationally representative sample, a strength of our sample is its size and geographic diversity (~11,000 respondents from 212 communities in 20 states).

We also acknowledge the limitations inherent in the non-randomized design. As mentioned previously, states established the criteria for deciding which communities would receive funding in the state under the discretionary grant program which could bias our results. We attempted to minimize this bias by choosing comparison communities that, as a group, were as similar as possible to the group of intervention communities. As demonstrated by Preisser et al. (2003), in the absence of randomization, the use of propensity scores to match EUDL communities resulted in intervention and comparison communities being well-balanced on measured community-level characteristics, including population size, median income, number of liquor law arrests per 100,000 population, and size of the college population.

A different method of classifying drinking behaviors and alcohol-related problems could have resulted in a somewhat different latent class structure. For example, none of the drinking behavior questions were designed to assess usual patterns of behavior and could result in an over-estimation of problem drinkers. The reference period for drinking behaviors and alcohol-related problems also lacks consistency with some questions asking about behaviors and

experiences occurring over the past 2 weeks, past month and past year. The lack of specificity regarding the duration of an “occasion” could result in its meaning different things for different respondents which could also compromise the results. In addition, the alcohol-related problems assessed in this survey ranged from fairly common problems such as experiencing headaches or hangovers after drinking to low prevalence problems such as driving after drinking and getting arrested for drinking. The inclusion of different types of problems more or less severe may have resulted in different findings and may limit the generalizability of our results.

Based on data from the YRBSS, an estimated 12.1% of students nationwide reported driving after drinking during the past 30 days. The rate in our total sample including non-current drinkers was 5% and the rate among current drinkers was 12.1%. Only 12% of our sample has never ridden a motor vehicle. The difference in our results is likely due to a difference in question wording. The YRBSS asks “During the past 30 days, how many times did you drive a car or other vehicle when you had been drinking alcohol?” while we say “During the last 30 days, how many times (if any) have you driven after drinking two or more drinks in an hour or less?” Our more narrow definition may have resulted in lower rates of driving after drinking.

Finally, we recognize that the cross-sectional nature of the EUDL study precludes us from determining whether the resultant classes represent distinct subtypes of underage problem drinkers or possibly youths in different stages of problem drinking on the road to alcohol dependence. The cross-sectional design also does not allow us to answer important questions about whether youth who like to drink seek out friends who drink (social selection) or whether perceptions of friend's drinking is having a direct impact on behavior via social pressure (social conformity). To answer this question, future studies would require a longitudinal study of youth prior to onset of alcohol use and would need to collect data from their social network of friends and peers.

In conclusion, within the collection of prior studies on underage problem drinking, most have not had the benefit of a large, geographically diverse community sample of underage drinkers. The present study has attempted to shed light on the nature of underage problem drinking by modeling drinking patterns rather than relying on unidimensional measures or clinical criteria. As such, it provides a better understanding of the heterogeneous nature of underage problem drinking that result in negative consequences, namely risky problem drinking and regular problem drinking. Our study indicates that even for a group of underage drinkers with a moderate prevalence of heavy drinking behavior alcohol-related problems is a significant concern. The results of this study suggest that patterns of risky drinking can develop in late adolescence and the window of opportunity for preventing regular drinking may be narrower than previously thought. In addition, this study underscores the strong association between underage problem drinking and perceptions regarding friends drinking behaviors as well as illicit drug use. As such, these findings may set the stage for longitudinal studies which can probe even further the nature and emergence of problem drinking as well as which underage drinkers are at higher risk of becoming problem drinkers, in order to provide insight into prevention and early intervention.

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References

- Anthony JC, Petronis KR. Early-onset drug use and risk of later drug problems. *Drug Alcohol Depend* 1995;40:9–15. [PubMed: 8746919]
- Baer JS, Stacy A, Larimer ML. Biases in the perception of drinking norms among college students. *J. Stud. Alcohol* 1991;52:580–586. [PubMed: 1758185]
- Bandeem-Roche K, Miglioretti DL, Zeger SL, Rathouz PJ. Latent variable regression for multiple discrete outcomes. *J. Am. Stat. Assoc* 1997;92:1375–1386.
- Barnes GM, Farrell MP, Banerjee S. Family influences on alcohol abuse and other problem behaviors among Black and White adolescents in a general population sample. *J. Res. Adolescence* 1994;4:183–201.
- Beyers JM, Toumbourou JW, Catalano RF, Arthur MW, Hawkins JD. A cross-national comparison of risk and protective factors for adolescent substance use: the United States and Australia. *J. Adolescent Health* 2004;35:3–16.
- Callas PW, Flynn BS, Worden JK. Potentially modifiable psychosocial factors associated with alcohol use during adolescence. *Addict. Behav* 2004;29:1503–1515. [PubMed: 15451120]
- Centers for Disease Control and Prevention. Surveillance Summaries. May 21. 2004 2004, MMWR 53
- Champion HL, Foley KL, DuRant RH, Hensberry R, Altman D, Wolf-son M. Adolescent sexual victimization, use of alcohol and other substances, and other health risk behaviors. *J. Adolescent Health* 2004;35:321–328.
- Chung T, Colby SM, Barnett NP, Rohsenow DJ, Spirito A, Monti PM. Screening adolescents for problem drinking: performance of brief screens against DSM-IV alcohol diagnoses. *J. Stud. Alcohol* 2000;61:579–587. [PubMed: 10928728]
- Chung T, Martin CS, Armstrong TD, Labouvie EW. Prevalence of DSM-IV alcohol diagnoses and symptoms in adolescent community and clinical samples. *J. Am. Acad. Child Adolescent Psychiatry* 2002;41:546–554.
- Coleman, JC. Friendship and the peer group in adolescence.. In: Adelson, J., editor. *Handbook of Adolescent Psychology*. Wiley Inc.; New York: 1980. p. 408-431.
- Cooper ML. Alcohol use and risky sexual behavior among college students and youth: evaluating the evidence. *J. Stud. Alcohol Suppl* 2002;14:101–117. [PubMed: 12022716]
- D'Agostino RB Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Stat. Med* 1988;17:2265–2281. [PubMed: 9802183]
- Deas D, Riggs P, Langenbucher J, Goldman M, Brown S. Adolescents are not adults: developmental considerations in alcohol users. *Alcohol. Clin. Exp. Res* 2000;24:232–237. [PubMed: 10698377]
- DeWit DJ, Adlaf EM, Offord DR, Ogborne AC. Age at first alcohol use: a risk factor for the development of alcohol disorders. *Am. J. Psychiatry* 2000;157:745–750. [PubMed: 10784467]
- Donner A, Birkett N, Buck C. Randomization by cluster. Sample size requirements and analysis. *Am. J. Epidemiol* 1981;114:906–914. [PubMed: 7315838]
- Duncan SC, Strycker LA, Duncan TE. Exploring associations in developmental trends of adolescent substance use and risky sexual behavior in a high-risk population. *J. Behav. Med* 1999;22:21–34. [PubMed: 10196727]
- DuRant RH, Kahn J, Beckford PH, Woods ER. The association of weapon carrying and fighting on school property and other health risk and problem behaviors among high school students. *Arch. Pediatric Adolescent Med* 1997;151:360–366.
- Eaves LJ, Silberg JL, Hewitt JK, Rutter M, Meyer JM, Neal MC, Pickles A. Analyzing twin resemblance in multisymptom data: genetic applications of a latent class model of conduct disorder in juvenile boys. *Behav. Genet* 1993;23:5–19. [PubMed: 8476390]
- Ellickson PL, McGuigan KA, Adams V, Bell RM, Hays RD. Teenagers and alcohol misuse in the United States: by any definition, it's a big problem. *Addiction* 1996;91:1489–1503. [PubMed: 8917917]
- Ellickson PL, Tucker JS, Klein DJ. Ten-year prospective study of public health problems associated with early drinking. *Pediatrics* 2003;111:949–955. [PubMed: 12728070]
- Faden VP, Fay MB. Trends in drinking among Americans age 18 and younger: 1975–2002. *Alcohol. Clin. Exp. Res* 2004;28:1388–1395. [PubMed: 15365310]

- Fergusson DM, Horwood LJ, Lynskey MT. The prevalence and risk factors associated with abusive or hazardous alcohol consumption in 16 year olds. *Addiction* 1995;90:935–946. [PubMed: 7663315]
- Foley KL, Altman D, Durant RH, Wolfson M. Adults' approval and adolescents' alcohol use. *J. Adolescent Health* 2004;35:e17–e26.
- Foxcroft DR, Lister-Sharp D, Lowe G. Alcohol misuse prevention for young people: a systematic review reveals methodological concerns and lack of reliable evidence of effectiveness. *Addiction* 1997;92:531–537. [PubMed: 9219376]
- Garrett ES, Zeger SL. Latent class model diagnosis. *Biometrics* 2000;56:1055–1067. [PubMed: 11129461]
- Grant BF, Stinson FS, Harford TC. Age at onset of alcohol use and DSM-IV alcohol abuse and dependence. A 12-year follow-up. *J. Subst. Abuse* 2001;13:493–504. [PubMed: 11775078]
- Grunbaum JA, Basen-Engquist K, Pandey D. Association between violent behaviors and substance use among Mexican–American and non-Hispanic white high school students. *J. Adolescent Health* 1998;23:153–159.
- Guo J, Hill KG, Hawkins D, Catalano RF, Abbott RD. A developmental analysis of sociodemographic, family and peer effects on adolescent illicit drug initiation. *J. Am. Acad. Child Adolescent Psychiatry* 2002;41:838–845.
- Hawkins JD, Catalano RF, Miller JY. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance abuse prevention. *Psychol. Bull* 1992;112:64–105. [PubMed: 1529040]
- Hawkins JD, Graham JW, Maguin E, Abbott R, Hill KG, Catalano RF. Exploring effects of age of alcohol use initiation and psychosocial risk factors on subsequent alcohol misuse. *J. Stud. Alcohol* 1997;58:280–290. [PubMed: 9130220]
- Iannotti RJ, Bush PJ. Perceived vs actual friends use of alcohol, cigarettes, marijuana, and cocaine. Which has the most influence. *J. Youth Adolescence* 1992;21:375–389.
- Inhelder, B.; Piaget, J. *The growth of Logical Thinking from Childhood to Adolescence*. Basic Books; New York, NY: 1958.
- Institute of Medicine. *Broadening the Base of Treatment for Alcohol Problems*. National Academy Press; Washington, DC: 1990.
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Overall Teen Drug Use Continues Gradual Decline; But Use of Inhalants Rises. 2004 [February 1 2005]. University of Michigan News and Information Services, Ann Arbor, MI (on-line, December 21, 2004, available: <http://www.monitoringthefuture.org>)
- Kandel DB. On processes of peer influence in adolescent drug use: a developmental perspective. *Adv. Alcohol. Subst. Abuse* 1985;4:139–163. [PubMed: 3874527]
- Kandel DB, Andrews K. Processes of adolescent socialization by parents and peers. *Int. J. Addict* 1987;22:319–342. [PubMed: 3583481]
- Kandel DB, Logan JA. Patterns of drug use from adolescence to young adulthood. I. Periods of risk for initiation, continued use, and discontinuation. *Am. J. Public Health* 1984;74:660–666. [PubMed: 6611092]
- 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. *Am. J. Public Health* 2000;90:360–366. [PubMed: 10705852]
- Kreiter SR, Krowchuk DP, Woods CR, Sinal SH, Lawless MR, DuRant RH. Gender differences in risk behaviors among adolescents who experience date fighting. *Pediatrics* 1999;104:1286–1292. [PubMed: 10585979]
- Lazarsfeld, PF. The logical and mathematical foundation of latent structure analysis.. In: Stouffer, S., et al., editors. *Measurement and Prediction*. Princeton University Press; Princeton: 1950. p. 365–412.
- Magidson, J.; Vermunt, JK. *Latent Class Analysis*. Cambridge University Press; Cambridge: 2000.
- McCutcheon, AL. *Sage University Paper Series on Quantitative Applications in the Social Sciences No. 07–064*. Sage; Newberry Park, CA: 1987. *Latent Class Analysis*..
- Murray DM, Short B. Intraclass correlation among measures related to alcohol use by young adults: estimates, correlates and applications in intervention studies. *J. Stud. Alcohol* 1995;56:681–694. [PubMed: 8558900]

- Murray DM, Short B. Intraclass correlation among measures related to alcohol use by school aged adolescents: estimates, correlates and applications in intervention studies. *J. Drug Educ* 1996;26:207–230. [PubMed: 8952207]
- Oesterle S, Hill KG, Hawkins JD, Guo J, Catalano RF, Abbott RD. Adolescent heavy episodic drinking trajectories and health in young adulthood. *J. Stud. Alcohol* 2004;65:204–212. [PubMed: 15151351]
- Preisser JS, Young ML, Zaccaro DJ, Wolfson M. An integrated population-averaged approach to the design, analysis and sample size determination of cluster-unit trials. *Stat. Med* 2003;22:1235–1254. [PubMed: 12687653]
- Reboussin BA, Anthony JC. Latent class marginal regression models for modeling youthful drug involvement and its suspected influences. *Stat. Med* 2001;20:623–639. [PubMed: 11223904]
- Robins, LN.; Przybeck, TR. Implications for Prevention, NIDA Research Monograph 56. US Government Printing Office; Washington, DC: 1985. Age at onset of drug use as a factor in drug and other disorders.; p. 178-192.
- Stewart C, Power TG. Identifying patterns of adolescent drinking: a tri-ethnic study. *J. Stud. Alcohol* 2002;63:156–168. [PubMed: 12033692]
- Substance Abuse and Mental Health Services Administration. Overview of Findings from the 2003 National Survey on Drug Use and Health, Office of Applied Studies, NSDUH Series H-24, DHHS Publication No. SMA 04–3963. Rockville, MD: 2004.
- Swahn MH, Simon TR, Hammig BJ, Guerrero JL. Alcohol-consumption behaviors and risk for physical fighting and injuries among adolescent drinkers. *Addict. Behav* 2004;29:959–963. [PubMed: 15219342]
- Townshend JM, Duka T. Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures. *Alcohol Alcohol* 2002;37:187–192. [PubMed: 11912076]
- U.S. Department of Health and Human Services. Healthy People 2010, Conference Edition. II. USDHHS; Washington, DC: 2000. p. 26-29.
- U.S. Department of Health Human Services. Understanding Underage Drinking, NIH-04–5465. USDHHS; Washington, DC: 2004.
- Wagner FA, Anthony JC. Into the world of illegal drug use: exposure opportunity and other mechanisms linking the use of alcohol, tobacco, marijuana, and cocaine. *Am. J. Epidemiol* 2002;155:918–925. [PubMed: 11994231]
- Wechsler H, Kuo M, Lee H, Dowdall GW. Environmental correlates of underage alcohol use and related problems of college students. *Am. J. Prevent. Med* 2000;19:24–29.
- White HR, Loeber R, Stouthamer-Loeber M, Farrington DP. Developmental associations between substance use and violence. *Dev. Psychopathol* 1999;11:785–803. [PubMed: 10624726]
- Wilks J, Callan VJ, Austin DA. Parent, peer and personal determinants of adolescent drinking. *Br. J. Addict* 1989;84:619–630. [PubMed: 2752193]
- Wolfson, M.; Altman, D.; DuRant, R.; Patterson, TE.; Williams, A.; Zaccaro, D.; Shrestha, A.; Preisser, J.; Allen, D.; Garner, G. National Evaluation of the Enforcing Underage Drinking Laws Program: Year 2 Report. Wake Forest University School of Medicine; Winston-Salem, NC: 2001.
- Wood MD, Read JP, Mitchell RE, Brand NH. Do parents still matter? Parent and peer influences on alcohol involvement among recent high school graduates. *Psychol. Addict. Behav* 2004;18:19–30. [PubMed: 15008682]
- Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986;42:121–130. [PubMed: 3719049]

Fig. 1.
Estimated prevalence of drinking behaviors and alcohol-related problems for a three class model of underage problem drinking.

Table 1

Sample characteristics of underage drinkers

	No.	%
Sex		
Female	1940	47.8
Male	2116	52.2
Age		
16–17	1963	48.4
18–20	2093	51.6
Race		
White	3598	88.7
Non-white	458	11.3
Current cigarette use		
Yes	1897	46.8
No	2159	53.2
Current marijuana use		
Yes	1031	25.4
No	3025	74.6
Early onset drinking		
Yes	1643	40.5
No	2413	59.5
Belief that most peers in community drink		
Yes	2950	72.7
No	1106	27.3
Belief that most friends drink		
Yes	2506	61.8
No	1550	38.2
Belief that most friends get drunk weekly		
Yes	779	19.2
No	3277	80.8
Belief that parents will yell or punish you if caught drinking		
Yes	2098	51.7
No	1958	48.3

Table 2

Prevalence of drinking behaviors and alcohol-related problems among underage drinkers

	No.	%
Drinking behaviors		
Drank at least 6 days in past month	770	19.0
Binged past 2 weeks	1679	41.4
Got drunk at least 2–3 days a month during past year	1881	46.4
Alcohol-related problems		
Drove after drinking	501	12.4
Passed out	882	21.8
Unable to remember what happened	992	24.5
Had headache or hangover	2236	55.1
Cited or arrested for drinking, possessing or trying to buy alcohol	212	5.2
Missed any school	238	5.9
Warned by a friend	377	9.3
Broke or damaged something	335	8.3
Punished by parents	427	10.5

Table 3
Estimated class prevalences and response probabilities from a three class model of underage problem drinking

	Response probability (S.E.)			
	Class 1	Class 2	Class 3	
Class probabilities (prevalence)	0.43	0.30	0.27	
Drinking behaviors				
1. Drank at least 6 days past month	0.016 (0.003)	0.066 (0.010)	0.610 (0.024)	
2. Binge drinking past 2 weeks	0.110 (0.011)	0.350 (0.032)	0.977 (0.003)	
3. Got drunk at least 2–3 days a month during past year	0.118 (0.013)	0.518 (0.028)	0.960 (0.011)	
Alcohol-related problems				
1. Drove after drinking	0.030 (0.007)	0.064 (0.016)	0.342 (0.020)	
2. Passed out or unable to remember what happened	0.032 (0.004)	0.509 (0.037)	0.638 (0.017)	
3. Had headache or hangover	0.226 (0.023)	0.802 (0.025)	0.791 (0.016)	
4. Social consequences	0.076 (0.011)	0.395 (0.027)	0.508 (0.019)	
Drinking behaviors (max = 3)	0.2	0.5	0.6	2–3
Alcohol-related problems (max = 4)	0.3	0.5	0.7	0–4
Total (max = 7)	0.6	0.6	0.7	3–7

Table 4

Odds ratios (95% CI) of the association of risky problem drinking (Class 2) and regular problem drinking (Class 3) relative to non-problem drinking (Class 1) based on unadjusted and adjusted multinomial latent class logistic regression models

	Risky problem drinkers (Class 2) vs. non-problem drinkers (Class 1)		Regular problem drinkers (Class 3) vs. non-problem drinkers (Class 1)	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Sex (male vs. female)	1.0 (0.7, 1.3)	2.3 (1.8, 2.9)*	3.1 (2.4, 4.0)*	3.5 (2.5, 5.0)*
Age (18–20 vs. 16–17)	0.5 (0.3, 0.7)*	1.2 (0.9, 1.5)	2.3 (1.8, 3.0)*	2.2 (1.6, 3.2)*
Current cigarette use	2.1 (1.6, 2.7)*	2.8 (2.2, 3.6)*	5.0 (4.0, 6.2)*	3.2 (2.3, 4.6)*
Current marijuana use	3.2 (2.4, 4.5)*	4.0 (2.8, 5.6)*	10.8 (8.9, 13.2)*	10.2 (6.9, 15.2)*
Early onset drinking	2.3 (1.8, 3.0)*	2.2 (1.7, 2.8)*	5.0 (3.9, 6.5)*	4.2 (3.0, 5.8)*
Most peers in community drink	1.3 (1.1, 1.7)*	1.0 (0.8, 1.3)	3.4 (2.6, 4.4)*	1.4 (0.9, 2.0)
Most friends drink	2.1 (1.6, 2.7)*	4.0 (3.1, 5.1)*	16.4 (12.3, 22.0)*	10.8 (7.0, 16.7)*
Most friends get drunk weekly	1.6 (1.0, 2.6)	2.0 (1.3, 3.1)*	20.7 (14.7, 29.0)*	10.6 (6.9, 16.2)*
Parents yell/punish if caught drinking	1.7 (1.2, 2.4)*	1.2 (0.9, 1.5)	0.5 (0.4, 0.6)*	1.1 (0.8, 1.5)

* $p \leq 0.05$.

Table 5

Odds ratios (95% CI) of the association of regular problem drinking (Class 3) relative to risky problem drinking (Class 2) based on unadjusted and adjusted multinomial logistic regression models

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Sex (male vs. female)	3.3 (2.2, 4.8)*	1.5 (1.1, 2.1)*
Age (18–20 vs. 16–17)	4.5 (3.1, 6.5)*	1.9 (1.4, 2.5)*
Current cigarette use	2.4 (1.7, 3.3)*	1.1 (0.8, 1.6)
Current marijuana use	3.7 (2.5, 5.4)*	2.6 (1.9, 3.4)*
Early onset drinking	2.2 (1.5, 3.0)*	1.9 (1.4, 2.5)*
Most peers in community drink	2.5 (1.9, 3.4)*	1.4 (1.0, 1.9)
Most friends drink	7.8 (5.5, 11.0)*	2.7 (1.7, 4.3)*
Most friends get drunk weekly	12.9 (8.2, 20.2)*	5.3 (3.9, 7.1)*
Parents yell/punish if caught drinking	0.3 (0.2, 0.4)*	0.9 (0.7, 1.2)

* $p \leq 0.05$.