Alcohol Use Among American Indian High School Youths From Adolescence and Young Adulthood: A Latent Markov Model*

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ABSTRACT. Objective: We explored patterns of alcohol use among American Indian youths as well as concurrent predictors and developmental outcomes 6 years later. **Method:** This study used six semi-annual waves of data collected across 3 years from 861 American Indian youths, ages 14-20 initially, from two western tribes. Using a latent Markov model, we examined patterns of change in latent states of adolescent alcohol use in the past 6 months, combining these states of alcohol use into three latent statuses that described patterns of change across the 3 years: abstainers, inconsistent drinkers, and consistent drinkers. We then explored how the latent statuses differed, both initially and in young adulthood (ages 20-26). **Results:** Both alcohol use and nonuse were quite stable across time, although we also found evidence of change. Despite some rather troubling drinking patterns as teens, especially among consistent drinkers, most of the youths had achieved important tasks of young adulthood. But patterns of use during adolescence were related to greater levels of substance use in young adulthood. **Conclusions:** Latent Markov modeling provided a useful categorization of alcohol use that more finely differentiated those youths who would otherwise have been considered inconsistent drinkers. Findings also suggest that broad-based interventions during adolescence may not be the most important ones; instead, programs targeting later alcohol and other drug use may be a more strategic use of often limited resources. (*J. Stud. Alcohol Drugs* **69:** 666-675, 2008)

ALCOHOL USE HAS RECEIVED extensive attention among American Indian samples, especially youths. Large alcohol-related research studies with American Indian populations have not been uncommon—witness the work of May and colleagues (May, 1996; May and Gossage, 2001), Kunitz and Levy's landmark Navajo work (Kunitz et al., 1999), Oetting and Beauvais' surveillance of adolescent alcohol use (Beauvais, 1992, 1998), and Costello's examination of the changes in alcohol use and other problem behaviors before and after the establishment of a gambling casino (Costello et al., 2003). Most have found that American Indian youths use alcohol at higher levels or in more problematic patterns than do other youths (Beals et al., 2003; Beauvais, 1992; Federman et al., 1997; Plunkett and Mitchell, 2000). Even more disturbing, the overall death rate among American Indians between the ages of 15 and 24 is more than double that of a combined group of all races in the United States of the same age; the most common cause of death is unintentional injuries or accidents—both of which are often heavily influenced by alcohol use (Shalala et al., 1999). Rates of death attributable to alcoholism among American Indian adolescents and young adults, ages 15-24, are more than 15 times those of the same age group among a combined all-races group in the United States.

It is crucial to underscore that important tribal and individual variation exists across American Indian populations (Beals et al., 2003). In addition, many American Indian youths use no alcohol at all or use alcohol in ways that do not interfere with key developmental tasks or family and community responsibilities (Mitchell et al., 1996). Often, however, we cannot know the differential impact of alcohol on such outcomes until young adulthood. Thus, research that is restricted to only one developmental period limits our understanding of the diversity of pathways to nonproblematic alcohol use, alcohol misuse, and related problems among young adults (Schulenberg and Maggs, 2002).

Change in alcohol use

Many of the recent advances in research exploring the development of adolescent alcohol use have focused on *quantitative* aspects of change, characterized by increases

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and decreases of a particular behavior measured by a continuous variable, using such approaches as latent growth curve analysis (Collins et al., 1997; Hyatt and Collins, 2000; Mitchell et al., 2006). In general, however, alcohol use during adolescence is not yet a well-ingrained behavior. Therefore, growth or change in alcohol use may not be a fluid developmental process such as that assumed by such quantitative models. Instead, youths' alcohol use across time may be better conceptualized by shifts among *qualitatively* different states or stages. For instance, reverting from one state (e.g., use) to a different state (e.g., nonuse) may be especially important for teens, whose alcohol use is often much more sporadic and less under their own control than is use among adults (Langeheine and van de Pol, 2000; Logan, 1981).

Few studies have examined discrete patterns of alcohol use alone; most have focused on the stages of substance-use initiation, often including lifetime and recent use of not only alcohol but also marijuana and tobacco (Collins et al., 1997; Erkanli et al., 2001). Such explorations have not allowed us to understand how alcohol use develops in its own right. In addition, most of these efforts have simply described the prevalence of stages and patterns of use, without exploring ways in which the patterns differed or examining the outcomes of the various patterns of use in young adulthood. Two studies have examined adolescent drinking patterns as predictors of young adult outcomes. Guo et al. (2000) found that youths diagnosed with an alcohol-use disorder at age 21 were more likely than youths with no disorder to have begun or already have been drinking in middle school and were more likely to have reported heavy episodic drinking in high school. Bennett et al. (1999) used cluster analyses to identify four alcohol-use patterns across two time points covering 7 years among a sample ages 18-31 who were not abstainers: youth-limited problem drinkers, stable moderate drinkers, developmentally persistent problem drinkers, and stable low drinkers. Developmentally persistent problem drinkers showed higher levels of problem behaviors in adulthood than did youth-limited drinkers.

Although some youths drink in ways that seem problematic, most will mature out of such drinking. However, little is known about who will continue problem drinking patterns into young adulthood and who will stop (Bennett et al., 1999; Jackson et al., 2001). In considering what might be associated with problematic adolescent alcohol use either concurrently or in later years, researchers have suggested a number of variables. Some have reported that positive alcohol outcome expectancies and extroversion predicted who would not mature out of problem drinking several years after college graduation (Gotham et al., 1997). Other variables found to be related to more worrisome patterns of drinking included family history of alcohol use problems; sensation seeking; low self-esteem; problem behaviors and deviance; tobacco, marijuana, and hard-drug use; lower school achievement and more negative attitudes toward school; and more antisocial peers (Bryant et al., 2003; Eccles et al., 1997; Ludden and Eccles, 2007; Nation and Heflinger, 2006). Fewer researchers have explored outcomes of youthful drinking patterns in young adulthood. However, problematic patterns have been associated with more negative outcomes in employment, marriage, and educational achievement as well as with greater substance use and misuse (Bennett et al., 1999; Gotham et al., 1997).

Markov models

Although not often used to investigate alcohol use, Markov models offer a straightforward approach to testing models of discrete change and stability such as alcohol use among adolescents (Langeheine and van de Pol, 2000). In a Markov model, each measurement occasion is associated with one or more observed categories or states (Garner, 2003). In the simplest case—one dichotomous variable measured across time—a Markov model characterizes the change process by estimating the conditional probabilities of moving from one state at one occasion to another state on another occasion (Eid, 2002; Rost, 2002). This simple Markov model makes two basic assumptions. First, it considers the data to be completely free of measurement error. As a result, any measurement error that does exist can be modeled only as change, thereby overestimating the amount of change (Langeheine and van de Pol, 2000). Because measurement error is ubiquitous in social science research, a useful extension of the simple Markov model is the latent Markov model (LMM, also called a hidden Markov model; Bockenholt, 2002; Eid, 2002; Rost, 2002). The LMM separates variability owing to measurement error from true change on the latent level, allowing a more accurate estimation of stability and change (van de Pol and Langeheine, 1990; van de Pol and Mannan, 2002).

The second assumption of a simple Markov model lies in the presumption that a person's state is determined by his/her behavior during the immediately preceding period, with no influence from earlier points in time—called a first-order process or a lag-1 model—in effect, a "process without memory" (Eid and Langeheine, 1999; Langeheine and van de Pol, 2000). Yet Markov models can also estimate change processes in which current behavior is influenced by more distal behavior as well. Such models are referred to as higher-order models, most appropriate for change processes such as current alcohol use that likely have a strong effect of history (Cook and Moore, 2001; Erkanli et al., 2001; Kerr et al., 2002; Langeheine and van de Pol, 2000).

Study goals

With the linked data sets used here, we had a unique opportunity to examine stability of alcohol use across 3 years

among American Indian adolescents. In this study, we used a 6-year longitudinal dataset of 861 American Indian youths, ages 14-20 initially, from two western tribes. With six semi-annual waves collected across 3 years, we examined patterns of change in latent states of adolescent alcohol use using an LMM. We combined these states of alcohol use into latent statuses that described patterns of change across the 3 years, separating measurement error from true change and testing for the influence of alcohol use lagged across all six time points. We compared observed status, derived only from the self-reported individual items, with the latent status, derived from the model-estimated latent class memberships, to explore the value added by the latent model to describing the true nature of youthful alcohol use across time. Finally, we investigated how the latent statuses differed, both initially and in young adulthood (ages 20-26).

Method

Sample

The Voices of Indian Teens (VOICES) participants were drawn from the school rosters of seven high schools in four American Indian communities in the West; data were collected semi-annually from fall 1993 to spring 1996 (Waves [W] 1-6) in the schools. Once the base cohort was established, community-based follow-up consisted of recontacting those participants who could no longer be found in the schools. For these analyses, we used the three schools from the two communities—one in the Northern Plains (NP), one in the Southwest (SW)—that continued in the follow-up project, discussed next. (In work with American Indian groups, maintenance of community confidentiality can be as important as that of individual confidentiality [Norton and Manson, 1996]. Therefore, we use cultural descriptors rather than specific tribal names.)

The Pathways of Choice (CHOICES) project initially attempted to contact a subgroup (n = 1,522) of VOICES participants—those on the 1993 rosters in two schools in the NP community and one large school in the SW community. Overall, 85% (n = 1,292; 518 NP, 774 SW) filled out a CHOICES survey in 1996 and formed the CHOICES sample. We surveyed this group once a year from 1996 through 1999. Here, we used only the final wave of data from 1999, which we refer to as W7, to provide information about possible young adult outcomes. Most participants were contacted in the community and in nearby towns; if participants had left the area, we contacted them in their new locations. All participants provided informed consent; parents of minors provided their consent before we approached the minor for assent. The projects were approved by the university's institutional review board as well as the appropriate tribal authorities.

A total of 1,320 youths (mean [SD] age = 16.0 [1.4]; 49.8% female) made up the base cohort at W1. On average, the W1 cohort had 4.8 of the 6 semi-annual waves from the VOICES project; 66.5% had 5 or 6 waves. Comparing those with at least five waves to those with four or fewer, we found that the former group was more likely to be female and younger; but a multivariate analysis of variance (MANOVA) using the W1 analysis variables showed no significant differences between groups overall. Of the base cohort, 861 (65%) also had information at W7. We compared those with both W1 and W7 data (n = 861) with those who had only W1 data (n = 459) on age, gender, and the variables used in the LMM analyses: Those with both W1 and W7 data were more likely to be female and younger; again, however, a MANOVA using the analysis variables showed no other significant differences.

Procedures

School-based data collection in VOICES consisted of 1 scheduled testing day, with a follow-up day in school for absentees approximately 1 week later. Those completing the survey received compensation worth $5 (e.g., a $5 money order or gift certificate). Additionally, community-based follow-up was conducted for 2 to 3 months by research staff who were members of each community. Data collection for CHOICES was completely community-based, again using research staff who were tribal members. The majority of constructs in the VOICES survey were retained in the CHOICES instrument and, where necessary, altered to be more age-appropriate; constructs such as work, parenting, and romantic relationships were added as well. All who completed a CHOICES survey received compensation of $20.

Measures

The VOICES survey was developed in the first year of the project through three activities: the use of focus groups in two of the VOICES communities, pretesting (including test-retest procedures) in three of the VOICES schools, and scientific review of the results. This process is described at the authors' Web site (www.uchsc.edu/ai/ncaianmhr/pastrsch/vcmethod.pdf). The final measures demonstrated acceptable validity and reliability (as also detailed at the authors' Web site: www.uchsc.edu/ai/ncaianmhr/pastrsch/vcscales.pdf).

Alcohol use. In each semi-annual wave of the VOICES survey, youths answered the question, "Have you had a drink of alcohol in the past six months?" with responses of "yes," "no," or "I don't know" (recoded to missing data). Table 1 presents descriptive statistics for all measures.

Predictors from adolescence of alcohol use latent statuses. From W1 data, we drew from other research to identify several domains that represented adaptation among high school students and that have been found to be related

TABLE 1. Descriptive properties of analysis variables

Variable	No. of items	Range	Mean (SD) or %
Had a drink of alcohol in past 6 months			
Wave 1	1	0 = no/1 = yes	54%
Wave 2	1	0 = no/1 = yes	54%
Wave 3	1	0 = no/1 = yes	58%
Wave 4	1	0 = no/1 = yes	54%
Wave 5	1	0 = no/1 = yes	55%
Wave 6	1	0 = no/1 = yes	51%
Predictors (Wave 1)			
Self-reported grades	1	1 = mostly D's or lower/4 = mostly A's	2.59 (0.77)
How feel about school	1	1 = hate school/5 = like school very much	4.03 (0.91)
Ever run away	1	0 = no/1 = yes	15%
Ever had sex	1	0 = no/1 = yes	43%
Acting-out behaviors, past 6 months	5	1 = never/5 = 5 or more times	1.70 (0.78)
Competencies	7	1 = rarely or never/4 = almost always	2.76 (0.68)
Self-esteem	6	1 = disagree/5 = agree	3.91 (0.80)
Sensation-seeking	6	1 = disagree/5 = agree	2.34 (1.00)
Pro-social peer values	6	1 = disagree/5 = agree	3.34 (0.67)
Positive alcohol outcome expectancies	8	1 = disagree/5 = agree	2.01 (0.97)
Mother had serious problem with alcohol in past	1	0 = no/1 = yes	20%
Mother has serious problem with alcohol now	1	0 = no/1 =yes	6%
Father had serious problem with alcohol in past	1	0 = no/1 = yes	47%
Father has serious problem with alcohol now	1	0 = no/1 = yes	16%
Frequency of smoking cigarettes	1	0 = not at all/5 = >1 pack/day	0.67 (0.89)
No. of drugs ever tried (among those who had drunk alcohol at least once at Wave 1)	7	count of 7 drug categories	1.01 (1.32)
No. of days drank alcohol	1	0 - 31 days	2.80 (5.01)
Average no. of drinks	1	0 - 21 or more drinks	4.54 (6.18)
Most to drink in one day	1	0 - 21 or more drinks	4.83 (6.21)
Problems with alcohol, past month	8	0 = rarely or never/1 = yes	0.36 (0.42)
Outcomes (Wave 7)			
Currently married/living with partner	1	0 = no/1 = yes	42%
Ever attended college	1	0 = no/1 = yes	49%
Working at least half-time	1	0 = no/1 = yes	48%
Not enough money for food, clothing housing	1	1 = never/4 = always	1.79 (0.92)
No. of legal convictions, lifetime	7	count of 7 convictions	0.15 (0.45)
How often smoke cigarettes	1	0 = not at all/4 = every day	0.75 (1.10)
No. of drugs ever tried	8	count of 8 drug categories	1.05 (1.47)
No. of days drank alcohol	1	0-31 days	2.36 (4.94)
Average no. of drinks	1	0-99	4.79 (10.01)
Most to drink in one day	1	0-99	4.36 (7.92)
Problems with alcohol, past month	8	0 = rarely or never/1 = yes	0.90 (0.72)

to alcohol use. We assessed aspects of school involvement using a question about self-reported grades and one that asked, "How do you feel about school?" We asked whether the youths had ever run away and whether they had ever had sex. Drawn from Jessor's deviance scale (Donovan et al., 1988), we included a composite measure of five acting-out behaviors (e.g., started a fist fight, shoplifted; α = .73). We also used a seven-item measure of competencies (Seidman, 1991), with items such as, "I am good at making other kids feel comfortable" and "I am good at all kinds of sports and athletic games" (α = .81); a six-item version (α = .79) of Rosenberg's self-esteem scale (Rosenberg, 1979); a six-item measure (α = .74) of sensation-seeking (Huba et al., 1981); a six-item measure of pro-social peer values (α = .81) adapted from Allen et al. (1989); and a shortened version of the positive alcohol outcome expectancies scale (α = .91) by Reese et al. (1994). Four questions asked whether the youth's mother or father had a problem with alcohol in the past or currently had problems with alcohol. Finally, we included several measures related to substance use: whether he or she had ever smoked cigarettes; the number of seven different types of drugs he or she had reported ever having tried; three items about past-month alcohol use (quantity, frequency, most consumed in 1 day); and a count of eight

alcohol problems in the past month, drawn from the Diagnostic Interview Schedule for Children, Version 2.3 (Shaffer et al., 1996).

Young adulthood variables. From W7, we selected five markers of developmental outcomes or roles representing a transition into young adulthood: currently married or living with a partner, ever having attended college, presently working at least half time, having enough money to pay the bills in the past year, and the number of legal convictions ever. In addition, we asked again about current cigarette smoking, the number of different kinds of drugs ever used, and the same four variables about past-month alcohol use and alcohol problems asked in W1.

Results

The Multiple Imputation procedures (PROC MI) available in SAS (SAS Institute Inc., Cary, NC) were used to estimate missing values. We created five different data sets with imputed data; in addition to all of the independent and dependent variables described here, we included four W1 variables as predictors of missingness in a school-based sample (Collins et al., 2001): gender, age, drugs used in the past month, and self-rated health. With Mplus Version 4.21 (Muthén and Muthén, 1998-2006), we used the IMPUTATION option, which conducted the analysis with each of the five data sets and created final parameter estimates that were averaged over the five analyses. Because the IMPUTATION option analyzed five data sets, it could not save the variables necessary to assign participants to their most likely latent status. Therefore, we first conducted all analyses using the IMPUTATION option; we then conducted the same analyses with just one of the five data sets (randomly selected). Conclusions drawn from both sets of analyses about the model parameters were identical; thus, to be consistent, we report here only the results from the single data set so that the class assignments for the final set of analyses reflect the parameters reported.

Latent Markov model

In the first step of an LMM, two or more latent classes at each occasion of measurement represent interindividual differences. At each time, the self-reported states are linked to each latent class by conditional response probabilities, which are conceptually similar to factor loadings in a factor analysis. The LMM then characterizes the process of change across each latent class by the latent transition probabilities—the conditional probabilities of staying in the same state over time (e.g., no alcohol use at two time points) or of moving from one state (no alcohol use) to another state (alcohol use; Eid, 2002). In the second step, one identifies a small number of latent *statuses,* each summarizing a pattern of latent classes across time—for example, consistent abstainer, who reported no alcohol use at all periods (Dijkstra, 2001; Garner, 2003; van de Pol and Mannan, 2002).

We tested a single-indicator LMM (did or did not drink alcohol during the previous 6 months) across the six waves of data. Just as one would constrain the factor loadings of observed variables on a latent variable across time to ensure that the meaning of the latent variable did not change over time, we constrained the conditional response probabilities of the observed variable to be equal across time to ensure measurement invariance (Muthén and Muthén, 1998-2006). We entered three dummy-coded time-invariant covariates combining tribe and gender (with NP males as the referent category); we constrained these parameters to be equal across all waves also. Transition probabilities were estimated freely across all waves. Because we had as many as five lags possible across the six waves, we tested six nested models, beginning with no Markov model (lag-0), in which current behavior had no relationship to any past behavior (Langeheine and van de Pol, 2002), through a fifth-order (lag-5) model; we constrained each lag to be constant across the previous time period. We used the Bayesian Information Criterion (BIC), in which smaller numbers represent better fit, to determine the best-fitting model. With consistently

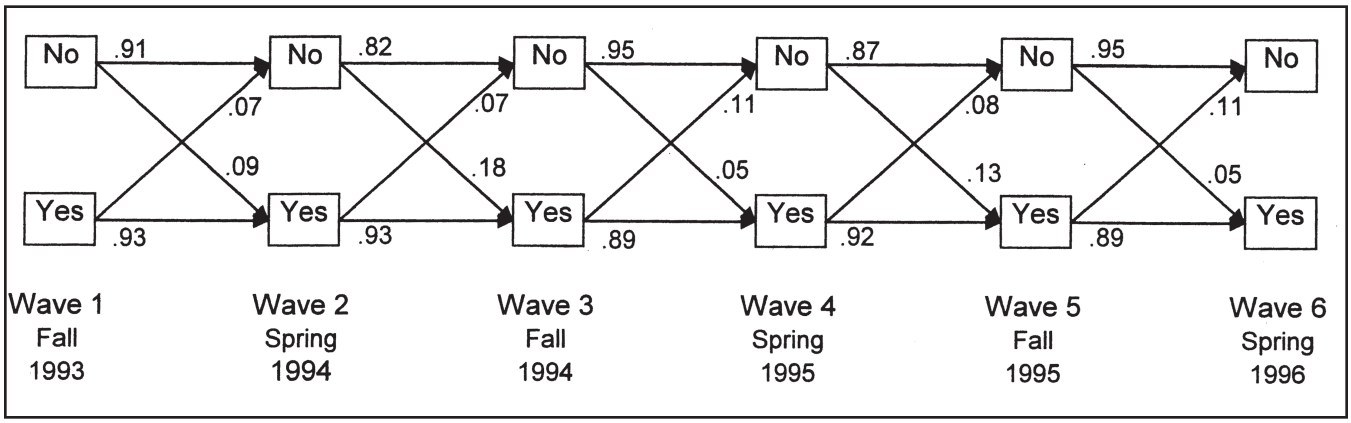

FIGURE 1. Transition probabilities

decreasing BICs from the no-Markov (lag-0) model (6,850.3) to the fifth-order model (5,685.7), we determined that a fifth-order model was the best-fitting one. Thus, early states of alcohol use continued to influence drinking as long as 3 years later.

Looking first at the covariates' relationships with the latent classes (not shown), NP males and NP females were least likely to be in the "no use" latent class at any wave; their probabilities were not significantly different from each other. However, both SW males and SW females were more likely than NP males to be in the "no use" latent class at any wave.

Figure 1 shows the transition probabilities of moving from one state to another across the six waves. Overall, the stabilities (the probability of being in the "yes" latent class or in the "no" latent class in two consecutive waves) were quite high, ranging from .82 to .95, with a mean of .91.

Finally, latent statuses were defined by latent class membership across time. Participants were assigned to the latent status for which they had the highest probability of membership. We collapsed the latent statuses into three broad categories: abstainer ("no" at all six waves; 32%), consistent drinkers ("yes" at all six waves; 44%), and inconsistent drinkers (all other categories; 25%). It should be noted that we initially separated inconsistent drinkers into starters (8%) and quitters (11%) as well as inconsistent drinkers (6%). However, these subgroups were proportionately too small to provide robust statistical tests; therefore, we combined them into the category of inconsistent drinkers.

Differences between observed and latent statuses

Our first question was whether the latent model mattered—in other words, what did the use of a latent model add over and above the simpler approach of relying solely on the observed variables? We used the same three categorizations of the observed variables to define abstainer, inconsistent drinker, and consistent drinker. Table 2 shows the crosstabluation of the observed statuses by the latent statuses. Using just observed variables, the largest group of youths (61%) fell in the inconsistent drinker category. Interestingly, the only points of disagreement between the two approaches were in the classification of this large group: Of the 524 youths classified as inconsistent drinkers using the observed variables, only 40% fell in that category using the latent model. Instead, 94 (18%) of the observed inconsistent drinkers were considered abstainers by the latent model; 219 (42%) were considered consistent drinkers. We compared these three subgroups of observed inconsistent drinkers on a composite variable from each of the six waves that combined items about past-month quantity and frequency of alcohol use and the greatest amount drunk (all standardized before combining). At all six waves, the subgroups were significantly different (not shown). In 17 of the 18 Tukey pairwise comparisons, the following pattern emerged: The latent abstainers reported significantly less alcohol use than did the latent inconsistent drinkers; and the latent inconsistent drinkers reported drinking significantly less use than did the latent consistent drinkers. The latent model thus capitalized on both assessments of measurement error and information from earlier alcohol use to separate the large, undifferentiated group of observed inconsistent drinkers into more finely honed subgroupings that reflected meaningfully different alcohol-use patterns.

Predictors from adolescence (W1)

We conducted a MANOVA including all W1 variables not related to alcohol use as dependent variables; independent variables were tribe, gender, and the three-category latent status variable, allowing us to check for two- and three-way interactions involving latent status. The main effect for latent status was significant and no interactions involving latent status were statistically significant. In addition to a significant overall multivariate F statistic, all of the independent variables except self-reported grades and mother's currently having a problem with alcohol were significant. Two general patterns of group differences dominated the results (Table 3). First, both abstainers and inconsistent drinkers scored lower than consistent drinkers on parental problems with drinking; those in the first two groups also reported feeling better about school and higher levels of competencies than did the consistent drinkers. Second, abstainers scored significantly lower than inconsistent drinkers, and inconsistent drinkers scored significantly lower than consistent drinkers on the following variables: ever having run away, ever having had

Table 2. Observed status versus latent status

	Observed status							
	Abstainers		Inconsistent drinkers		Consistent drinkers		Total	
Latent status	*n*	%	*n*	%	*n*	%	*n*	%
Abstainers	180	100.0	94	17.9	0	0.0	274	31.8
Inconsistent drinkers	0	0.0	211	40.3	0	0.0	211	24.5
Consistent drinkers	0	0.0	219	41.8	157	100.0	376	43.7
Total	180	20.9	524	60.9	157	18.2	861	–

TABLE 3. Predictors (Wave 1) and outcomes (Wave 7), by latent status

Variable	Abstainers	Inconsistent drinkers	Consistent drinkers	Univariate *F*
Wave 1				
Self-reported grades	2.62	2.59	2.56[A]	1.74
How do you feel about school	4.03[C]	3.91[C]	3.67[A,I]	8.03*
Ever run away, proportion yes	0.07[I,C]	0.16[A]	0.20[A]	6.19*
Ever had sex, proportion yes	0.23[I,C]	0.43[A,C]	0.58[A,I]	20.97*
Antisocial behavior	1.33[I,C]	1.64[A,C]	2.01[A,I]	47.14*
Competencies	2.85[C]	2.81[C]	2.67[A,I]	7.12*
Self-esteem	4.01[C]	3.92	3.84[A]	4.07*
Sensation seeking	1.95[I,C]	2.32[A,C]	2.64[A,I]	30.41*
Peer values, high = prosocial	3.55[I,C]	3.33[A,C]	3.18[A,I]	7.43*
Positive alcohol expectancies	1.48[I,C]	1.92[A,C]	2.44[A,I]	65.63*
Mom has problem with alcohol now, proportion yes	0.02	0.06	0.09	1.94
Mom had problem with alcohol in past, proportion yes	0.11[C]	0.18[C]	0.27[A,I]	4.17*
Father has drinking problem now, proportion yes	0.10[C]	0.14[C]	0.22[A,I]	7.83*
Father had drinking problem in past, proportion yes	0.33[I,C]	0.47[C]	0.57[I]	11.29*
Frequency of smoking cigarettes	0.21[I,C]	0.56[A,C]	1.03[A,I]	54.37*
No. of drugs, ever	0.32[I,C]	0.97[A,C]	1.55[A,I]	45.26*
Pillais' multivariate approximate	$F = 8.09$, 32/1,670 df, $p < .05$			
Inconsistent drinkers and consistent drinkers only				
No. of days drank alcohol, past month	–	1.47[C]	3.54[I]	15.86*
No. of drinks, past month	–	2.09[C]	5.92[I]	45.65*
Most number of drinks in one day, past month	–	2.20[C]	6.30[I]	55.12*
Alcohol problems	–	0.05[C]	0.14[I]	10.26*
Pillais' multivariate approximate		$F = 15.26$, 4/576 df, $p < .05$		
Wave 7				
Married/living with partner, proportion yes	0.38	0.47	0.41	2.09
Working at least half-time, proportion yes	0.47	0.45	0.51	2.73
Ever attended college, proportion yes	0.49	0.52	0.48	0.09
How often couldn't pay bills in past month	1.82	1.75	1.79	0.33
No. of convictions	0.07[I,C]	0.12[A,C]	0.24[A,I]	7.41*
How often smoke cigarettes	0.35[I,C]	0.76[A,C]	1.03[A,I]	9.55*
No. of drugs, ever	0.47[I,C]	1.02[A,C]	1.48[A,I]	26.03*
No. of days drank alcohol, past month	1.06[C]	2.08[C]	3.47[A,I]	13.48*
No. of drinks, past month	2.15[I,C]	3.94[A,C]	7.20[A,I]	11.33*
Most no. of drinks in 1 day, past month	1.81[I,C]	3.88[A,C]	6.49[A,I]	13.75*
Alcohol problems	0.67[I,C]	0.86[A,C]	1.09[A,I]	11.59*
Pillais' multivariate approximate	$F = 3.67$, 26/1,676 df, $p < .05$			

Notes: Superscripts indicate significantly different statuses: A = abstainer; I = inconsistent drinkers; C = consistent drinkers.
*$p < .05$.

sex, smoking cigarettes, positive alcohol outcome expectancies, antisocial behaviors, and sensation seeking. This pattern existed in reverse order (i.e., abstainers scored higher than inconsistent drinkers, inconsistent drinkers scored higher than consistent drinkers) for pro-social peer values.

Because the abstainer group had not consumed alcohol at W1, we compared the four W1 alcohol-related variables for inconsistent and consistent drinkers only. A MANOVA again revealed no significant interactions involving latent status, and the main effect for latent status was significant. All four variables were significant univariately as well. In the past month, consistent drinkers had consumed alcohol on more days in the past month, had consumed more drinks when they drank, had consumed more on 1 day, and reported more alcohol-related problems than had inconsistent drinkers.

Outcomes in young adulthood (W7)

A MANOVA with all W7 developmental outcomes and substance-use variables, along with the three independent variables, again found no significant interactions involving latent status. Few significant differences between categories emerged among the developmental outcomes (e.g., married, working, and college attendance); the only exception was that both abstainers and inconsistent drinkers had had fewer lifetime convictions than had consistent drinkers (Table 3). In contrast, the bulk of differences existed among the substance-use variables. Abstainers scored significantly lower than inconsistent drinkers, who were significantly lower than consistent drinkers, for the following variables: number of drugs ever used, past-month cigarette smoking, greatest

number of drinks in 1 day in the past month, and number of alcohol-related problems. Both abstainers and inconsistent drinkers scored significantly lower than consistent drinkers on number of days drinking in the past month and number of drinks in the past month.

Discussion

Using a longitudinal data set that covered 6 years of development, we modeled the individual-level alcohol-use patterns of a group of American Indian high school students across 3 years, providing a unique opportunity to complement work in this area that has to date focused on either a single tribe or a group of tribes assessed cross-sectionally (Beauvais et al., 2004; Costello et al., 2003). An important initial point is that almost one third of this young sample drank *no* alcohol at all during the 3-year period. Therefore, although adolescent alcohol use among American Indian youths receives considerable attention in both the scientific and popular presses, a substantial proportion of American Indian youths does not drink at all. We have found similar high rates of abstinence among American Indian adults as well (Beals et al., 2003). More generally, considerable stability in alcohol use or nonuse emerged across time—76% of the sample either never drank from W1 to W6 or had drunk at least something during each wave. But at the same time, change was evident in almost one quarter of the sample, as others have found (Cook and Moore, 2001; Kerr et al., 2002; Webb et al., 1991). Clearly, individual variation is important to consider. Tribal variation emerged as well, with SW youths consistently more likely not to have consumed alcohol than the NP youths. Again, we have found similar patterns with other problem behaviors (Mitchell and Beals, 1997; Mitchell et al., 1999, 2003).

One important outcome of this study is the demonstration of the concrete benefits of using LMMs. By taking into account both the measurement error and the influence of earlier drinking decisions on later drinking behavior, the LMM proved to be a very useful tool, further parsing in important and meaningful ways the large group of youths who would have been labeled inconsistent drinkers based only on their observed data. Youths who drink consistently are often of greatest concern for prevention and therapeutic interventions. However, using just the observed variables, we would have missed a sizable number of youths in the inconsistent drinker category whose drinking patterns were actually more like those in the consistent drinker category. At the same time, we were also able to identify a subgroup of observed inconsistent drinkers who might not have been of as much a concern, because their drinking patterns were more like the patterns of the abstainers.

Perhaps most important, however, is the finding of few differences among the drinking statuses at W7—6 years after data collection began—despite a number of differences among the statuses at W1. This may speak to what developmentalists refer to as "equifinality"—youths head toward adulthood along a variety of paths, but most arrive at a developmentally appropriate end point (Cicchetti and Rogosch, 1996). In effect, despite some rather troubling drinking patterns reported during adolescence—especially by the consistent drinkers group— youths did not differentially accomplish important developmental tasks of young adulthood. The latent statuses of adolescence were, however, strongly related to problematic substance use in young adulthood. Thus, alcohol-related interventions during adolescence that focus on future substance use and misuse could be important. Alternatively, 3-6 years after adolescence may be too short a period to uncover some of the more distal, non-substance-related effects of alcohol use; or the outcome measures used here—marriage, employment, education—may have been too molar, missing more subtle but important outcomes (e.g., the nature of a marriage partnership, type of employment, etc.). Also, use/nonuse per se may not be the critical variable that differentiates those with later challenges; instead, early use may initially lead to *problems,* which in turn lead to problematic outcomes a number of years later.

Limitations

In addition to issues of measurement, this study has several other limitations that help to place these findings in their appropriate context. Some reflect the nature of the sample. For example, this study began as a school-based study, thereby underrepresenting youths who were not attending high school—some of whom may have had the most serious issues with alcohol use. As a result, the degree of problems in young adulthood may have been underestimated. However, extensive community-based follow-up among those who were listed on the school rolls but not in school at the time of assessment helped to limit this bias. Another limitation of the sample was the inclusion of only two American Indian tribes; however, even this limited sampling provided evidence of the importance of considering tribal diversity.

Some limitations were methodological. The LMM was a single-indicator model, in which two latent classes were defined by just one dichotomous question at each time point. Traditionally, Markov models focus on moving from one "state" (e.g., no alcohol use) to a different "state" (alcohol use), often relying on dichotomous variables to define the states. However, more than two classes could have been used based on a categorization of either the quantity-of-use variable or the frequency-of-use variable. Yet even with just two latent classes, as used here, the model had many empty and small-sized cells, which threatened model convergence. Adding more categories to the dependent variable increased these problems dramatically; therefore, we used the dichotomous dependent variable. Multiple indicators could also allow for a more thorough estimation of the measurement model

(Langeheine and van de Pol, 2002), and such a model is the logical next step in understanding these transitions. One strength of this dependent variable, however, is that—unlike a number of other investigations of alcohol use—the timeframe of the question ("…in the past six months") exactly matched the timeframe of the assessments. In this way, we were able to avoid the common problem of asking, for example, about alcohol use in the past 3 months when the measurement period covered a longer period (e.g., annual data collection), leaving no way to know whether no use in the past 3 months also meant no use *at all* since the prior data collection period.

Finally, we used tribe and gender as covariates to understand initially how those variables were related to alcohol use patterns. However, this approach assumes that change among all participants was characterized by the same set of parameters (Bockenholt, 2002; Eid, 2002; Langeheine and van de Pol, 2000). Alternatively, we could have performed a multigroup analysis, allowing the parameters depicting the change process to vary by subgroup. Given the number of empty and small-membership latent statuses that emerged with the full sample, however, cutting the sample size even further would have exacerbated this problem and threatened model convergence, as noted above (Eid, 2002). However, we did stratify the MANOVAs with W1 and W7 variables by community. Although a few differences emerged in W1 predictors, no differences emerged with the W7 findings. Thus, in both communities, even the youths exhibiting the most problematic alcohol-use patterns showed worrisome outcomes in young adulthood only in the area of substance use.

Conclusions

We strongly recommend the use of latent Markov modeling as a way to understand more completely adolescent alcohol use—especially for identifying youths who are drinking inconsistently but may be of greater concern than are other youths with similar reported drinking patterns. We determined that both alcohol use and nonuse were quite stable across time; but we also found evidence of change. Moreover, despite some rather troubling drinking patterns as teens, especially among consistent drinkers, most of the youths had equally achieved important tasks of young adulthood. But more consistent patterns of use during adolescence *were* related to greater levels of substance use in young adulthood. These findings suggest that programs for more consistent drinkers in adolescence, targeting later alcohol and other drug use, may be a strategic use of often limited resources.

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