Published in final edited form as:

J Youth Adolesc. 2014 March ; 43(3): 437–453. doi:10.1007/s10964-013-0026-2.

Trajectories of Substance Use among Young American Indian Adolescents: Patterns and Predictors

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Abstract

Substance use often begins earlier among American Indians compared to the rest of the United States, a troubling reality that puts Native youth at risk for escalating and problematic use. We need to understand more fully patterns of emergent substance use among young American Indian adolescents, risk factors associated with escalating use trajectories, and protective factors that can be parlayed into robust prevention strategies. We used growth mixture modeling with longitudinal data from middle-school students on a Northern Plains reservation (Wave 1 *N*=381, *M* age at baseline = 12.77, 45.6% female) to identify subgroups exhibiting different trajectories of cigarette, alcohol, and marijuana use. We explored how both risk (e.g., exposure to stressful events, deviant peers) and protective (e.g., positive parent-child relationships, cultural identity) factors were related to these trajectories. For all substances, most youth showed trajectories characterized by low rates of substance use (nonuser classes), but many also showed patterns characterized by high and/or escalating use. Across substances, exposure to stress, early puberty, and deviant peer relationships were associated with the more problematic patterns, while strong relationships with parents and prosocial peers were associated with nonuser classes. Our measures of emergent cultural identity were generally unrelated to substance use trajectory classes among these young adolescents. The findings point to the importance of early substance use prevention programs for American Indian youth that attenuate the impact of exposure to stressful events, redirect peer relationships, and foster positive parent influences. They also point to the need to explore more fully how cultural influences can be captured.

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Research interests of all authors:

Substance use patterns among American Indian youth

Risk and protective factors for substance use and other health risk behaviors among American Indian youth

Author Contributions

NRW contributed to the conception and design of the study; assisted with the acquisition, analysis, and interpretation of the data; and participated in the preparation of the manuscript. NLA assisted with the analysis and interpretation of data; and participated in the preparation of the manuscript. CEK, CBC, CS, EMK, and CMM contributed to the conception and design of the study; assisted with the acquisition, analysis, and interpretation of the data; and contributed to the intellectual content of the manuscript. ACM contributed to the intellectual content of the manuscript. All authors read and gave final approval of the manuscript.

Keywords

American Indian; adolescence; substance use; developmental trajectories; Growth mixture model

Introduction

Substance use disorders are more prevalent among American Indians (AI) than among other racial/ethnic groups in the United States (Whitesell, Beals, Mitchell, Spicer, et al., 2007; Wu, Woody, Yang, Pan, & Blazer, 2011), and, as a result, substance use prevention in AI communities is an important part of the national public health agenda (U. S. Department of Health and Human Services, 2001). Substance use among AI youth often begins at earlier ages, with precipitous increases in initiation occurring between early and middle adolescence (Beauvais, Jumper Thurman, Burnside, & Plested, 2007; Indian Health Service, 2009; Whitbeck, Yu, Johnson, Hoyt, & Walls, 2008). Estimates of the size of these disparities vary across studies, across tribes, and by gender within tribes; but some of the highest rates of problems have been found consistently in Northern Plains (NP) reservation communities (Beals et al., 2003; Nez Henderson, Jacobsen, Beals, & The AI-SUPERPFP Team, 2005; Whitesell, Beals, Mitchell, Spicer, et al., 2007). The overall age-adjusted alcohol-related death rate for AIs and Alaska Natives (ANs) from 2002–2004 was more than six times higher than the U.S.-all-races rate for 2003(Indian Health Service, 2009). Moreover, alcohol-attributable deaths account for four times as many deaths among AI/ANs as in the U.S. general population (11.7% vs. 3.3%, respectively), with the highest rates observed in the Northern Plains region (Centers for Disease Control and Prevention, 2008).

A Developmental Perspective on the Roots of Substance Disparities

Research into the origins of substance use problems increasingly points to early adolescence as a critical period (National Institute on Alcohol Abuse and Alcoholism, 2004/2005). Close to one third of adolescents begin drinking by age 13 and 10%, by age 10 (Donovan, 2004; Grunbaum, Kann, & Kinchen, 2004); tobacco use often begins even earlier. Early use is associated with increased risk for substance use disorder later in life (Kunitz, 2008; Windle et al., 2008) and with a variety of concurrent problems that include risky sexual behavior, driving while intoxicated and motor vehicle accidents, school failure, cognitive deficits and alterations in brain morphology and activity, psychopathology, and antisocial behavior (Biglan, Brennan, & Foster, 2004; Windle et al., 2008). Links between early initiation and risk of disorder documented in other populations have also been found among AIs (Rodgers & Fleming, 2004; Whitesell, Beals, Mitchell, Manson, & Turner, 2009). Although the latter findings relied on retrospective accounts from older adolescents and adults, they converged with other evidence highlighting early adolescence as a critical window for substance use patterns.

Numerous studies have explored patterns of substance use development in general population samples of adolescents and young adults from the U.S. and other countries. These investigations have used a diverse set of alcohol, marijuana, and/or smoking measures; examined a variety of age periods; and implemented an array of analytical

strategies. Substantial variation has been reported in the number of distinct developmental patterns characterizing adolescent substance use. Some report few substance use trajectories, including a large normative group (low use, slight to moderate increases over time) and one or two smaller groups exhibiting more dramatic escalations in use (Flory, Lynam, Milich, Leukefeld, & Clayton, 2004; Li, Duncan, & Hops, 2001; Spaeth, Weichold, Silbereisen, & Weisner, 2010). Others report multiple trajectories, distinguished by varying levels of use at baseline and rates of change over time (Brook, Rubenstone, Zhang, & Brooko, 2012; Martino, Ellickson, & McCaffrey, 2009; Orlando, Tucker, Ellickson, & Klein, 2005; Van Der Vorst, Vermulst, Meeus, Dekovis, & Engels, 2009). Although important, these findings do not necessarily illuminate the substance use patterns that characterize AI adolescents.

In one of the few studies that specifically focused on AI youth, Cheadle and Whitbeck (2011) used growth mixture modeling (GMM) and found three alcohol use trajectory classes among AI youth in the Northern Midwest U.S. and Canada. Abstainers (64%) were characterized by nonuse across the study period; early-onset users (18%) began drinking around age 11 and showed steady increases in use to age 14; adolescent-onset users (18%) initiated a couple of years later (around 13) but showed rapid escalation in use. Problem drinking in later adolescence was five to nine times higher among the early- and adolescent-onset groups compared to the abstainer group, providing additional evidence of the critical role that early substance use plays in future patterns of maladaptive use. Cheadle and Sittner Hartshorn (2012) reported similar developmental patterns in their analysis of marijuana use trajectories in the same AI sample. Both studies also identified a number of risk factors related to the different trajectories.

The current study adds to this important literature on emergent substance use among AI youth. It did so by using longitudinal data collected during early adolescence on a Northern Plains reservation to identify common trajectories of use during this critical developmental period and explore factors that predicted which trajectories children will follow. Identifying factors that place young AI youth at risk for developing substance use problems as well as factors that promote healthier outcomes will be critical to the development of successful prevention and health promotion efforts in AI communities.

Risk and Protective Factors Related to Developmental Trajectories of Substance Use

Researchers trying to understand the potent impact of substance use in early adolescence within the general population have turned to developmental science for guidance in designing interventions, focusing on how the unique biological, social, cognitive, emotional, and identity processes at work in this period influence susceptibility to either the initiation or escalation of substance use. A number of intertwined developmental risk factors have been identified as having implications for emergent substance use patterns among White youth, but relatively little data exist about such risk factors among AI youth. In a recent study that did explore differential risk, Chen et al. (2012) used 2006–2009 data from the National Survey on Drug Use and Health (NSDUH) to examine correlates of binge drinking and illicit drug use separately in White and AI youth nationally. Delinquent peers and negative

perceptions of substance use were predictive of alcohol and drug use in both racial/ethnic groups, although those associations were weaker among AI youth. In contrast, the social bonding variables examined in this study (parental attachment, school attachment, parental disapproval of substance use, participation in extracurricular activities and health promotion programs) were predictive of alcohol and drug use among Whites but not among AI youth, although a direct comparison of the regression coefficients in each sample revealed that only parental disapproval of substances was a significantly stronger predictor among Whites compared to AI youth.

In this study, we focused on factors that have shown particularly robust relationships to substance use and explored their relevance among young AIs in a Northern Plains reservation setting. We developed a conceptual model, depicted in Figure 1, to capture this confluence of factors and serve as a guiding heuristic for our research on early adolescent substance use in AI communities.

Stressful life events

Stressful experiences are associated with increased susceptibility to substance use and misuse (Dawson, Grant, & Ruan, 2005; Dohrenwend, 2000), with the effects particularly potent early in life when cognitive, emotional, and social resources have not matured (LeMaster, Connell, Mitchell, & Manson, 2002). The role of stress in the development of substance use has received particular attention within AI populations, given high levels of both exposure to stressful events and trauma in many AI communities and the concomitant high levels of substance use problems (Szlemko, Wood, & Jumper Thurman, 2006). Stress has been clearly associated with greater risk of both initiation and escalation of substance use among AIs (Biafora, Warheit, Vega, & GIl, 2002; Majewska, 2002), and both the accumulation of significant stressors across childhood and recent exposure to stress predict subsequent onset of symptoms of substance disorder (Whitesell, Beals, Mitchell, Keane, et al., 2007). One study found the association between childhood stress and substance use problems to be largely explained by earlier initiation of substance use (Whitesell et al., 2009). We add to this literature by examining how exposure to stressful events impacts developing trends in substance use, once it is initiated.

One significant life event that has received particular attention in relation to risk for substance use is early puberty, and relationships between puberty and increased risk of substance misuse have been documented (Westling, Andrews, Hampson, & Peterson, 2008; Witt, 2007). This effect may be attributable to the biological and physiological transitions at puberty that impact the extent to which adolescents are willing to experiment with substances, the way their bodies process substances they ingest, and hormonal changes that influence emotion and behavior (Simon, Wardle, Jarvis, Steggles, & Cartwright, 2003; Windle et al., 2008; Witt, 2007). The effects of early puberty may also be social; the early maturation hypothesis (or adult status hypothesis) emphasizes the social consequences of precocious physical development (Biehl, Natsuaki, & Ge, 2007; Costello, Sung, Worthman, & Angold, 2007). According to this theory, increased risk of substance use is the result of developmental asynchrony – when physical maturation gets ahead of cognitive, social, and emotional maturation (Taga, Markey, & Friedman, 2006; van Jaarsveld, Fidler, Simon, &

Wardle, 2007). Early-maturing adolescents are drawn into older peer groups, where they have access to drugs, tobacco, and alcohol but lack the maturity to handle this exposure (Costello et al., 2007). Empirical reports have not only confirmed an association between early puberty and substance use among AI adolescents but also demonstrated that peer influences — including peer substance use, positive perceptions of substance-using peers, and involvement with the opposite sex — account for much of that association (Costello et al., 2007; Walls & Whitbeck, 2011).

Peer influences

Peer influences play a pivotal role in the early maturation hypothesis, but they also have a well-documented influence in substance use more broadly (Simons-Morton, Haynie, Crump, Eitel, & Saylor, 2001), including among AI youth(Cheadle & Sittner Hartshorn, 2012; Cheadle & Whitbeck, 2011). Deviant peers pose a risk at any age; but because of their relative cognitive, emotional, and physical immaturity, young adolescents are particularly susceptible to these influences. Less attention has surrounded the influence of prosocial peers. Affiliation with peers who are engaged in positive activities immerses young adolescents in social contexts that can support the development of personal strengths and exposes them to positive peer pressures that could reduce risk of substance problems. We know very little about the role these protective factors play in early adolescence, however, and virtually nothing about how they operate among AI youth. In this study, we examined both deviant and prosocial peer influences independently, not simply as two ends of a single continuum.

Parent-child relationships

The literature includes ample evidence linking parenting practices and the quality of parent-child relationships to adolescent outcomes (Barber, Stolz, & Olsen, 2005; Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2006). Parental monitoring and the quality of the parent-child relationships (particularly warmth and emotional support) have been shown to be particularly important (Eisenberg et al., 2005; Fletcher, Steinberg, & Williams, 2004). Scant literature has examined parent-child relationships within AI families in general and in relation to substance use in particular. Cheadle found evidence of a protective effect among AI and Canadian First Nations youth (Cheadle & Sittner Hartshorn, 2012; Cheadle & Whitbeck, 2011) while Chen et al. (2012) found no link between parental attachment among AI adolescents, although they did find an association among White adolescents. Work with other ethnic groups (e.g., Asian, Hispanic, and African American) suggests that both monitoring and relationship quality may have manifestations and implications that are somewhat unique (Chao & Tseng, 2002; Dixon, Graber, & Brooks-Gunn, 2008; Mason, Walker-Barnes, Tu, Simons, & Martinez-Arrue, 2004). Thus, it is important that we examine these effects specifically within an AI context if we are to understand their implications for AI youth.

Cultural Identity

Many argue that substance use problems in AI communities are linked to disengagement of AI people from their cultural heritages, the legacy of colonial policies, historical traumas, boarding schools, and forced deculturation (Szlemko et al., 2006). Engagement in cultural

practices and internalization of cultural values are purported to confer resilience, fostering the development of specific strengths (e.g., interdependence, courage) that serve as protective factors (Whitbeck et al., 2008). An example of this view is the indigenist stress-coping paradigm in which cultural factors are explicitly included as mediators of the link between exposure to stress and poor health outcomes, including substance use disorders (Walters, Simoni, & Evans-Campbell, 2002). One important reflection of culture in the lives of individuals is the integration of cultural identity within personal identity. The construction of a personal identity is a key task of adolescence (Erikson, 1968), and for AI youth, this entails the development of a sense of self as AI and the determination of how salient that ethnic or cultural identity will be for the self (Windle et al., 2008).

Assessment of cultural identity offers a way to quantify the internalization of culture for adolescents and, in turn, to examine how culture is related to substance use. In an attempt to capture the emergence of cultural identity among young adolescents, we focused on two components. First, *ethnic identity* is identification as a member of the cultural group (tribe) and the salience of that group membership to personal identity, which Phinney calls affirmation and belonging (Phinney & Ong, 2007). Second, *cultural engagement* is participation in tribal culture, adoption of cultural values, use of tribal language, etc. This component draws on the work of Oetting and Beauvais and parallels Phinney's behaviors and practices dimension of ethnic identity (Oetting & Beauvais, 1990–91; Phinney, 1992). In the current study, we explored how ethnic identity and cultural engagement each related to substance use patterns among young AI adolescents.

Hypotheses

The analyses presented here represent a first step at investigating the relationships depicted in Figure 1, specifically identifying *Emergent Substance Use Groups* and examining direct predictors of group membership (solid black lines in the figure). The three shaded boxes in Figure 1 – *gender*, *age*, and adult *substance use problems* (substance use problems among one or more important adult in the youth's life, herein referred to as adult substance use) – were conceptualized as control variables; ample evidence suggests that these factors influence adolescence substance use, but they are not the focus of inquiry here. The scope of adult substance use problems was not limited to problems among parents because of the prominence of the extended family in many AI communities. Mediator and moderator effects depicted in Figure 1 (dashed lines) will be examined in future analyses. We tested three initial hypotheses implicit in the model.

Our first hypothesis postulated the existence of *emergent substance use groups for alcohol, marijuana, and cigarettes*, with some groups reflecting high-risk patterns (high and/or escalating use) and others, healthier patterns (low use across early adolescence). This was based on the evidence reviewed above regarding patterns of early onset of substance use among some AI youth. Our second hypothesis was that membership in the higher-risk trajectory classes for each substance would be linked to exposure to stressful events, early puberty, and affiliation with deviant peers. Our third hypothesis was that membership in healthier trajectory classes for each substance would be linked to affiliation with prosocial peers, strong parent-child relationships, and cultural identity. The latter two hypotheses were

grounded in theory and empirical evidence relating risk and protective factors to substance use patterns among young AI youth, as reviewed above.

Method

Sample and Procedures

Both the original study and the secondary analysis project under which these analyses were conducted were reviewed and approved by the university IRB and the Research Review Board (RRB) overseeing research for the tribe within which these data were collected. In accordance with our agreement with the RRB, we protect the privacy of the tribe by not explicitly naming the reservation in publications or public presentations of findings but instead include only broad descriptive information about the tribe to provide context.

Participants were middle-school students on an AI reservation in the Northern Plains. The reservation is located in one of the poorest regions in the United States, with striking gaps in both income and education compared to the rest of the country. It is relatively remote, isolated from population centers, and characterized by small villages separated by great distances. Rates of substance use disorder among older adolescents and adults are elevated (Beals et al., 2005). It is also important to note that, at the time of the study, this reservation was “dry” – possession of alcohol on the reservation was illegal, placing it in the category of illicit drugs, such as marijuana.

Data were from a larger study involving all middle schools (n=14) across the reservation. Participating students completed surveys at their schools each semester from the spring of 2006 through the spring of 2009. The overall sample constituted 71% of the middle-school population on the reservation at Wave 1 (W1). A total of 81% of parents/guardians were located and asked to allow their children to participate; 98% of these provided consent; 90% of these youth then assented to participate (Kaufman et al., 2010). The subsample reported on here (N=381) included students attending seven of the participating schools that were randomly selected for this component of the study and data from only the first four waves of the study were analyzed (spring of 2006, fall of 2006, spring of 2007, and fall of 2007). Age, gender, and grade distributions for the study sample are shown in Table 1. Correlations among the substance use outcomes variables at W1 were significant and moderate in size; alcohol and marijuana use were correlated more strongly (r=.52) than were either alcohol and cigarette use (r=.41) or marijuana and cigarette use (r=.36).

Measures

Substance Use—Alcohol, marijuana, and cigarette use served as the outcomes in this analysis. Because alcohol use among youth tends to be intermittent (particularly on a dry reservation), combined with findings suggesting that heavy-quantity drinking (chronic or irregular) is an important indicator of problematic alcohol use, we selected maximum number of drinks rather than average frequency or quantity of alcohol use as the alcohol outcome in this analysis (Greenfield & Kerr, 2008; NIAA, 2003). Alcohol use at each wave of the study was assessed with the question, *During the past month, what was the most you had to drink in any one day?* Participants who reported no past-month alcohol use received a

value of zero. To correct for a positive skew in the distribution, we grouped responses into four levels: 0 (no past-month use), 1 (1–2 drinks), 2 (3–4 drinks), or 3 (5 or more drinks). Marijuana use was assessed as the number of times marijuana use was reported in the past month. As with alcohol, marijuana use was positively skewed, and we grouped responses: 0 (no use), 1 (used 1–2 times), 2 (3–4 times), or 3 (5 or more times). Current smoking was assessed with the question, *Do you smoke cigarettes?* Response options included not at all, once in a while but not every day, 1–5 cigarettes per day, 6–10 cigarettes per day, 11–20 cigarettes per day, and more than a pack a day. Few participants smoked more than 10 cigarettes per day, so we recoded this variable as follows: 0 (not at all), 1 (once in a while), 2 (1–5 per day), and 3 (6 or more per day).

Stressful Life Events—Life stress was assessed by asking about the lifetime occurrence of a series of negative events. We classified events as either *traumas* (threatened by gang violence, important person attempted suicide, important person committed suicide, involved in a serious car accident, witnessed violence between family members, or physically attacked by a non-family member), *major childhood disruptions* (entered a new school, repeated a grade in school, placed in foster care, put up for adoption, moved in with relatives because of family problems, an important adult had a drug/alcohol problem, or had a serious illness), or *deaths of significant others* (mother/female guardian, father/male guardian, sibling, grandparent, other family member, close friend, or someone else). The number of events reported in each category were used as observed indicators of a latent life stress construct in the analytic models. Correlations among the three measures of stressful life events ranged from .19 to .52 (ps ≤.001).

Early Puberty—Early puberty was a dichotomous variable, with adolescents classified as either having experienced early puberty or not having done so. Girls were classified as having started puberty early if they reported that they were younger than 12 years of age when they had their first menstrual period. Boys were classified as having started puberty early if, before they reached the age of 14, they reported that, compared to when they were in the 4th grade, their voice changed *a lot* or *a whole lot*.

Peer Influences—One measure of peer affiliations focused on deviant peers and one, on prosocial peers. The former was assessed based on self-report of the number of friends who encouraged disobeying parents, encouraged dangerous behavior, got in trouble at school, and got into a lot of fights. These items served as indicators of a latent factor representing deviant peer influence. A prosocial peer factor, likewise, was reflected by the number of friends who volunteered or participated in community groups, went to Inipi (sweat/ceremony) or church regularly, thought schoolwork was very important, and planned to go to college. Response options for all items ranged from *none* (scored 1) to *almost all or all* (scored 5). Scores on both the deviant peer and prosocial peer influence measures ranged from 1 to 5, with higher scores reflecting greater involvement with peers of that type. Cronbach's alpha was .69 for the deviant peers measure and .63 for the prosocial peers measure. The measures were uncorrelated with each other (r=−.04, *ns*).

Parent-Child Relationship—Four measures were used to assess the quality of the parent-child relationship: *maternal warmth*, *paternal warmth*, *parent-child communication*, and *shared activities*. These four components served as indicators of an overall parent-child relationship factor in models predicting substance use trajectory classes. *Maternal warmth* was based on participants' ratings of how often their mother/female guardian enjoyed doing things with them, cheered them up when they were sad, gave them a lot of care and attention, and often praised them. *Paternal warmth* was based on participants' ratings of how often their father/male guardian engaged in the activities listed above. Responses to all warmth items were classified as either *not at all*, *sometimes*, or *a lot*. Total maternal and paternal warmth scores ranged from 1 to 3, with higher scores reflecting greater warmth. Preliminary factor analysis indicated the importance of retaining separate measures for maternal and paternal warmth. *Parent-child communication* was based on a parallel set of three items assessing the frequency with which participants talked with their mother/female guardian and the frequency with which they talked with their father/male guardian about how things were going with their friends, their plans for the future, and problems they were having in school. Response options ranged from *never* to *almost every day/every day*. Scores on the six-item measure of parent-child communication ranged from 1 to 5 and higher scores reflected higher levels of communication. Communication with mother and father were combined into a single measure based on preliminary factor analyses indicating a single factor of communication with parents. The final parent-child measure, *shared activities*, was an assessment of shared activities between parents and children based on responses to a parallel set of items asking whether participants engaged in six activities with their mother/female guardian and with their father/male guardian: going shopping, attending church, a spiritual event or a cultural event, talking about a party they attended, talking about a personal problem, talking about school, and going for a walk. One point was assigned to each activity, resulting in a score range of 0 to 12. As with communication, preliminary factor analyses led us to create a combined shared activities scale, rather than separate scales for mothers and fathers. Cronbach's alpha was .86 for the parent-child communication measure, .77 for maternal warmth, and .81 for paternal warmth (shared activities between parent and child was an index and therefore internal consistency was not assessed). Correlations among the four measures of parent-child relationship ranged from .47 to .54 (all ps <.001).

Cultural Identity—We assessed identification with AI cultural identity on two dimensions. The first assessed *ethnic identity*, using three items: a) Being a part of my tribe or cultural group is important to me, b) I have a lot of pride in my tribe or cultural group, and c) I feel good about my cultural and tribal background. These three items were included as indicators of a latent ethnic identity factor in predictive models. The second factor, *cultural engagement*, was indicated by two items that assessed participation in AI cultural practices and traditions: a) I speak or am learning to speak my tribal or cultural language and b) I listen, sing, or dance to traditional music. Responses on both measures ranged from strongly disagree (scored 1) to strongly agree (scored 4); higher scores reflected greater cultural identification. Cronbach's alpha was .75 for the three-item ethnic identity measure and .46 for the two-item cultural engagement measure. The ethnic identity and cultural engagement

measures were correlated .47 (p<.001) at Wave 1, a magnitude consistent with related but distinct measures.

Analyses

We completed all variable construction and descriptive analyses in SPSS v.20. We used Mplus v. 7 (Muthén & Muthén, 1998–2012) to conduct growth mixture modeling (GMM), with type=complex to adjust for clustering by school and to conduct multinomial logistic regressions. GMM is used with longitudinal data to classify unobserved heterogeneity in growth trajectories within a population. We conducted separate analyses to examine trajectories of past-month alcohol use, past-month marijuana use, and current cigarette use in our sample of AI adolescents. We used confirmatory factor analysis to define measurement models for each construct prior to using these constructs in multinomial logistic regression models, which predicted class membership from the constructs in our conceptual model (see Figure 1). We first conducted separate multinomial regression analyses for each substance and each predictor, controlling for participant gender and age, in order to examine associations between each theoretical construct and class membership.[1] We conducted a final set of multinomial regressions models (one each for the alcohol, marijuana, and cigarette trajectory classes) that simultaneously estimated the effects of all constructs found to be significant in separate predictor models.

Results

Sample Characteristics

Table 1 presents descriptive data on sample demographics and socioeconomic characteristics, substance use outcomes at all four waves, and W1 measures of model constructs. Males were slightly overrepresented in the sample. Mean age was 12.77 years (SD=1.04) and nearly two thirds were in the 6th grade. Reports of socioeconomic hardship among youth were common; nearly one quarter reported that their household sometimes or often didn't have enough money for food, heat, or electricity in the past year and nearly 60% reported currently receiving food stamps.[2] Overall, nearly one third of the sample started puberty early, with similar rates among boys and girls. The majority of youth in this sample reported experiencing one or more deaths of a significant other, a non-fatal trauma event, or another major life event. Adolescents generally reported high levels of parent-child relationship quality and ethnic identification and higher prosocial peer influences than deviant peer influences. Approximately one quarter of the sample (22%) reported past-

[1]We initially included a third control variable—adult substance use problems. Cheadle and colleagues found strong relationships between adult substance use and adolescents' trajectories of early use (Cheadle & Sittner Hartshorn, 2012; Cheadle & Whitbeck, 2011). As anticipated, the effects of adult substance use problems on class membership were strong and significant, especially for alcohol and marijuana use (odds ratios ranged from 1.35 – 4.18). However, the inclusion of this variable had only a trivial impact on the direction and magnitude of associations between class membership and the other covariates, and missing data on the adult substance variable resulted in the loss of approximately 100 cases from each analysis. Therefore, we chose to exclude adult substance use from the analyses reported here in order to preserve power and precision for the remaining parameter estimates.

[2]Youth's responses to the socioeconomic items generally converged with reports from a subsample of parents in this population, although youth tended to underestimate final hardship relative to their parents (except for reports of food stamps, which were nearly identical). Given this correspondence, combined with the fact that only a small subsample of parents provided data, we chose to present the socioeconomic data reported by youth rather than parents.

month alcohol use at W1; 24% reported smoking marijuana at least once in the past month; and 41% reported current smoking at W1.

Identifying Classes with Divergent Trajectories of Substance Use

We compared trajectory models (linear, non-linear, quadratic) and one-, two-, three-, and four-class solutions to identify best-fitting models for alcohol, marijuana (count variables, Poisson distribution), and cigarettes (continuous).[3] For each substance, we sought the solution with optimal fit statistics (minimizing Log-likelihood and Bayesian Information Criteria [BIC] values), high classification quality (entropy), and interpretable classes. We rejected solutions with very small class sizes (< 5% of the sample), due to the likely instability of such solutions.

Table 2 summarizes the selection criteria for the one- to four-class solutions within the best-fitting trajectory model for each substance: linear for alcohol (Poisson distribution) and cigarettes (continuous distribution); non-linear for marijuana (Poisson distribution). The three-class solution provided the best fit for each substance. For example, the three-class linear solution for alcohol resulted in an improvement in both the Log-likelihood and BIC values relative to the two- and four-class linear solutions, without a substantial decrement in entropy. For the non-linear marijuana model, the three-class solution was associated with an improvement in the Log-likelihood relative to the two-class solution and was more stable and interpretable than the four-class solution, which had zero cases in one class. Finally, fit statistics for the three- and four-class linear solutions for cigarette use were substantially better than those for the corresponding two-class solution without suffering a loss in classification quality. We selected the three-class solution because fewer than 5% of cases were assigned to one of the classes in the four-class solution.

The trajectories for the three alcohol, marijuana, and cigarette use classes are shown in Figures 2–4. The largest class for alcohol (n=259, 62%), marijuana (n=234, 58%), and cigarettes (n=265, 62%) represented nonusers. Youth in those classes reported no or little substance use at W1 (intercepts of .05,.03, and .07, respectively) and either maintained a pattern of non-use or showed only a small positive upward trend in use over the course of the study (alcohol slope=.34, marijuana slope=1.38, cigarette slope=.14). We refer to these as the *nonuser* classes. For alcohol, a second class (n=52, 12%) showed a pattern of little or no alcohol use at the beginning of the study period (intercept=.04) followed by an initial gradual increase and a later precipitous escalation in use (slope=3.33, see Figure 2); we refer to this as the *alcohol starter* class. At the end of the study period, youth in this class reported an average maximum consumption of approximately two drinks on a given day in the past month. A third alcohol class (n=106, 25%) reported a maximum consumption of nearly 3–4 drinks at W1 (intercept=1.7) and exhibited a small increase in this level over the duration of the study period (slope=1.08); this was the *alcohol user* class. Similar groups of *marijuana starters* (n=67, 17%, intercept=.21, slope=2.43) and *marijuana users* (n=104, 26%,

[3]We evaluated both continuous and categorical models for the cigarette use outcome. Fit statistics for the one- and two-class categorical models were somewhat improved over the corresponding continuous models. However, we encountered estimation problems with the three- and four-class categorical models. As such, we chose to use the continuous models, which permitted exploration of a larger number of classes.

intercept=1.96, slope=1.01) were identified (Figure 3); the trajectories for these groups were very parallel to those for alcohol groups. The remaining two classes identified with regard to cigarette use, however, had trajectories quite distinctive from those for alcohol and marijuana use (see Figure 4), undoubtedly reflecting, at least in part, the different metrics for reports of cigarette use. A group of *occasional smokers* (n=131, 30%) was characterized by a consistent pattern of intermittent use (*once in a while, but not every day*) over the study period (intercept=.97, slope=.01). Another group (n=35, 8%) reported daily cigarette smoking at W1 followed by a gradual decline to intermittent, non-daily use by the end of the study period (intercept=2.14, slope=−.28); we refer to this group as the *experimental smokers*.

Given previous evidence of the strong relationships among risk for use of these three substances (and other substances), we were curious about the extent to which the three classes within each substance were populated by the same adolescents. Crosstabulation of class membership revealed considerable alignment across the nonuser classes. At the low-risk end of the spectrum, 40% of adolescents were in the nonuser class for all three substances and an additional 22% were in the nonuser class for two of the three substances (9% for alcohol and marijuana; 8% for alcohol and cigarettes, and 6% for marijuana and cigarettes). The remaining 38% of adolescents showed patterns that included membership in discrepant risk classes across substances; for example, 12% were in both the *alcohol user* and *marijuana user* classes but were split across the *experimental smoker* (4%) and *occasional smoker* (8%) classes.

Examining Predictors of Class Membership

Table 3 presents results of multinomial logistic regression analyses predicting class membership for each substance. In each analysis, the reference class was the nonuser group and the coefficients represent the change in the odds of membership in a given class (relative to the nonuser class) associated with a one-unit increase in scores on the predictor variable. For alcohol use, older age and early puberty significantly increased the odds of classification in the starter class relative to the nonuser class, whereas female gender, higher levels of deviant peer influences, and increased life stress increased the odds of being classified as an alcohol user compared to a nonuser. Female gender, older age, increased life stress, and greater deviant peer influence significantly increased the odds of classification in the marijuana starter class relative to the nonuser class. The interaction of early puberty and gender was also significant; counter to findings in the literature, early maturing boys were at increased risk of being in the marijuana starter class (rather than nonuser), whereas early maturing girls were not (early puberty was not related to risk of being in the marijuana user class). Membership in the marijuana user class was significantly associated with increased life stress and older age. For smoking, female gender, increased life stress, and poorer parent-child relationship quality significantly increased the odds of classification in the experimental cigarette user class relative to the nonuser class. Female gender and increased life stress also predicted membership in the cigarette user class, along with higher levels of deviant peer influences.

Discussion

The current study sought to understand better the nature and correlates of substance use patterns among young AI youth in an attempt to identify important windows for intervention as well as critical focal points for intervention efforts. Toward that end, we used longitudinal data from middle-school students living on a Northern Plains reservation to evaluate several hypotheses about trajectories of substance use in early adolescence and the contextual factors associated with those trajectories.

Emergent Substance Use Groups

Our first hypothesis was that subgroups of young adolescents would exhibit distinct emergent substance use patterns, with some reflecting high-risk patterns (high and/or escalating use) and others, healthier patterns (low use across early adolescence). We found clear evidence of such patterns. For alcohol use, the classes we identified were similar to those found by Cheadle and Whitbeck (2011) in a sample of indigenous adolescents in the U.S. and Canada that were linked clearly to differential risk for later substance disorder in that sample. This similarity in findings is particularly striking given the different metrics of alcohol use we employed. We focused on quantity of alcohol (highest quantity on any one day) in the past month, while they focused on frequency over the past year. Moreover, we investigated alcohol use among youth ranging in age from 11 to 15 at W1 and followed them for approximately two years, whereas Cheadle and Whitbeck studied a cohort that aged from 10 to 14 over the observation period. Thus, while the trajectories themselves were not identical, the essential similarity of the classes is undeniable and suggests that the classes characterize robust patterns of emerging alcohol use that are, in turn, predictive of later substance problems.

The trajectories we identified for marijuana use closely paralleled those we found for alcohol use and those identified by Cheadle and Sittner Hartshorn (2012). Across these two substances, *user*, *starter*, and *nonuser* classes showed similar growth curves and were of similar size. The overlap of class membership across these classes was extensive; 69% of adolescents were in the same classes for alcohol and marijuana use. The primary distinction between the class trajectories for alcohol and marijuana was that the *marijuana starter* class was characterized by earlier escalation of use (between W2 and W3) than was the *alcohol starter* class (escalating use after W3). This finding is consistent with our previous analysis of substance use initiation in this sample, using discrete-time survival analyses, that showed earlier and greater risk for marijuana initiation compared to alcohol initiation (Whitesell et al., 2012). We do know from other studies that early marijuana initiation is a substantial risk factor for later problematic use and disorder (Whitesell et al., 2009); both the marijuana *users* and *starters* are likely to be at elevated risk and, thus, important targets for intervention efforts.

The trajectory groups identified for cigarette use were distinct, likely a reflection not only of the different scales of measurement for cigarette use compared to alcohol and marijuana use but also of different ways these substances are used and their relatively availability. Binge drinking, for example, does not have a parallel in binge smoking; also the altered mental state accompanying alcohol or marijuana use is more pronounced than that accompanying

cigarette use. In addition, both alcohol and marijuana were illegal on the reservation when this study took place and the relative availability of cigarettes likely supported a pattern of more consistent periodic use. One cigarette class was analogous to the *nonuser* classes for both alcohol and marijuana use, characterized by low risk of use across early adolescence. Most adolescents were in this class, and many of these were also in the *nonuser* classes for alcohol and/or marijuana. The other two classes identified based on cigarette use trajectories, however, were quite distinct from those found for alcohol and marijuana. The *occasional smokers* made up a large minority of adolescents (about 30%) and exhibited infrequent but consistent use across early adolescence. The smaller group (about 8%) of *experimental smokers* started at W1 with more frequent use that then tapered off over time to approximate the use of the *occasional smokers*. These groups are intriguing and were not what we anticipated. It is less clear what implications they might have for subsequent substance use problems and disorder, but it is clear that even chronic occasional cigarette use can have deleterious health implications for these adolescents and intervening to abate use is an important goal.

Predictors of Class Membership

Our subsequent analyses assessed predictors of class membership. First, we examined the effects of demographic factors (gender and age). These factors were conceptualized as control variables, expected to be related to trajectory classes but not of primary interest in this study. Given the narrow age range that was the focus of this study (64% of participants were 12 to 13 years old at W1), we did not expect age to have a striking effect; instead, we expected the change over time within individuals – evident in the growth trajectories – would capture most of the development change that was occurring. As expected, older age at W1 was generally related to membership in risk classes (as compared to nonuser classes), but these effects were significant for only half of the parameters (both classes for marijuana, the *starter* class only for alcohol, and neither class for cigarettes).

While gender was also conceptualized primarily as a control variable, it is worth greater discussion here. In general, girls were less likely than boys to be in the *nonuser* classes for all three substances, but which risk classes they were likely to be in varied by substance – more likely to be alcohol *users*, marijuana *starters*, and both *experimental* and *occasional smokers*. These gender effects are somewhat counter to general findings of higher substance use and disorder risk among males compared to females. But they are consistent with the patterns observed in recent work Cheadle and colleagues (Cheadle & Whitbeck, 2011; Cheadle & Sittner Sittner Hartshorn, 2012; Walls, 2008) as well as our own findings on early initiation of substance use on this reservation: Girls' risk for initiation escalated earlier than did boys' across substances (Whitesell et al., 2012). Such early risk among girls may explain the lack of large gender differences in adult substance disorder within this tribe, where women's rates have been found to be much closer to men's rates than in the U.S. population more generally or than in other AI populations (Beals et al., 2005; Whitesell, Beals, Mitchell, Spicer, et al., 2007).

Although investigation of the mechanisms by which female gender confers risk for early substance use behaviors is beyond the scope of this paper, it is a central focus of

supplemental analyses that are currently underway with this dataset. The results of those analyses, which test the mediational and moderating pathways postulated in Figure 1, will go a long way toward elucidating the nature of the associations identified here, including a better understanding of the processes that lead young girls in this community on a path of escalated substance use. For now, the present findings suggest the importance of recognizing that girls on this reservation are at significant risk for developing substance problems and that early prevention efforts need to address the unique challenges they face in early adolescence. Understanding the patterns and risk factors in early adolescence and how they vary across gender will be important to intervening to reduce risk for both males and females.

Our second hypothesis was about covariates that would be predictive of membership in more substance-involved classes across substances. Higher exposure to *stressful events*, indications of *early puberty*, and affiliation with *deviant peer*s were all expected to be associated with *user* and *starter* classes for alcohol and marijuana and with *occasional* and *experimental smoker* classes. We found greater support for some of these effects than for others in the final models. Stressful life events were generally associated with increased risk of membership in the use classes across all three substances, and these effects remained significant when all covariates were included in the model. Significant effects were found for both risk classes for both marijuana and cigarettes, and for the users class for alcohol. These findings are consistent with the results of other investigations of the context of substance use among AI youth (Cheadle & Sittner Hartshorn, 2012; Cheadle & Whitbeck, 2011). Early puberty was likewise consistently associated with an increased likelihood of being in the risk classes. In the final multivariable analyses, early puberty was significantly associated with membership in both alcohol risk classes for both boys and girls (no gender by early puberty interaction was found); with membership in the marijuana *starter class*, but only for boys (significant gender by early puberty interaction); but not with either risk class for cigarettes. We were somewhat surprised that reports of deviant peer relationships were not more consistently linked to class membership, as it is a risk factor with strong and consistent links to substance use among AI youth (Cheadle & Sittner Hartshorn, 2012; Chen, Balan, & Price, 2012; Walls & Whitbeck, 2011). Although all the effects were in the same direction, only the *alcohol user*, *marijuana starter*, and *occasional smoker* classes were predicted by deviant peers when all covariates were in the model. In interpreting these findings, we are drawn back to our original conceptual model, positing mediating and moderating effects, with complex interplay among these risk factors. Our next step will be to expand these analyses to include modeling these effects, to determine whether the inconsistent patterns we identified here reflect these interrelationships.

Our third and final hypothesis suggested protective factors that would be associated with reduced risk of membership in the use classes and, conversely, increased likelihood of being in the nonuser classes. These hypothesized protective factors were affiliation with *prosocial peers*, strong *parent-child relationships*, and greater *cultural identity*. As with the risk factors just discussed, we obtained some interesting – and sometimes puzzling – findings when we included all the significant univariate covariates in the final models. To begin with, while prosocial peers were significantly associated with lower risk of being in the *user* or *starter* classes for alcohol and marijuana when included in analyses with only the control variables

(gender and age), the effects became nonsignificant when entered along with the other covariates in the final analyses. A similar pattern was observed for the parent-child relationships; only one significant effect of the parent-child relationship remained significant in the final multivariable analysis (less risk of being an *experimental smoker*). As suggested above, further analyses modeling the precise mediating and moderating pathways predicted by our model of emergent substance use will help to illuminate the mechanisms behind these patterns.

The story for cultural identity was somewhat different. Only one of the two cultural identity measures – cultural engagement – was significantly related to class membership and only to cigarette use class. The effect became nonsignificant in the multivariate analysis. This finding is consistent with previous work showing little or no relationship between cultural identity and substance use among AI adolescents (Markstrom, Whitesell, & Galliher, 2011; Whitesell, Spicer, & Mitchell, 2005). These types of findings continue to baffle both researchers and community partners because cultural effects are so strongly predicted in qualitative data. We suspect that the failure to find associations between cultural identity and substance use risk trajectories may reflect the developmental context in which we are trying to understand emergent substance use. In addition, the tools we have for measuring nascent cultural identity are limited as well. We attempted to measure the impact of culture via its role in shaping the identities of young adolescents and, thus, infusing their lives. However, these adolescents were just on the cusp of developing the cognitive wherewithal to explore their identities; in identity theory terms, they were most likely still in a period of diffuse identity, having not yet begun the process of identity exploration. It is not surprising, then, that our attempts to assess the impact of culture on substance use risk by asking young adolescents about their own ethnic identity were met with little success.

We attempted to address this conundrum in this study by separating items relating to cultural engagement from items more closely aligned with ethnic identity, and it was the cultural engagement items that showed glimmers of relationships. However, it may be important to look at identity and culture through a broader lens, since youth function in and are influenced by both AI and non-AI settings. In moving forward, it will be important to articulate a more nuanced model of the impact of culture on emergent substance use and developing measures that can assess the cultural context that shapes behavior in children and young adolescents in ways that are reliable and valid for AIs (Markstrom et al., 2011).

Limitations, Implications for Prevention, and Directions for Future Research

AI communities exhibit tremendous variability in rates of adult substance use and substance use disorder; while we know less about variability in adolescent substance use across tribal communities, we assume that there is parallel diversity. It is critical to remember, therefore, that this study explored early substance use patterns and risk and protective factors within a single cultural context – a Northern Plains reservation with high rates of both adolescent and adult substance use and disorder – and should not be seen as indicative of patterns in other AI communities, particularly those with a lower prevalence of adult substance use problems (e.g., as documented in one Southwest tribe; Beals et al., 2003). These findings also reflect only trajectories of use among Northern Plains adolescents living on their reservation (where

alcohol use or possession, along with use and possession of marijuana, were illegal). Generalizations should not be made to use among AI youth in urban settings or other non-reservation settings. Given the increasing numbers of AI youth growing up off-reservation, it will be important to examine early risk for substance use within urban contexts.

In addition, the trajectories examined here, and thus the classes identified, reflect patterns of use only in early adolescence. They do not speak to where those trajectories lead in later adolescence or adulthood and we cannot assume that the groups identified move forward in a stable or consistent manner. While it is critical to identify these early patterns to help inform prevention efforts at a critical time of transition and risk for young adolescents, it is also important to remember that these data represent a relatively narrow developmental period.

Exposure to cultural practices may also be an important protective factor, but our findings (and those of many researchers before us) are inconclusive in this regard. If we are to move this work forward, we must make concerted efforts to clearly articulate a model of how culture influences development – both in terms of reducing risk and in terms of promoting positive development. It is not enough to assert that culture matters, that it has a positive effect; we must gain clarity on why it matters, how it has an impact, what aspects of culture are protective. And in articulating this model, we must pay close attention to the interplay of culture and development if we are to understand how cultural practices might be used to intervene in development to steer it along positive, rather than risky, paths. Such a model can help define the critical research questions, guide the development of appropriate measures of cultural influences, and focus efforts to identify how culture might be brought to bear to enhance the effectiveness of prevention efforts for AI youth and communities.

Conclusions

These limitations notwithstanding, the findings from this study revealed important information about the substance use patterns characterizing a sample of young AI adolescents from a Northern Plains reservation and the contextual factors that are associated with those patterns. In general, being older, female, experiencing stressful life events (including early puberty) and associating with deviant peers were predictive of the more risky substance use trajectories. In addition, some evidence was obtained for the role of prosocial peer influence and positive parenting experiences in promoting healthier trajectories. These findings are important for our understanding of adolescent development and the ways in which adolescents' maturational processes, along with social and cultural contexts, impact risk for early substance use, which can derail normative development and lay the foundations for significant substance use problems in late adolescence and adulthood. Specifically, these findings are important for understanding the nature of those impacts among AI youth, who, as a group, are at elevated risk for a variety of challenges to successful development. We believe that the findings presented here can serve several important roles in informing successful prevention efforts. First, they can help target groups for whom prevention efforts are most likely to be effective – namely children exposed to significant numbers of life stresses and those who experience early pubertal transitions (especially boys). Second, they can help identify optimal timing of prevention efforts –

before rapid escalation in use takes hold. Our findings suggest that prevention should occur at or before the transition to adolescence, early in middle school or late in elementary school. Third, they can suggest protective mechanisms that can be capitalized on to reduce risk, such as prosocial peer networks and strong parent-child relationships.

Acknowledgments

We thank the schools and the tribal community in which these data were collected for their ongoing support, and the parents, guardians, and youth who gave so generously of their time to complete the surveys. We are grateful for the thoughtful guidance of the EAST Council, our community advisory board, who provided invaluable insights into the interpretation of findings within the local context. This project reflects the dedicated work of project staff, led by Jennifer Desserich, Angela Sam, and Cindy Wheeler, without whom the extensive data collection necessary to this longitudinal project would not have been possible. We appreciate Jacob Cheadle's input on our analytic design. This research was funded by the National Institute on Drug Abuse (R01 DA027665) and the National Institute of Mental Health (R01 MH069086).

References

Barber BK, Stolz HA, Olsen JA. Parental support, psychological control, and behavioral control: Assessing relevance across time, culture, and method. Monographs of the Society for Research in Child Development. 2005; 70:1–137.

Barnes GM, Hoffman JH, Welte JW, Farrell MP, Dintcheff BA. Effects of parental monitoring and peer deviance on substance use and delinquency. Journal of Marriage & the Family. 2006; 68:1084–1104.

Beals J, Novins DK, Whitesell NR, Spicer P, Mitchell CM, Manson SM. The AI-SUPERPFP Team. Prevalence of mental disorders and utilization of mental health services in two American Indian reservation populations: Mental health disparities in a national context. American Journal of Psychiatry. 2005; 162(9):1723–1732. [PubMed: 16135633]

Beals J, Spicer P, Mitchell CM, Novins DK, Manson SM. The AI-SUPERPFP Team. Racial disparities in alcohol use: Comparison of two American Indian reservation populations with national data. American Journal of Public Health. 2003; 93(10):1683–1685. [PubMed: 14534221]

Beauvais F, Jumper Thurman P, Burnside M, Plested B. Prevalence of American Indian adolescent tobacco use: 1993–2004. Substance Use and Misuse. 2007; 42:591–601. [PubMed: 17558952]

Biafora FA, Warheit GJ, Vega WA, GIl AG. Stressful life events and changes in substance use among a multiracial/ethnic sample of adolescent boys. Journal of Community Psychology. 2002; 22(4):296–311.

Biehl MC, Natsuaki MN, Ge X. The influence of pubertal timing on alcohol use and heavy drinking trajectories. Journal of Youth and Adolescence. 2007; 36:153–167.

Biglan, A., Brennan, PA., Foster, SL. Helping adolescents at risk: Prevention of multiple problem behaviors. New York: Guilford; 2004.

Brook JS, Rubenstone E, Zhang C, Brooko DW. Maternal predictors of comorbid trajectories of cigarette smoking and marijuana use from early adolescence to adulthood. Addictive Behaviors. 2012; 37:139–142. [PubMed: 21968229]

Centers for Disease Control and Prevention. Alcohol-attributable deaths and years of potential life lost among American Indians and Alaskan Natives – United States, 2001–2005. Morbidity and Mortality Weekly Report. 2008; 57(34):938–942. [PubMed: 18756193]

Chao, R., Tseng, V. Parenting of asians. In: Bornstein, MH., editor. Handbook of parenting: Vol. 4 Social conditions and applied parenting. 2. Mahwah, NJ: Lawrence Erlbaum Associates; 2002. p. 59-93.

Cheadle JE, Sittner Hartshorn KJS. Marijuana use development over the course of adolescence among North American indigenous youth. Social Science Research. 2012; 41:1227–1240. [PubMed: 23017929]

Cheadle JE, Whitbeck LB. Alcohol use trajectories and problem drinking over the course of adolescence: A study of North American indigenous youth and their caretakers. Journal of Health and Social Behavior. 2011; 52(2):228–245. [PubMed: 21558489]

Chen J, Balan S, Price RK. Association of contextual factors with drug use and binge drinking among white, Native American, and mixes-race adolescents in the general population. Journal of Youth and Adolescence. 2012; 41:1426–1441. [PubMed: 22791181]

Costello EJ, Sung M, Worthman C, Angold A. Pubertal maturation and the development of alcohol use and abuse. Drug and Alcohol Dependence. 2007; 88S:S50–S59.

Dawson DA, Grant BF, Ruan WJ. The association between stress and drinking: Modfiying effects of gender and vulnerability. Alcohol and Alcoholism. 2005; 40(5):453–460. [PubMed: 15972275]

Dixon SV, Graber JA, Brooks-Gunn J. The roles of respect for parental authority and parenting practices in parent-child conflict among African American, Latino, and European American families. Journal of Family Psychology. 2008; 22:1–10. [PubMed: 18266527]

Dohrenwend BP. The role of adversity and stress in psychopathology: Some evidence and its implications for theory and research. Journal of Health and Social Behavior. 2000; 41(1):1–19. [PubMed: 10750319]

Donovan JE. Adolescent alcohol initiation: A review of psychosocial risk factors. Journal of Adolescent Health. 2004; 35:529, e527–518.

Eisenberg N, Zhou Q, Spinrad TL, Valiente C, Fabes RA, Liew J. Relations among positive parenting, children's effortful control, and externalizing problems: A three-wave longitudinal study. Child Development. 2005; 76:1055–1071. [PubMed: 16150002]

Erikson, EH. Identity: Youth and crisis. New York: Norton; 1968.

Fletcher A, Steinberg L, Williams M. Parental influences on adolescent problem behavior: Revisiting Stattin and Kerr. Child Development. 2004; 75:781–796. [PubMed: 15144486]

Flory K, Lynam D, Milich R, Leukefeld C, Clayton R. Early adolescent through young adult alcohol and marijuana use trajectories: Early predictors, young adult outcomes, and predictive utility. Development and Psychopathology. 2004; 16(1):193–213. [PubMed: 15115071]

Grunbaum JA, Kann L, Kinchen S. Youth Risk Behavior Surveillance--United States, 2003. Morbidity and Mortalitiy Weekly Report Surveillance Summary. 2004; 53(May 21):1–96.

Indian Health Service. Trends in Indian health. Washington: Government Printing Office; 2009.

Kaufman CE, Mitchell CM, Beals J, Desserich JA, Wheeler C, Keane EM, Sedey C. Circle of Life: Rationale, design, and baseline results of an HIV prevention intervention among young American Indian adolescents of the Northern Plains. Prevention Science. 2010; 11(1):101–112. [PubMed: 19798577]

Kunitz SJ. Risk factors for polydrug use in a Native American population. Substance Use and Misuse. 2008; 43:331–339. [PubMed: 18365935]

LeMaster PL, Connell CM, Mitchell CM, Manson SM. Tobacco use among American Indian adolescents: Protective and risk factors. Journal of Adolescent Health. 2002; 30:426–432. [PubMed: 12039512]

Li F, Duncan TE, Hops H. Examining developmental trajectories in adolescent alcohol use using piecewise growth mixture modeling analysis. Journal of Studies on Alcohol and Drugs. 2001; 62:199–210.

Majewska MD. HPA axis and stimulant dependence: An enigmatic relationship. Psychoneuroendrocinology. 2002; 27(1–2):5–12.

Markstrom, CA., Whitesell, NR., Galliher, RV. Ethnic identity and mental health among American Indian and Alaska Native adolescents. In: Sarche, MC.Spicer, P.Farrell, P., Fitzgerald, HE., editors. American Indian and Alaska Native children and mental health: Development, context, prevention, and treatment. Denver: Praeger; 2011. p. 101-131.

Martino SC, Ellickson PL, McCaffrey DF. Multiple trajectories of peer and parental influence and their association with the development of adolescent heavy drinking. Addictive Behaviors. 2009; 34:693–700. [PubMed: 19423232]

Mason CA, Walker-Barnes CJ, Tu S, Simons J, Martinez-Arrue R. Ethnic differences in affective meaning of parental control behaviors. The Journal of Primary Prevention. 2004; 25:59–79.

Muthén, LK., Muthén, BO. Mplus User's Guide. Los Angeles: Muthén & Muthén; 1998–2012.

National Institute on Alcohol Abuse and Alcoholism. Alcohol and Development in Youth: A Multidisciplinary Overview. Alcohol Research and Health. 2004/2005; 28(3):107–175.

Nez Henderson P, Jacobsen C, Beals J. The AI-SUPERPFP Team. Correlates of cigarette smoking among selected Southwest and Northern Plains tribal groups: The AI-SUPERPFP study. American Journal of Public Health. 2005; 95(5):867–872. [PubMed: 15855467]

Oetting ER, Beauvais F. Orthogonal cultural identification theory: The cultural identification of minority adolescents. The International Journal of the Addictions. 1990–91; 25:655–685. [PubMed: 2101397]

Orlando M, Tucker JS, Ellickson PL, Klein DJ. Concurrent use of alcohol and cigarettes from adolescence to young adulthood: An examination of developmental trajectories and outcomes. Substance Use and Misuse. 2005; 40:1051–1069. [PubMed: 16040368]

Phinney JS. The Multigroup Ethnic Identity Measure: A new scale for use with diverse groups. Journal of Adolescent Research. 1992; 7(2):156–176.

Phinney JS, Ong AD. Conceptualization and measurement of ethnic identity: Current status and future directions. Journal of Counseling Psychology. 2007; 54(3):271–281.

Rodgers KB, Fleming WM. Individual, family, and community factors related to alcohol use among Native American adoelscents. Adolescent and Family Health. 2004; 3(3):140–147.

Simon AE, Wardle J, Jarvis JJ, Steggles N, Cartwright M. Examining the relationship between pubertal stage, adolescent health beahviours and stress. Psychological Medicine. 2003; 13:1369–1379.

Simons-Morton B, Haynie DL, Crump AD, Eitel P, Saylor KE. Peer and parent influences on smoking and drinking among early adolescents. Health Education & Behavior. 2001; 28(1):95–107. [PubMed: 11213145]

Spaeth M, Weichold K, Silbereisen RK, Weisner M. Examining the differential effectiveness of a life skills program (IPSY) on alcohol use trajectories in early adolescence. Journal of Consulting and Clinical Psychology. 2010; 78(3):334–348. [PubMed: 20515209]

Szlemko WJ, Wood JW, Jumper Thurman P. Native Americans and alcohol: Past, present, and future. The Journal of General Psychology. 2006; 133(4):435–451. [PubMed: 17128961]

Taga KA, Markey CN, Friedman HS. A longitudinal investigation of associations between boys' pubertal timing and adult behavioral healh and well-being. Journal of Youth and Adolescence. 2006; 35(3):401–411.

U. S. Department of Health and Human Services. Mental health: Culture, race, and ethnicity—A supplement to Mental health: A report of the Surgeon General (SMA01–3613). Rockville, MD: U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Mental Health Services; 2001.

Van Der Vorst H, Vermulst AA, Meeus WHJ, Dekovis M, Engels RCME. Identification and prediction of drinking trajectories in early and mid-adolescence. Journal of Clinical, Child, & Adolescent Psychology. 2009; 38(3):329–341. [PubMed: 19437294]

van Jaarsveld CHM, Fidler JA, Simon AE, Wardle J. Persistent impact of pubertal timing on trends in smoking, food choice, activity, and stress in adolescence. Psychosomatic Medicine. 2007; 69:798–806. [PubMed: 17942841]

Walls ML, Whitbeck LB. Maturation, peer context, and indigenous girls' early-onset substance use. Journal of Early Adolescence. 2011; 31(3):415–422. [PubMed: 22228919]

Walters KL, Simoni JM, Evans-Campbell T. Substance use among American Indians and Alaska natives: Incorporating culture in an "indigenist" stress-coping paradigm. Public Health Reports. 2002; 117(Suppl 1):S104–117. [PubMed: 12435834]

Westling E, Andrews JA, Hampson SE, Peterson M. Pubertal timing and substance use: The effects of gender, parental monitoring, and deviant peers. Journal of Adolescent Health. 2008; 42:555–563. [PubMed: 18486864]

Whitbeck LZ, Yu M, Johnson KK, Hoyt DR, Walls ML. Diagnostic prevalence rates from early to mid-adolescence among indigenous adolescents: First results from a longitudinal study. Journal of the American Academy of Child and Adolescent Psychiatry. 2008; 47(8):890–900. [PubMed: 18596558]

Whitesell NR, Beals J, Mitchell CM, Keane E, Spicer P, Turner RJ. The AI-SUPERPFP Team. The relationship of cumulative and proximal adversity to onset of substance dependence symptoms in

two American Indian communities. Drug and Alcohol Dependence. 2007; 91:279–288. [PubMed: 17640829]

Whitesell NR, Beals J, Mitchell CM, Manson SM, Turner RJ. Childhood exposure to adversity and risk of substance use disorder in two American Indian populations: The meditational role of early substance use initiation. Journal of Studies on Alcohol and Drugs. 2009; 70:971–981. [PubMed: 19895776]

Whitesell NR, Beals J, Mitchell CM, Spicer P, Novins DK, Manson SM. The AI-SUPERPFP Team. Disparities in drug use and disorder: Comparison of two American Indian reservation communities and a national sample. American Journal of Orthopsychiatry. 2007; 77:131–141. [PubMed: 17352594]

Whitesell NR, Kaufman CE, Keane EM, Big Crow C, Shangreau C, Mitchell CM. Patterns of substance use initiation among young adolescents in a Northern Plains American Indian tribe. The American Journal of Drug and Alcohol Abuse. 2012; 39(5):383–388.

Whitesell, NR., Spicer, P., Mitchell, CM. Ethnic identity development among American Indian adolescents. Paper presented at the Society for Research in Child Development; Atlanta. 2005.

Windle M, Spear LP, Fuligni AJ, Angold A, Brown JD, Pine D, Dahl RE. Transitions into underage and problem drinking: Developmental processes and mechanisms between 10 and 15 years of age. Pediatrics. 2008; 121:S273–S289. [PubMed: 18381494]

Witt ED. Puberty, hormones, and sex differences in alcohol abuse and dependence. Neurotoxicology and Teratology. 2007; 29:81–95. [PubMed: 17174531]

Wu L, Woody GE, Yang C, Pan J, Blazer DG. Racial/ethnic variations in substance-related disorders among adolescents in the United States. Archives of General Psychiatry. 2011; 60(11):1176–1185.

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Cecelia “CeCe” K. Big Crow, BS, is an Oglala Sioux Tribal mother of two children; grandmother of one. She earned her undergraduate degree at the University of South Dakota. She has been working towards helping Lakota people live healthier lives. She is a Senior Professional Research Assistant with the Centers for American Indian and Alaska Native Health in the Colorado School of Public Health at the University of Colorado Anschutz Medical Campus, with 16 years of research experience working with American Indian tribes. She is proud to say that the research projects she has been involved with have helped improve health and health education for members of her tribe. She has served on the research teams very proudly and honorably.

Carly Shangreau, BSHS, is an enrolled member of the Oglala Sioux Tribe and a Veteran of the United States Armed Forces, having served four years active duty in the US Air Force as a Critical Care Medical Technician. Ms. Shangreau is a Senior Professional Research Assistant with the Centers for American Indian and Alaska Native Health in the Colorado School of Public Health at the University of Colorado Anschutz Medical Campus. For the past several years, she has been working in the areas of health promotion and disease prevention among American Indian populations, with a special emphasis in sexual health. She has been responsible for the hands-on implementation of preventive interventions within Native American communities across the Northern Plains.

Ellen M. Keane, MSPH, MA, LPC, is a Research Associate with the Centers for American Indian and Alaska Native Health in the Colorado School of Public Health at the University of Colorado Anschutz Medical Campus. She has over 18 years of research experience working with Native people coupled with experience in direct mental health service provision. She has worked on a variety of data collection and intervention evaluation efforts collaborating with many different tribes, including projects related to substance use, sexual health, and HIV/STD prevention. Her roles on these projects have included project director, interventionist supervisor, sampling director, data manager, technology implementation director, and analyst. Her direct mental health experience has provided both conceptual and direct project expertise.

Alicia C. Mousseau, Ph.D., is an enrolled member of the Oglala Sioux Tribe and lives on the Pine Ridge Reservation in South Dakota where she works to provide effective and efficient services to her reservation community and American Indian youth. She received her doctorate in Psychology from the University of Wyoming in 2012 and currently serves as Research Instructor with the Centers for American Indian and Alaska Native Health in the Colorado School of Public Health at the University of Colorado Anschutz Medical Campus and as Director of the Little Wound School Behavioral Health and Wellness Department. Her research career has focused on the development, implementation, and evaluation of mindfulness programs for reservation youth.

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specific interest in the development of protective and risk factors for problem and positive behaviors.

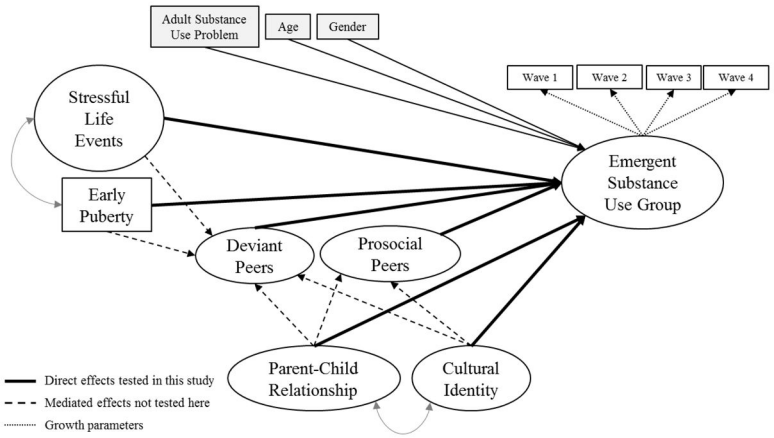

Fig. 1.

Conceptual model of substance use development for young American Indian adolescents

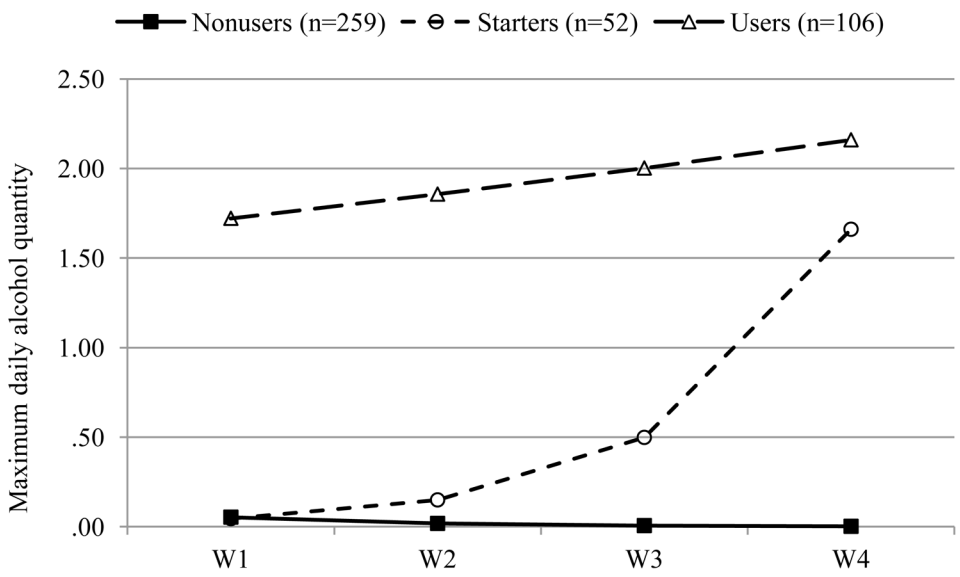

Fig. 2.
Alcohol trajectories by class

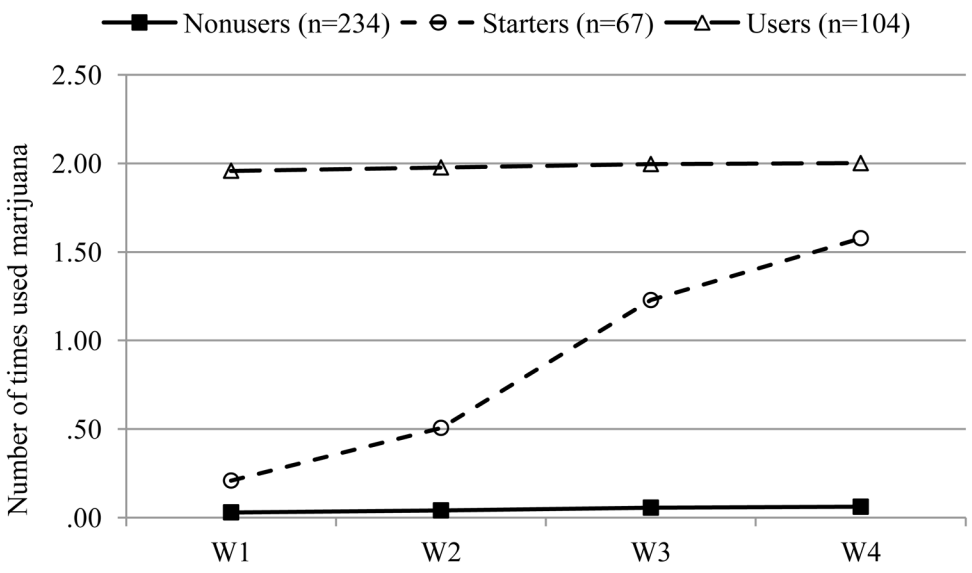

Fig. 3.
Marijuana trajectories by class

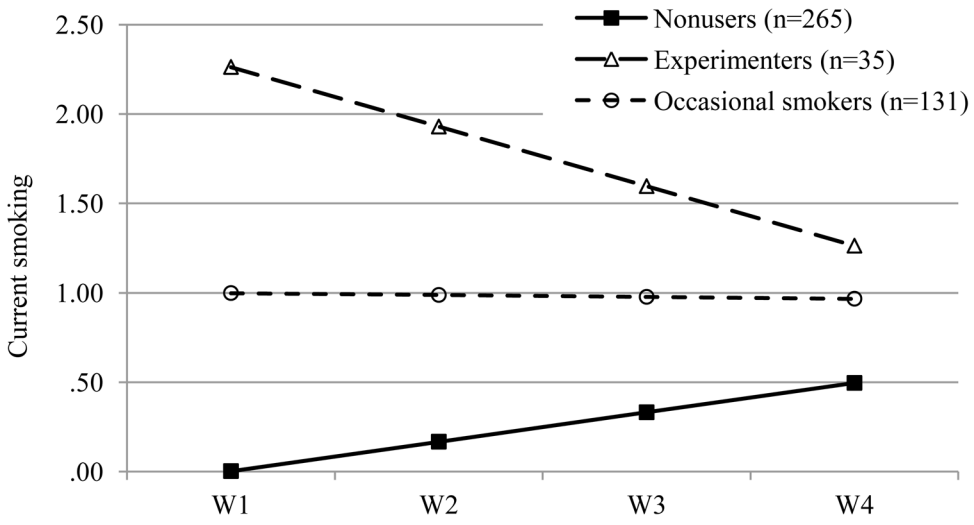

Fig. 4.
Cigarette trajectories by class

Table 1

Study Measures, Northern Plains AI Adolescents

	Study wave			
Measure	**W1 (*n*=381)**	**W2 (*n*=375)**	**W3 (*n*=276)**	**W4 (*n*=246)**
Gender (*n*, %)				
Male	253 (54.4)	--	--	--
Female	212 (45.6)	--	--	--
Age (n, %)				
11	55 (11.9)	--	--	--
12	126 (27.3)	--	--	--
13	172 (37.3)	--	--	--
14 or older	108 (23.5)	--	--	--
Grade in school (*n*, %)				
6	243 (63.8)	--	--	--
7	138 (36.2)	--	--	--
Socioeconomic indicators				
Sometimes/often little money for food (*n*, %)	73 (23.7)	--	--	--
Sometimes/often little money for heat (*n*, %)	53 (17.1)	--	--	--
Sometimes/often little money for electricity (*n*, %)	70 (22.6)	--	--	--
Receive food stamps (*n*, %)	182 (58.7)	--	--	--
Substance use				
Max # drinks in a day/past mos. (*n*, %)				
None	250 (77.6)	229 (74.8)	174 (70.2)	146 (68.5)
1–2	24 (7.5)	19 (6.2)	20 (8.1)	15 (7.0)
3–4	15 (4.7)	16 (5.2)	7 (2.8)	14 (6.6)
5 or more	33 (10.2)	42 (13.7)	47 (19.0)	38 (17.8)
Marijuana frequency/past mos. (*n*, %)				
None	234 (75.7)	192 (67.6)	145 (65.0)	123 (62.8)
1–2	33 (10.7)	27 (9.5)	28 (12.6)	23 (11.7)
3–4	13 (4.2)	24 (8.5)	17 (7.6)	17 (8.7)
5 or more	29 (9.4)	41 (14.4)	33 (14.8)	33 (16.8)
Current cigarette use (*n*, %)				
Not at all	209 (59.4)	177 (53.2)	125 (48.8)	121 (52.8)
Once in a while, not daily	115 (32.7)	128 (38.4)	99 (38.7)	69 (30.1)
1–5 cigarettes/day	21 (6.0)	23 (6.9)	20 (7.8)	34 (14.8)
6 + cigarettes/day	7 (2.0)	5 (1.5)	12 (4.7)	5 (2.2)
Stressful life events				
Deaths, 0–6 (*M, SD*)	1.88 (1.40)	--	--	--
Trauma, 0–6 (*M, SD*)	1.62 (1.30)	--	--	--
Major disruptions, 0–7 (*M, SD*)	1.57 (1.40)	--	--	--
Early puberty (*n*, %)				
Early	139 (32.4)	--	--	--

	Study wave			
Measure	**W1 (*n*=381)**	**W2 (*n*=375)**	**W3 (*n*=276)**	**W4 (*n*=246)**
Not early	290 (67.6)	--	--	--
Peer influences				
Deviant peer influences, 1–5 (*M, SD*)	2.02 (0.83)	--	--	--
Prosocial peer influence, 1–5 (*M, SD*)	3.07 (0.93)	--	--	--
Parent-child relationship				
Maternal warmth, 1–3 (*M, SD*)	2.43 (0.51)	--	--	--
Paternal warmth, 1–3 (*M, SD*)	2.38 (0.57)	--	--	--
Parent-child communication, 1–5 (*M, SD*)	3.08 (1.20)	--	--	--
Parent-child activities, 0–12 (*M, SD*)	5.99 (3.00)	--	--	--
Cultural identity				
Ethnic pride, 1–4 (*M, SD*)	3.39 (0.64)	--	--	--
Cultural engagement, 1–4 (*M, SD*)	2.90 (0.77)	--	--	--

Note. -- data not presented.

Table 2

Fit Statistics for Growth Mixture Models by Substance Use Outcome and Class Solution

Class solution	Log-likelihood	BIC	Entropy
Alcohol use[a]			
1 class	−1001.48	2033.12	n/a
2 classes	−950.50	1949.27	0.73
3 classes	−933.07	1932.51	0.67
4 classes	−933.07	1950.60	0.60
Marijuana use[b]			
1 class	−1014.53	2065.09	n/a
2 classes	−973.85	2001.74	0.68
3 classes	−964.52	2001.08	0.60
4 classes	−964.52	2019.10	0.68
Cigarette use[c]			
1 class	−1146.85	2348.30	n/a
2 classes	−1107.80	2288.30	0.90
3 classes	−861.70	1814.32	0.87
4 classes	−850.51	1810.20	0.84

Note. n/a=not applicable.

[a]Poisson distribution, linear model.

[b]Poisson distribution, nonlinear model.

[c]Continuous distribution, linear model.

Table 3

Results of Multinomial Logistic Regression Analyses Predicting Substance Use Class

	Alcohol		Marijuana		Cigarette	
	Starter	User	Starter	User	Experimenter	Occasional Smoker
Predictor variable	OR	OR	OR	OR	OR	OR
Female gender	1.33	3.06***	1.87*	1.23	1.95*	1.77*
Age	1.31*	1.22	1.39*	1.67***	1.35	1.04
Cultural engagement	n/a	n/a	n/a	n/a	0.44	1.02
Early puberty	2.02**	1.83	2.34*	1.33	n/a	n/a
Early puberty * female gender	n/a	n/a	0.40*	1.3	n/a	n/a
Parenting	1.64	0.27	0.86	0.4	0.14**	0.60
Deviant peer influence	1.29	3.70**	2.32**	1.75	1.84	2.05*
Prosocial peer influence	0.6	0.57	1.11	0.53	n/a	n/a
Stressful life events	1.27	2.92*	1.55*	2.33**	0.99***	1.80**

Note. For each substance, the nonuser class served as the reference group. OR=Odds Ratio. n/a=not applicable; the predictor variable was not included in the final model because it was not associated with class membership in initial multinomial analyses.

* p<.05.

** p<.01.

*** p<.001.