

A Multiprocess Latent Class Analysis of the Co-Occurrence of Substance Use and Sexual Risk Behavior Among Adolescents*

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ABSTRACT. Objective: To assess the co-occurrence of patterns of adolescent substance use and sexual behavior and test for potential moderating effects of gender. **Method:** The 2005 Youth Risk Behavior Survey sample of 13,953 high school students was used in this study. Latent class analyses were conducted to examine the relation between patterns of substance use and sexual risk behavior in a nationally representative adolescent sample. The final model controlled for demographic covariates and an interaction between gender and substance-use classes. **Results:** Four class solutions to each behavior provided optimal fit. Substance-use classes were nonusers (27%), alcohol experimenters (38%), occasional polysubstance users (23%), and frequent polysubstance users

(13%). Sexual risk classes were abstainers (53%), monogamous (15%), low-frequency multipartner (18%), and high-frequency multipartner (14%). Substance-use class had a strong association with sexual behavior even when controlling for demographic covariates. African Americans were less likely to use substances but more likely to report sexual risk behaviors. Interaction effects indicated that substance use among females was associated with increased sexual risk behavior compared with males. **Conclusions:** The results of this study provide impetus for the development of preventive interventions targeting change across multiple risk behaviors, and also for targeting particular high-risk groups or patterns of behavior. (*J. Stud. Alcohol Drugs* 70: 943-951, 2009)

ADOLESCENCE MARKS a crucial developmental period during which multiple risk behaviors emerge (e.g., substance use, sexual behavior) that influence health outcomes in adulthood (Eaton et al., 2006a,b; Irwin et al., 2002). Rates of alcohol, tobacco, and other drug use begin to escalate in adolescence, with national data indicating that use, particularly for alcohol, is highly prevalent (Eaton et al., 2006a; Johnston et al., 2006; Office of the Surgeon General, 2007). Person-centered analyses of substance-use patterns (e.g., latent class analysis [LCA]; Dierker et al., 2007) underscore the heterogeneity of substance-use behavior patterns that emerge during adolescence, and stage-sequential theories of substance use (e.g., the Gateway model; Kandel, 2002) provide a framework for understanding this heterogeneity within a progressive pattern of use for some individuals. Evidence indicates that early initiation of substance use or a pattern of more frequent and intense use predisposes youth to numerous physical, social, and mental health problems in adolescence and young adulthood (Newcomb et al., 1997).

Substance use also significantly increases the likelihood of engaging in risky sexual behavior (Office of the Surgeon

General, 2007). Nearly one quarter of sexually active youth report that they consumed alcohol at the time of their most recent sexual encounter (Eaton et al., 2006a). Substance use in adolescence is related to increases in number of sexual partners, earlier initiation of sex, regretful sexual acts, and decreases in condom use (Dunn et al., 2003; Guo et al., 2002; Santelli et al., 1998; Tapert et al., 2001). Such risky sexual behaviors are associated with myriad negative health and social outcomes including unwanted pregnancy or sexually transmitted disease (STD)/HIV infection, and these effects are amplified when risky substance use and sexual behaviors co-occur (Eaton et al., 2006a; Office of the Surgeon General, 2007).

Previous studies of the association between substance use and sexual risk behaviors have typically focused on variable-centered analyses that assume a homogeneous population with respect to how predictors influence relationships among variables (Laursen and Hoff, 2006). Variable-centered approaches provide strong evidence that more frequent or intense substance use is associated with increased sexual risk behavior (Lowry et al., 1994; Tapert et al., 2001). In contrast, person-centered analyses focus on identifying different and distinct patterns of behavior within the broader population—an approach that may facilitate development of more targeted prevention or intervention efforts to meet the needs of particular subgroups. Fewer studies have taken a person-centered approach to investigate the associations between substance use and sexual risk behaviors. Person-

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centered studies have either (1) examined patterns of substance use or sexual behavior in isolation or (2) combined indicators of multiple problem behaviors (e.g., substance use, sexual behavior, delinquent behavior) into a single cluster model to identify more general patterns of risky behavior. Examples of the first approach distinguish specific patterns of use among individual substances such as alcohol (Lanza et al., 2007; Reboussin et al., 2006) or tobacco (Velicer et al., 2007), or address patterns of initiation and use across a range of substances (Dierker et al., 2007). These studies identify a progressive pattern of substance use from nonuse or light use to alcohol experimentation before expanding to more intense use across a range of licit and illicit substances (e.g., polysubstance use). Very few studies have examined classes of sexual risk behavior, although one study distinguished between abstainers, monogamous youth, multipartner safe youth (i.e., not exposed to STDs), and multipartner STD-exposed youth (Lanza et al., 2003). Studies that focus on clusters of multiple risk behaviors have generally shown that high-risk behaviors tend to co-occur (Fergusson et al., 1994; Hallfors et al., 2004; Halpern et al., 2004; Paxton et al., 2007), although the particular patterns that emerge are difficult to disentangle or compare across studies.

The present study incorporated a more dimensional person-centered perspective, multiprocess LCA, which treated substance use and sexual behavior as separate-but-related domains of potentially risky adolescent behavior. This approach allowed us to better examine how patterns of substance use influence involvement in distinct patterns of sexual behavior while also incorporating sociodemographic covariates (i.e., age, gender, and race/ethnicity) known to be related to both sets of risk behaviors.

Based on prior research and patterns of initiation of alcohol, tobacco, and other drug use during adolescence, we hypothesized that at least three classes of substance use would be found, including nonusers, alcohol users, and polysubstance users (i.e., those indicating use of a wider variety of substances). Further, we expected to find at least four classes of sexual behavior, including sexual abstainers, monogamous, and differing multipartner groups. Given the association between substance use and sexual behavior described previously, we hypothesized that youth engaged in more intense patterns of substance use would demonstrate significantly greater likelihood of engaging in more risky patterns of sexual behavior. Finally, we examined whether the relation of substance use to sexual behavior differs for males and females. Although males are more likely to engage in risky sexual behavior during adolescence (Eaton et al., 2006b; Fergus et al., 2007; Zimmer-Gembeck and Helfand, 2008), evidence suggests that early alcohol and substance use poses a particular risk for sexual initiation and recent sexual intercourse among females (Bellis et al., 2008; Stueve and O'Donnell, 2005). Gender-based analyses are needed to help explain differential risks by gender and to

aid in developing more targeted prevention efforts to reduce negative outcomes associated with these risk behaviors.

Method

Sample data

Data for this study were obtained from the 2005 Centers for Disease Control and Prevention (CDC) Youth Risk Behavior Survey (YRBS). The YRBS is the principal epidemiological assessment of the CDC Youth Risk Behavior Surveillance System (YRBSS). The YRBSS is used to track health-compromising behaviors that tend to occur in adolescence and have the greatest impact on adult morbidity and mortality (e.g., substance use, dietary behaviors). The sampling frame for the YRBS included all adolescents in Grades 9 to 12 who attended regular public, private, or Catholic schools in the 50 states and the District of Columbia (excluding all other territories). The YRBS employed a three-stage cluster sampling design to estimate national rates of health-related behaviors among high school students. A total of 159 high schools (78% school response rate) completed the YRBS in 2005. Student response rate at participating schools was 86%. The 2005 sample included data from 13,953 high school students with an oversampling of black/African American and Hispanic respondents. A more detailed description of the sampling methods and study procedures is published elsewhere (Eaton et al., 2006a).

The final weighted sample was 49.5% female. Approximately 11% of respondents were 14 years or younger, 14% were 18 years or older, and the remaining respondents were evenly dispersed among 15 to 17 years of age. Each grade level was approximately one quarter of the sample. Racial and ethnic breakdown was as follows: approximately 62% of respondents were white, 15% were African American, 10% were Hispanic or Latino, and 13% were from other racial/ethnic backgrounds.

Measures

The 2005 YRBS included 95 items covering a range of domains comprising substance use, sexual behavior, and other health-related behaviors. For purposes of the present study, we focused on a number of indicators of both substance use and sexual behavior. All indicators were modeled as categorical variables. To measure substance use we coded alcohol, tobacco, marijuana use, and heavy episodic drinking items to reflect no history, no past-month use, infrequent past-month use (i.e., 1-5 days), or frequent past-month use (i.e., ≥ 6 days). Because of lower prevalence rates, cocaine-use items were coded to reflect no history of use, no past-month use, or any past-month use. Similarly, inhalant and other hard-drug-use items were coded to reflect any history of use. To measure sexual behavior, we used the following

items: age at first sexual intercourse, number of sexual partners (lifetime), number of sexual partners (past 3 months), condom use during last sexual intercourse, and history of HIV testing. Finally, we included gender, grade in school, and racial/ethnic group as demographic covariates.

Data analysis

LCA (Lubke and Muthén, 2005; McCutcheon, 1987) was conducted using Mplus Version 5.1 (Muthén and Muthén, 1998-2008). Like cluster analysis, LCA is used to identify homogeneous subgroups within a heterogeneous population based on similarity of responses to measured variables, and to identify covariates that differentiate membership across classes (Auerbach and Collins, 2006; Lanza et al., 2007; Magidson and Vermunt, 2002; Nylund et al., 2007). The primary advantage of LCA over alternative approaches, such as cluster analysis, is the reliance on a model-based method for estimating population characteristics derived from sample data, adjustment of estimates for measurement error, formal statistical procedures for determining the number of classes, use of probabilities as the basis for interpretation of results, and flexible treatment of variance among classes (Magidson and Vermunt, 2002; Nylund et al., 2007). LCA may be used with continuous, dichotomous, categorical, and other data structures (e.g., count variables; Muthén and Muthén, 1998-2008).

LCA provides estimates of class membership probabilities (e.g., sexual-behavior classes) and behavioral probability estimates within class (e.g., class-specific patterns of sexual behavior; Auerbach and Collins, 2006; Lanza et al., 2003). The relationship of covariates to class membership is determined through simultaneously estimated multinomial logistic regression with corresponding odds ratios estimated to indicate the effect of a given level of the covariate on probability of class membership relative to a reference class.

An initial series of models were run separately to determine the appropriate number of classes for substance use

and for sexual behavior. For substance use, we began with a one-class (no covariates) model and then tested a series of models with covariates specifying increased number of classes (e.g., two class, three class) representing different patterns of substance-use behavior. We compared fit among freely estimated models and also among models with a restricted "nonuser" class. Similar procedures were also implemented for sexual-behavior indicators. Optimal model selection was based on recommended indices including low adjusted Bayesian Information Criterion relative to other models, significant Lo-Mendell-Rubin likelihood ratio test, and acceptable quality of classification (i.e., entropy values; Nylund et al., 2007).

Following these separate analyses, we conducted a final combined LCA model in which both substance-use and sexual-behavior classes were estimated simultaneously. Sexual-behavior class membership was regressed on substance-use class, and both substance-use and sexual-behavior classes were regressed on demographic covariates in this final model. In addition, interaction effects between gender and substance use were tested by permitting gender effects on sexual behavior to vary across substance-use classes. Sample weights were included in analyses to adjust for survey nonresponse and sample selection probabilities. Primary sampling units and stratum variables were included to account for the complex sampling design. Because Mplus is not able to incorporate nonnested cluster and strata variables, primary sampling units representing more than one stratum were treated as distinct clustering units (L.K. Muthén, personal communication, August 16, 2007). Full-information, maximum-likelihood procedures were used to address missing data within the YRBS file.

Results

Results of successive LCA models are presented in Table 1. The first set of data columns summarizes successive models for substance-use behavior, and the second set is for

TABLE 1. Fit statistic comparisons of latent class analysis models of substance use and sexual-behavior models with covariates

Model	Description	Substance LCA models			Sexual-behavior LCA models		
		Adjusted BIC	LMR LRT <i>p</i>	Entropy	Adjusted BIC	LMR LRT <i>p</i>	Entropy
1	One class (no covariates)	726,124.25	—	—	235,144.22	—	—
2	Two class, unrestricted	129,262.95	<.001	.93	89,857.37	.02	.98
3	Two class, restricted ^a	134,313.52	<.001	.95	89,723.39	<.001	.98
4	Three class, unrestricted	117,509.44	<.001	.86	86,719.33	<.001	.91
5	Three class, restricted ^a	121,593.32	<.001	.86	86,585.35	<.001	.91
6	Four class, unrestricted	114,386.83	<.001	.85	85,455.40	<.001	.91
7	Four class, restricted ^a	117,303.53	.002	.82	85,101.32	<.001	.91
8	Five class, unrestricted	113,128.33	.35	.83	85,333.78	.10	.81
9	Five class, restricted ^a	114,213.84	1.00	.82	84,418.49	1.00	.89

Notes: Best fitting models identified in **bold**. LCA = latent class analysis; BIC = Bayesian Information Criterion; LMR LRT = Lo-Mendell-Rubin likelihood ratio test *p* value for (K-1) classes; a significant *p* value indicates that the (K-1) class model should be rejected in favor of a model with at least K classes. ^aRestricted one class to no history of use across all substance-use variables.

sexual behavior. A four-class unrestricted model (indicated in bold type) provided the best overall fit to the data for substance-use behavior; a four-class restricted model (also indicated in bold type) provided the best overall fit to the data for sexual behavior.

A combined model was run specifying a four-class unrestricted model for substance use and a four-class restricted model for sexual behavior. Results of this model were used to summarize conditional probabilities for both substance use and sexual behavior based on class membership (Tables 2 and 3, respectively).

With regard to substance use, Class 1 accounted for 27% of the sample and comprised youth with little or no history of substance use (nonusers). Class 2 (alcohol experimenters) accounted for 38% of the sample. All members of this class reported some history of alcohol use, although about two thirds indicated no use in the past month, and the remaining youth had used 5 or fewer days. Heavy episodic drinking and other substance use, particularly in the past month, were limited. Class 3 (occasional polysubstance users) accounted for 23% of the sample and exhibited a higher probability of use for each of the substance-use categories than either Class 1 or Class 2. All youth in this class reported a history of alcohol use in the past month, although probability of

frequent alcohol use was low; youth in this class also had a high probability of infrequent heavy episodic drinking in the past month and a moderate probability of past-month cigarette and marijuana use. Finally, Class 4 (frequent polysubstance users) accounted for 13% of the sample. Youth in this class endorsed the highest probability of frequent alcohol, tobacco, and marijuana use during the previous 30 days; reported higher rates of heavy episodic drinking; and produced the highest probabilities of cocaine, inhalant, and other hard-drug use.

With regard to sexual behavior, Class 1 accounted for 53% of the sample and was restricted to youth with no reported history of sexual intercourse (sexual abstainers). Class 2 (monogamous) accounted for 15% of the sample. Age at first intercourse was highest for members of this class relative to other classes engaged in sexual activity, with few initiating intercourse before the age of 15. The majority of youth in Class 2 indicated they had one to two lifetime sexual partners, with one or zero sexual partners in the past 3 months. Probability of condom use during their most recent sexual encounter was moderate, and youth in this group were about three times as likely as abstainers to report having received HIV testing. Class 3 (low-frequency multipartner) accounted for 18% of the sample, with an age

TABLE 2. Four-class unrestricted latent class analysis model of conditional probabilities of substance use by class

Class prevalence	Nonusers (26.7%)	Alcohol experimenters (38.0%)	Occasional polysubstance users (22.6%)	Frequent polysubstance users (12.8%)
Alcohol use				
Never	1.000	.000	.000	.000
No past-month use	.000	.694	.000	.141
1-5 days	.000	.304	.746	.336
≥6 days	.000	.001	.254	.523
Heavy episodic drinking				
Never	1.000	.000	.000	.000
No past-month use	.000	.998	.211	.276
1-5 days	.000	.002	.718	.450
≥6 days	.000	.000	.071	.274
Cigarette use				
Never	.858	.470	.198	.018
No past-month use	.125	.431	.419	.206
1-5 days	.009	.059	.199	.152
≥6 days	.008	.040	.185	.623
Marijuana use				
Never	.964	.714	.363	.021
No past-month use	.025	.213	.282	.258
1-5 days	.007	.058	.274	.255
≥6 days	.004	.015	.081	.466
Cocaine use				
Never	.998	.992	.988	.445
No past-month use	.001	.008	.009	.302
Past-month use	.001	.000	.003	.253
Inhalant use				
Never	.976	.909	.876	.575
Ever	.024	.091	.124	.425
Other hard-drug use				
Never	.995	.984	.971	.363
Ever	.005	.016	.029	.637

at first intercourse midway between that of Classes 2 and 4. Youth in this class had a higher probability of reporting two or more lifetime sexual partners than those in Class 2, although they were more likely to report no sexual partners in the past 3 months. Condom use during most recent sexual encounter and history of HIV testing were comparable to youth in Class 2. Finally, Class 4 (high-frequency multipartner) accounted for 14% of the sample and reported the lowest age at initiation of sex. Nearly all youth in this class reported having at least three lifetime sexual partners, with more than half reporting six or more. A majority of youth in this class also reported having two or more sexual partners in the past 3 months. Likelihood of condom use during their most recent sexual encounter was lower than for Classes 2 and 3, and youth were twice as likely as those in other classes to report having received HIV testing.

Multinomial logistic regression analyses examined the complex model in which sexual behavior was regressed on substance use. In addition, both behaviors were regressed on demographic covariates, and the interaction between gender

and substance use on sexual behavior was tested. Model results are presented in Table 4. Regression estimates for demographic covariates on substance use are included in the first series of data columns, and estimates of covariate and substance-use effects on sexual-behavior classes are included in the second series of data columns.

As school grade increased, odds of being identified as an alcohol experimenter, occasional polysubstance user, or frequent polysubstance user also increased. Relative to white youth, African American youth had increased odds of being identified as alcohol experimenters but decreased odds of being identified in the occasional or frequent polysubstance-user classes. Hispanic youth had increased odds of being identified as alcohol experimenters and as frequent polysubstance users, whereas youth from other ethnic or racial backgrounds were less likely to be identified as occasional polysubstance users.

Demographic covariates also were strongly associated with sexual-behavior classes, even when controlling for substance-use class membership. Males were at increased

TABLE 3. Four-class restricted latent class analysis model of conditional probabilities of sexual behavior use, by class

Class prevalence	Abstainers (53.0%)	Monogamous (14.9%)	Low-frequency multipartner (17.9%)	High-frequency multipartner (14.2%)
Age at first sexual intercourse				
No history of intercourse	1.000	.000	.000	.000
11 years	.000	.000	.057	.153
12 years	.000	.000	.067	.131
13 years	.000	.000	.193	.191
14 years	.000	.008	.371	.281
15 years	.000	.225	.312	.172
16 years	.000	.477	.000	.065
≥17 years	.000	.289	.000	.007
No. of sexual partners (lifetime)				
0 (lifetime)	1.000	.000	.000	.000
1	.000	.639	.438	.000
2	.000	.224	.291	.008
3	.000	.076	.182	.151
4	.000	.035	.073	.163
5	.000	.024	.016	.149
≥6	.000	.002	.000	.528
No. of sexual partners (past 3 months)				
0 (lifetime)	1.000	.000	.000	.000
0 (past 3 months)	.000	.265	.439	.073
1	.000	.703	.526	.364
2	.000	.032	.035	.260
3	.000	.000	.000	.139
4	.000	.000	.000	.058
5	.000	.000	.000	.018
≥6	.000	.000	.000	.088
Condom use during most recent sexual intercourse				
No history of intercourse	1.000	.000	.000	.000
Yes	.000	.670	.708	.586
No	.000	.330	.292	.414
HIV testing history				
Yes	.045	.131	.150	.348
No	.880	.823	.792	.603
Don't know	.075	.046	.059	.049

TABLE 4. Odds ratio results of latent class multinomial logistic regression model

Covariates	Substance-use classes			Sexual-behavior classes		
	Alc. exp. vs Nonusers OR (95% CI)	Occ. poly. vs Nonusers OR (95% CI)	Freq. poly. vs Nonusers OR (95% CI)	Monog. vs Abstainers OR (95% CI)	Low freq. vs Abstainers OR (95% CI)	High freq. vs Abstainers OR (95% CI)
Gender (female)	0.89 (0.78-1.02)	1.05 (0.89-1.23)	1.17 (0.99-1.37)	1.04 (0.68-1.59)	1.99 [†] (1.31-3.02)	5.74 [†] (2.38-13.83)
Grade in school	1.21* (1.12-1.30)	1.39 [†] (1.26-1.53)	1.38 [†] (1.25-1.52)	3.11 [†] (2.72-3.56)	0.79 [†] (0.70-0.89)	1.61 [†] (1.47-1.77)
Race/ethnicity (white)						
African American	1.26* (1.02-1.55)	0.58 [†] (0.41-0.81)	0.35 [†] (0.23-0.53)	2.85 [†] (2.00-4.08)	5.49 [†] (4.22-7.14)	28.47 [†] (20.05-40.44)
Hispanic	1.49 [†] (1.18-1.87)	0.99 (0.72-1.36)	1.59 [†] (1.15-2.21)	1.40* (1.08-1.81)	1.59 [†] (1.20-2.11)	2.11 [†] (1.38-3.21)
Other	0.86 (0.65-1.14)	0.48 [†] (0.32-0.72)	0.68 (0.44-1.04)	0.72* (0.53-0.99)	0.91 (0.63-1.33)	1.25 (0.75-2.01)
Substance-use classes (nonuser)						
Alcohol experimenters	–	–	–	5.46 [†] (2.39-12.47)	15.43 [†] (6.54-36.40)	18.60 [†] (3.66-94.43)
Occasional	–	–	–	7.13 [†] (3.20-15.89)	37.94 [†] (13.72-104.92)	307.97 [†] (54.67-1734.93)
Frequent polysubstance users	–	–	–	28.36 [†] (8.66-92.83)	280.34 [†] (67.96-1156.42)	7,918.84 [†] (1,062.10-59,041.74)
Gender × Substance-Use Class Interactions						
Male × Alc. Experimenters	–	–	–	0.70 (0.41-1.20)	0.46 [†] (0.28-0.77)	0.42 (0.18-1.01)
Male × Occ. Polysubstance Users	–	–	–	1.07 (0.63-1.79)	0.56 (0.31-1.00)	0.25 [†] (0.10-0.64)
Male × Freq. Polysubstance Users	–	–	–	0.74 (0.35-1.58)	0.32 [†] (0.14-0.73)	0.17 [†] (0.05-0.56)

Notes: Reference categories for covariates are indicated in parentheses. OR = odds ratio; CI = confidence interval; Alc. exp. = alcohol experimenter; Occ. poly. = occasional polysubstance user; Freq. poly. = frequent polysubstance user; Monog. = monogamous; Low freq. = low frequency; High freq. = high frequency.

* $p \leq .05$; [†] $p \leq .01$

odds of being identified in the low- and high-frequency multipartner classes. Similar to the pattern observed for substance use, as school grade increased, so did the odds of being identified in the monogamous or high-frequency multipartner classes, although the odds decreased for the low-frequency multipartner class. Both African American and Hispanic youth were at increased odds of being identified in the monogamous, low-frequency multipartner, and high-frequency multipartner classes, whereas youth from other ethnic or racial backgrounds were more likely to be identified as sexual abstainers.

As suggested by the cross-classification of sexual-behavior and substance-use classes presented earlier, substance use had a strong association with sexual-behavior class membership in the multinomial model even when controlling for demographic covariates. Compared with nonusers, the odds of being identified as monogamous or in the low- or high-frequency multipartner sexual classes increased significantly for each of the substance-use groups, and these odds were stronger among more intense patterns of substance use.

Interaction effects between gender and substance-use class indicated that relative odds of males being identified in the low-frequency multipartner sexual-behavior class were decreased in the alcohol experimenter and frequent polysub-

stance-user classes (the effect for occasional polysubstance users approached significance; $p = .051$) compared with females. Relative odds of males being identified in the high-frequency multipartner class also were decreased in the occasional and frequent polysubstance-user classes (the effect for alcohol experimenters approached significance; $p = .052$). As an example to clarify interpretation of interaction effects, the odds of a female being classified in the low-frequency multipartner class, rather than the abstainer class, increase 15.43 times for alcohol experimenters relative to nonusers. Among males, this increase in odds would be 7.11 times, as represented by the significant interaction effect (odds ratio = 0.46, 95% confidence interval: 0.28-0.77). These findings suggest that the effect of substance use, particularly frequent polysubstance use, on risky sexual behavior (i.e., a pattern of sexual activity with multiple partners) is stronger for females than males.

Figure 1 summarizes sexual-behavior class membership as a function of substance-use class separately for males and females; the prevalence rates of sexual-behavior classes, overall, for males and females also are represented in Figure 1. Probabilities for these figures are derived from most likely class membership as determined by the final combined model. The pattern of sexual behavior by substance-use

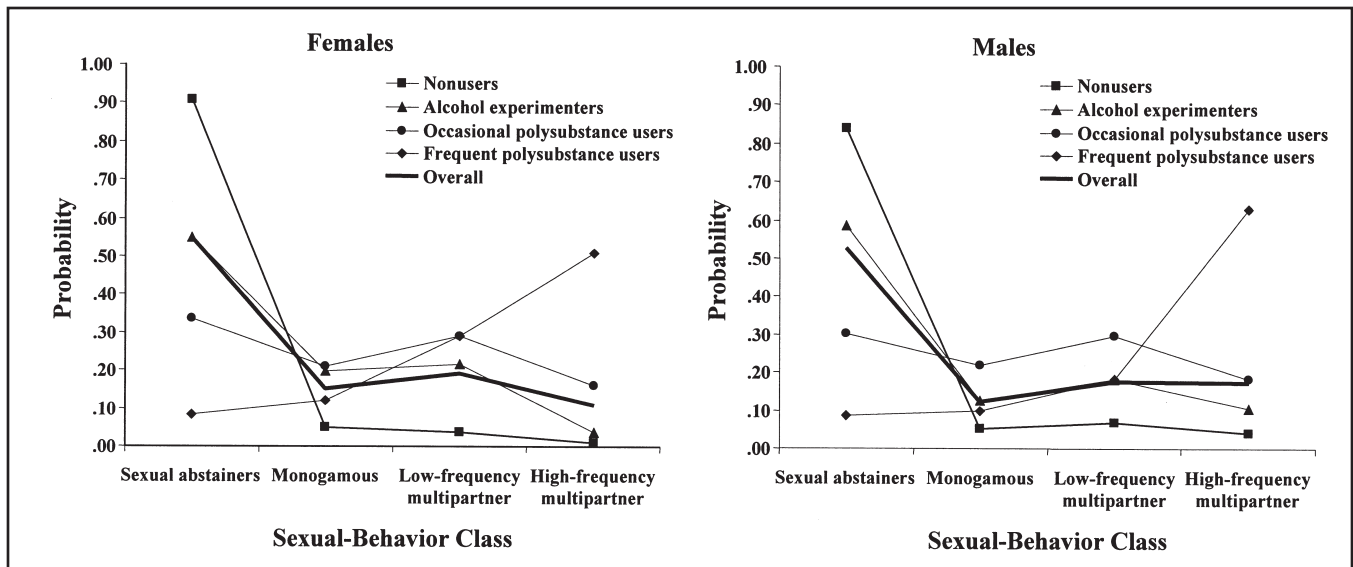


FIGURE 1. Conditional probability of sexual-behavior class membership based on substance-class membership, by gender

class, in general, is similar for males and females. Nonusers had a high probability of being identified as sexual abstainers (albeit slightly higher among females) and a very low probability of being classified in any of the groups that had initiated sexual intercourse. Alcohol experimenters also were more likely to be identified as sexual abstainers, but the likelihood of being identified in either the monogamous or low-frequency multipartner classes was higher than for nonusers. Occasional polysubstance users had a lower probability of being identified as sexual abstainers, and were more likely to be identified with any of the classes that had initiated sexual intercourse than either nonusers or alcohol experimenters. Finally, frequent polysubstance users had a low probability of being identified in either the sexual-abstainer or monogamous classes, and the probability of being identified in the high-frequency multipartner class was highest for these youth. The effect of gender interactions on the relation between substance-use and sexual risk behavior classes also is depicted in Figure 1. Nonusing females have a near-zero probability of engaging in either low- or high-frequency multipartner sexual behavior, with odds significantly lower than those observed for males. When females are identified with any of the substance-using classes their risk for engaging in multipartner sexual behavior increases relative to this effect for males.

Discussion

Analyses provided support for the hypothesis that youth who engage in patterns of escalating substance use also are more likely to engage in patterns of risky sexual behavior, and that this effect is more pronounced among females.

More specifically, the joint relationship between substance use and sexual behavior was striking, showing a clear relation between intensity of involvement across a range of substances and likelihood of engaging in more risky patterns of sexual behavior. Even after accounting for these effects, significant demographic differences in risky sexual behavior were observed. Males were significantly more likely to engage in low- or high-frequency multipartner behavior than females. Both African American and Hispanic youth were significantly more likely than their white counterparts to engage in nonabstaining sexual-behavior patterns, and the odds were greatest for high-frequency multipartner behavior. Further, our findings indicated that the association between substance use and either low- or high-frequency multipartner sexual activity was significantly stronger for females than for males, especially among frequent polysubstance users. That is to say, although females are less likely to be identified in either multipartner sexual risk groups than males, their relative risk for involvement in such behaviors is higher than males when they engage in frequent polysubstance-use behaviors.

These findings have important implications for the field of public health. First, they underscore the strong relationship between adolescent substance use and involvement in risky sexual-behavior patterns. Prevention efforts targeting reductions in frequency and intensity of substance use, particularly patterns of polysubstance use, may also be effective strategies for reducing engagement in risky sexual behavior for some youth. Second, although males were more likely to engage in risky sexual behavior than females, the interaction between gender and substance use points to the need for targeted interventions to reduce this association for

females. Recent evidence indicates that one in four adolescent girls has contracted an STD (Forhan, 2008), and that risks for STDs (particularly chlamydia and gonorrhea) fall disproportionately on females between the ages of 15 and 24 (CDC, 2007a). Substance-using adolescents are less likely to use condoms and more likely to report unwanted pregnancies (Dunn et al., 2003; Guo et al., 2002; Santelli et al., 1998; Taupert et al., 2001). In addition, substance use among females is associated with increased risk of exposure to physical and sexual violence, which may further increase risk of substance use as well as unhealthy weight control, sexual risk behavior, pregnancy, and suicidal thoughts or behaviors (Eaton et al., 2007; Silverman et al., 2001). More research is needed to identify processes that account for differential risk patterns among males and females to guide development of more targeted intervention strategies.

The pattern of effects among African American youth also bears particular mention. African American youth were less likely to engage in either occasional or frequent polysubstance use than white youth, a finding that is consistent with previous research (CDC, 2007b; Grunbaum et al., 2004). However, this reduced risk of substance-use involvement did not translate into a reduced hazard of risky sexual behavior. In fact, African American youth were nearly 30 times as likely to be identified in the high-frequency multipartner class as their white counterparts. We know from previous research that African American males, in particular, are likely to display earlier patterns of sexual risk behavior than white males, although such differences tend to decline with age (Fergus et al., 2007). African Americans suffer higher morbidity and mortality related to the health consequences of risky sexual behaviors (CDC, 2007b; Grunbaum et al., 2004). They account for 49% of persons recently diagnosed with HIV/AIDS, with the majority of these cases attributed to high-risk sexual contact (CDC, 2007b). This issue is particularly relevant to adolescents and young adults; African Americans account for 61% of new cases of HIV/AIDS among persons younger than age 25 (CDC, 2006). It is important to identify risk factors, apart from substance use, that increase odds for engaging in risky sexual behavior to guide more effective prevention efforts.

Although based on a large, nationally representative sample of U.S. adolescents, the present study does have a number of limitations. First, the data are cross-sectional, limiting our ability to establish a causal direction for observed effects. Future research should continue to examine the relation among these risk behaviors using a longitudinal framework. In addition, data are based on youth self-report, which may result in some bias, particularly given the sensitive nature of the items used in the present analyses. One study of the 1999 YRBS revealed that respondents generally reported indicators of both lifetime and recent behavior with a high degree of reliability, and that responses to substance use and sexual behavior were generally more reliable than

other health-related behaviors (Brener et al., 2002). In addition, the YRBS sampling strategy is intended to represent the U.S. sample of high school-enrolled youth, limiting our ability to generalize results to youth who may have dropped out of school. Finally, the YRBS provides rich detail in terms of adolescent risk behavior but does not provide much detail about the family, peer, and other contextual influences that may be related to substance use or sexual behavior. Future research is needed that examines the role of these influences on the relationships observed in the present study. Such research is essential to explain why some youth move toward riskier patterns of behavior during adolescence and to explain the gender and racial/ethnic differences observed in this study.

Despite these limitations, the present study provides added clarity to the relationship of substance use and sexual behavior in adolescence. Although substance use, in general, increases the likelihood that youth will initiate sexual activity or engage in riskier patterns of such behavior, the risks are much stronger with greater intensity of use and with a broader involvement in polysubstance use. Additionally, the identification of specific co-occurring substance-use and sexual-behavior patterns suggests a need for prevention and intervention efforts to simultaneously target multiple behaviors for change.

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