SIMULTANEOUS POLYDRUG USE AMONG TEENS: Prevalence and Predictors

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ABSTRACT: *The use of two or more substances in combination, simultaneous polydrug use (SPU), is a particularly dangerous form of drug use that appears to be established by late adolescence. We examined the prevalence of SPU in a diverse sample of 12th graders, and identified risk and protective factors for SPU that are present at 10th grade. We also tested for differences in SPU across race and gender, and explored the basis for observed differences. Our goals were to determine the extent of SPU problems in different groups and how to address these problems. Twenty-nine percent of participants had engaged in SPU in the past year. The best predictors of alcohol/marijuana SPU were a pro-drug environment, pro-drug beliefs, social deviance, and family disruption; only a pro-drug environment was predictive of hard drug SPU. Women were far less likely to combine marijuana and alcohol than were men. Asian Americans were less likely to combine alcohol and marijuana than were other racial groups, apparently due to their advantaged standing on all predictors of this behavior. African Americans were less likely to use hard drugs in combination than were other groups. Overall, polydrug use is a substantial problem for older teens. Broader drug-use prevention programs may be sufficient to address SPU involving gateway drugs, but reducing drug availability appears central to addressing hard drug SPU.*

INTRODUCTION

Polydrug use is a particularly hazardous form of substance use associated with a unique set of complications and consequences. Relative to the use of the same substances in isolation, polydrug use results in a greater number of traffic accidents (Bo et al., 1975), higher levels

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of psychomotor impairment (Molander and Duvok, 1976), increases in toxicity (Hearn et al., 1991), and has a greater likelihood of death from overdose (Gay, 1972; Cohen, 1981). Such effects are attributable to multiple biochemical processes including drug synergy (the intermingling of two or more mood-altering substances to produce a third substance with unpredictable properties [Jatlow et al., 1991]), cross-tolerance, and additive effects (Starmer and Bird, 1984).

Many adolescents who use illicit substances engage in a form of polydrug use termed concurrent polydrug use (CPU). CPU refers to the use of more than one drug during a given period (e.g., 1 day, 1 month, or 1 year). Because most adolescents who use illicit substances began their drug use with alcohol and have continued drinking (Kandel and Faust, 1975), CPU rates are high among users of marijuana and other illicit drugs. A subset of CPU is simultaneous polydrug use (SPU). As the name indicates, SPU involves the use of two or more substances on the same occasion. Because the likelihood of synergistic or additive effects is highest under such conditions, SPU is a particularly problematic form of CPU.

While the prevalence and predictors of adolescent CPU have been documented (e.g., Single et al., 1974; Newcomb et al., 1987; Scheier et al., 1994), less is known about adolescent SPU. The goals of the present investigation are to: (1) determine the prevalence of SPU in a large, ethnically and socioeconomically diverse sample of 12th-graders; (2) test whether SPU prevalence varies by gender and race/ethnicity; (3) identify predictors of 12th-grade SPU that are present at an earlier age; and (4) determine whether these predictors mediate observed gender and racial differences in SPU.

A few studies of SPU have addressed the issue of prevalence, but it is difficult to draw general conclusions from them. First, they have used predominantly adult samples (Norton and Colliver, 1988; Grant and Harford, 1990; Martin et al., 1992) or samples of adolescent problem drinkers (Martin et al., 1992, 1993, 1996a, 1996b). Second, samples and measures have been idiosyncratic to each study; different sets of drug combinations were measured over varying periods of time in diverse populations. The SPU literature contains prevalence estimates of 7% for past-month combination of alcohol and marijuana (Norton and Colliver, 1988), 2% for past-year combination of alcohol and sedatives, and 2% for past-year combination of alcohol and tranquilizers in groups aged 12–17 (Grant and Harford, 1990). Estimates of the number of persons engaging in any form of SPU are 45% for past 4-month use among adolescent alcohol users (Martin et al., 1996a) and 35% for past-year use in a group of first-year college students (Martin et al., 1992). Clearly, conclusions regarding overall SPU prevalence among normal adolescents are difficult to draw from such data.

Findings regarding gender differences in SPU prevalence are somewhat clearer. A fairly consistent pattern of greater polydrug use among males has been observed; a finding we expect to replicate in the present investigation. Differences in SPU across races have also been noted. Grant and Harford (1990) observed a tendency for greater use of alcohol/sedative and alcohol/tranquilizer combinations among whites than among African Americans. Others have found more prevalent use of alcohol combined with marijuana among African Americans and whites than among Hispanics (Norton and Colliver, 1988). Although these findings require replication, they are broadly consistent with work indicating that there are racial differences in the prevalence of adolescent substance use (Bachman et al., 1991; Wallace and Bachman, 1991, 1993) and fit with the specific finding

that African American youth are much less likely to use "hard drugs" (illicit drugs other than marijuana) than are Whites (Ellickson et al., 1999). We therefore expect to find similar racial differences in SPU prevalence in the present study.

Other characteristics of adolescents also predict polydrug use. In previous work, a greater prevalence of SPU has been associated with adolescent problem behavior, sensation-seeking personality, and negative emotionality (Martin et al., 1992, 1996a). Each of these variables is generally a risk factor for adolescent substance use (Jessor and Jessor, 1977; Newcomb and Bentler, 1988, 1989; Brook et al., 1991). Indeed, adolescent substance use is associated with a broad range of contextual and personal factors, many of which may predict the specific behavior of using two or more drugs in combination. Social influence, contact with adults and peers who model drug use and provide reinforcement for the adolescent's use of drugs, is a key antecedent of adolescent drug use (Bandura, 1977). Several studies have documented associations between parents' drug use and their children's later use of drugs (Barnes, 1977; Newcomb et al., 1983; Ellickson and Hays, 1991a). Peer use and approval of use are even stronger predictors of adolescents' substance-use behavior (Jessor and Jessor, 1977; Huba et al., 1979; Barnes and Welte, 1986). Apart from social influence, peers and parents who use drugs may foster drug use in others by enhancing the availability of drugs. Adolescents who report that drugs are available in their homes are more likely to use drugs (Resnick et al., 1997). Finally, attachment to family, school, or religion can influence commitment to norms opposing drug use (Hirschi, 1969). Students from disrupted homes or who have poor relationships with their parents are at risk for substance use (Rhodes and Jason, 1990; Denton and Kampfe, 1994). Youth who perform poorly in school, repeat a grade, or plan to complete fewer years of education are more likely to use drugs (Newcomb et al., 1986; Chassin et al., 1988; Ellickson and Hays, 1991a, 1992; Resnick et al., 1997), as are those with lower levels of religiosity (Jessor et al., 1980; Kandel, 1982; Wallace and Bachman, 1991; Cochran, 1992).

Broader environment, in the form of demographics and social structure, also predicts adolescent drug use. Consistent with the findings regarding SPU described earlier, gender and race/ethnicity (Bachman et al., 1991), as well as parent education and income (Bachman et al., 1981; Maddahian et al., 1986; Ellickson et al., 1996), have been associated with a variety of forms of substance use among teens.

Another set of drug-use predictors, encompassing both cognitive and behavioral factors, resides within the adolescent. Adolescents who believe that alcohol and drugs provide more benefits and cause fewer problems are more likely to use these substances (Bentler and Speckart, 1979; Chassin, 1984; Bachman et al., 1991; Leigh and Stacy, 1991). Drug-use intentions and confidence in one's ability to resist pressures to use drugs ("resistance self-efficacy") also predict drug use at a later point in time (Ajzen and Fishbein, 1980; Ellickson and Hays, 1991b). Problem behavior, including prior drug use, early sexual activity, and general deviance, is associated with later drug use (Jessor and Jessor, 1977), as are patterns of recreation and socializing (Bachman et al., 1984).

The relationships between SPU and these personal and environmental factors need to be tested. In the present paper, we attempt to identify early factors that put adolescents at risk for SPU later in their lives. Such longitudinal research is of critical importance because early assessments may provide signals of developing problems that can be prevented through intervention. Because we wish to maximize our ability to detect SPU

TABLE 1
Comparison of Weighted and Unweighted Estimates of the Characteristics of Grade 12 Respondents with Characteristics of the Grade 7 Sample (Percentages)

		12th-Grade Analysis Sample	
Grade 7 Variable	*7th-Grade Sample (N = 6,527)*	*Unweighted (N = 4,070)*	*Weighted (N = 4,070)*
Female	48	54	48
White	70	75	71
Ever used alcohol	75	74	75
Ever used cigarettes	51	45	50
Ever used marijuana	20	14	19
Low grades (C or lower)	31	23	30
Intact nuclear family	59	65	59
Neither parent a high school graduate	20	16	18

predictors, we focus on the time period closest to self-reported SPU for which we had data, using 10th-grade data to predict SPU in the 12th grade.

Finally, we explore whether these predictive factors mediate racial and gender differences in SPU prevalence. Racial and gender differences in behavior can often be explained by factors that vary across these groups (Eagly, 1986; Betancourt and Lopez, 1993; Taylor et al., 1997). Identifying these factors provides important information about the underlying experiences and perceptions that are the basis of demographic difference.

METHODS

Sample

We drew our sample from the RAND Adolescent Panel Study. The study followed a sample of West Coast youth from seventh grade to young adulthood, focusing on substance use and related behaviors over time. The baseline panel of 6,527 adolescents was drawn from 30 middle schools representing diverse community and school environments. Nine schools had minority populations of 50% or more, the schools varied in the socioeconomic status of their average enrollees, and they were of varying sizes, as were the communities in which they were situated. The content and purpose of the study was described to participants when the instrument was distributed. For surveys administered in the classroom, student signatures signified their consent to participate. For those surveys mailed to respondents, completion of the questionnaire and its return was taken as an indication of consent. Data for the present analysis were collected at 10th (n = 5,523) and 12th grades (n = 4,390) (or the equivalent of 12th-grade, because the sample includes dropouts). Persons present at both these data collection waves were included unless: (1) data regarding race/ethnicity were missing or did not fit one of the four ethnic groups large enough to examine statistically (5%), or (2) the respondent had missing data on more than six of the predictor variables (1%). This yielded a sample of 4070 individuals. Of these, 75% (n = 3067) were non-Hispanic whites, 8% (n = 330) were African Americans, 8% (n = 318) were Mexican Americans, and 9% (n = 355) were Asian Americans.

Because care was taken to track and include school dropouts and those who transferred to another school, this group is fairly representative of the original panel enrollees. However, there was still 33% attrition by 12th grade, and this attrition was not entirely random. Slightly fewer minority, male, and high-risk youth were included in the 10th- and 12th-grade samples (see Table 1). For this reason, the data presented below were weighted to better represent the original seventh-grade sample. Weights were inversely proportional to the predicted probability of response in 10th and 12th grades based on a logistic regression using seventh-grade characteristics. Separate models were fit for the major racial–ethnic groups. As shown in Table 1, this produced estimates of risk behavior and ethnic composition that closely approximated those reported by the original sample. The linearization method was used to correct for the use of weights in tests of statistical significance (Binder, 1983; Research Triangle Institute, 1995).

Procedure

Participants completed self-administered surveys. All seventh-grade surveys were completed in the classroom. Tenth-grade surveys were completed in the classroom unless students dropped out of school or transferred to another school. In these cases (26% of the 10th-grade group), surveys were mailed to participants' homes. Because of high rates of school transfer and dropout, all 12th-grade surveys were mailed to participants' homes.

To examine the validity and reliability of self-reports over the first four waves of the study, several methods were used. We collected saliva samples prior to the survey and compared the results for cotinine (a metabolite of nicotine) with self-reported smoking (Ellickson et al., 1988). We also examined the consistency of self-reported substance use over time. The results suggest that the majority of students were honest about their substance use. At baseline and 15 months later, 95% of students with cotinine scores that identified them as recent tobacco users had admitted to recent use of cigarettes or smokeless tobacco on their questionnaires (Freier et al., 1991). Across four waves of data, the proportion of students who denied using a gateway substance after previously admitting use averaged about 5%. Retractions of frequent use averaged substantially less than 1% (Reinisch et al., 1991). For illicit drugs other than marijuana (cocaine, uppers, downers, psychedelics, heroine, morphine, codeine, and opium were studied at multiple waves), retractions averaged 2.6%.

MEASURES

Drug Use Variables

We measured four types of simultaneous polydrug use. At 12th grade, participants indicated how many times in the past year they had used each pair of drugs "on the same occasion": alcohol with downers, alcohol with uppers, alcohol with marijuana, and cocaine or crack with any other drug. The use of alcohol with other drugs was a particular focus of these measures because of the high prevalence of alcohol use among 12th-grade adolescents and the apparent high prevalence of alcohol-based SPU relative to SPU of

other types (Martin et al., 1992). Participants made their responses on a scale from zero (''none'') to six (''40 or more times''). We recoded these responses to reflect any use vs. no use of each of the four combinations.

To compare the prevalence of SPU with the broader class of CPU, we also assessed the use of several individual substances in the 12th-grade survey: alcohol, marijuana, uppers, downers, crack, cocaine in other forms, PCP, LSD, ''other psychedelics,'' heroin, and ''other narcotics.'' Synonyms and street names for each drug were listed when appropriate. Responses to these items were made on a variety of scales reflecting frequency of use in the past year. Any reported use of two or more of these substances was coded as CPU.

Predictor Variables

From the 10th-grade data set, we selected indicators of each major class of substance-use predictors described in the Introduction: social bonds, prior problem behavior, drug-related cognitions, social-learning factors, drug availability, and an indicator of mental health. In addition to race and gender, we included other demographics often associated with drug-use patterns: parental income and educational status, and participant age. The candidate-predictor variables are shown in Appendix A, together with descriptive statistics. Each of the measures described in Appendix A has been used effectively to predict substance use, violence, and school dropout in our previous studies (e.g., Saner and Ellickson, 1996; Ellickson et al., 1998, 1999). They show appropriate patterns of intercorrelation suggesting convergent and discriminant validity.

PRO-DRUG ENVIRONMENT

Four variables reflected the extent to which participants were exposed to a pro-drug environment. ''Parent Use/Approval of Drugs'' was composed of an approval scale and six parent-use items ($\alpha = 0.70$). For each of three substances (alcohol, marijuana, and cigarettes), students indicated how frequently they thought it was used by the most important male in their lives. The same three items were repeated for the most important female. The approval scale was an average of three items indicating the extent of upset students expected their parents to feel if the student used alcohol, cigarettes, or marijuana. All items were assessed using 4-point scales. A parallel scale measured ''Peer Use/Approval of Drugs'' ($\alpha = 0.89$). Six items measured perceived use of alcohol, marijuana, and cigarettes, first by the participant's ''best friend'' and then by other peers; a three-item scale measured perceived approval or disapproval by friends of participant's use, averaged across the three substances. All these scale components were assessed on response scales ranging from one to four.

For the measure of ''Offers of Drugs,'' participants indicated the number of times in the past year they had been offered each of three substances: cigarettes, alcohol, and marijuana. Ratings were made on three 5-point scales and we took their average ($\alpha = 0.81$). Being offered drugs taps both drug availability and exposure to drug-use role models. We measured ''Drug Availability'' more directly with the average of four items. Participants indicated on 4-point scales how difficult they thought it would be to obtain marijuana, uppers, cocaine, and alcohol ($\alpha = 0.80$).

OTHER FAMILY, CHURCH, AND SCHOOL FACTORS

Four measures of family bonding were included in our analyses. A dichotomous variable, ''Intact Nuclear Family'' indicated whether participants lived with both their father and mother. Participants were also asked with whom they discuss their problems: friends, parents, both, or neither. The dichotomous variable ''Talks Over Problems with Parents'' indicated a choice of either the second or third category. ''Parents Don't Respect Feelings/Don't Respect Opinions'' was the average of two 4-point scales reflecting agreement with each of these sentiments ($\alpha = 0.77$). Finally, ''Number of Disruptive Family Events'' indicated how many of three major family events had occurred in the past year: a parent had remarried, a parent had been hospitalized, or a parent lost a job.

Four variables assessed school bonds and their disruption. To measure ''Poor Grades,'' participants indicated whether their grades were mostly As, Bs, Cs, Ds, or Fs, and were assigned a score from 1 to 5, respectively. ''Limited Academic Goals'' were measured using a 6-point scale on which participants indicated the amount of schooling they expected to complete (from post-college education to dropping out of high school). Two additional variables were collected at the 12th grade. In that survey, participants indicated the grades they had repeated, from K through 12, and how many elementary, junior high, and high schools they attended. ''Number of Grades Repeated'' was computed as the sum of repeated grades through the ninth; ''Number of Schools'' was computed as the sum of elementary and junior high institutions. Although procured at the later wave, these measures reflect conditions present at approximately the same time the other predictors were measured and prior to the period of drug use assessed by our outcome measures.

''Religiosity'' was measured as the mean of two items (with 4- and 5-point response scales) indicating the influence and importance of religion in participants' lives ($\alpha = 0.78$). The items were scored to reflect low religiosity.

PROBLEM BEHAVIOR

We included three potential problem behavior variables in our analyses; deviance, rebelliousness, and social activity. ''Deviance'' was an eight-item scale measuring frequency during the last year of theft from a store, skipping school, getting in trouble with the police, breaking into a house, being sent out of class, damaging on purpose something that belonged to another, taking something worth more than US$20, and running away from home overnight. These items were rated on a zero to 3 response scale and their average taken ($\alpha = 0.82$). ''Rebelliousness'' ($\alpha = 0.67$) was measured by average agreement (on a scale of 1 to 4) with the items: ''I get away with as much as I can,'' ''I enjoy doing things I should not do,'' ''I feel guilty when I break a rule'' (reversed), and ''When told to do something by a teacher I do it'' (reversed). ''Time Budgeted to Social Activities'' used the average of three items to measure the amount of time participants spent driving around for fun, attending dances or parties, and dating ($\alpha = 0.70$). In our previous work, these behaviors have been associated with later substance use among younger adolescents. The response scale for the items ranged from 1 (''almost never or never'') to 4 (''most days'').

DRUG-RELATED COGNITION

Three variables assessed different aspects of drug-related cognitions: pro-drug beliefs, drug-use intentions, and resistance self-efficacy. "Pro-drug Beliefs" were measured using the average of 34 items rated on a 4-point scale ($\alpha = 0.93$). Each item reflects agreement with commonly held beliefs about the positive or negative consequences of using marijuana, cigarettes, and alcohol (e.g., "cigarette smoking relaxes you," "smoking pot makes you do things you regret"). Items were scored so that higher numbers reflected more positive perceptions of drug-use outcomes. The measure of "Drug-Use Intentions" was the average of three items measuring intent to smoke cigarettes, drink alcohol, or use marijuana in the next 6 months. Responses were made on a 4-point scale ranging from "definitely no" to "definitely yes" ($\alpha = 0.75$). "Resistance Self-Efficacy" measured participants' perceptions that they could resist using alcohol, cigarettes, or marijuana in a number of situations: offers by a date, if a best friend was using, when at a party where peers were using, and when bored. Twelve items measured these expectations using response scales ranging from 3 to 5 points ($\alpha = 0.87$).

MENTAL HEALTH

To measure "Poor Mental Health," we used the MHI-5, a five-item scale commonly used to assess psychological distress (Stewart et al., 1992). Responses were made on a 6-point scale, and items were averaged to reflect the frequency of negative emotion in the past month ($\alpha = 0.81$).

RACE / ETHNICITY

Race/ethnicity was assessed by responses to the question "How do you describe yourself?" Options were: white, African American, Asian American, Mexican American, Puerto Rican/other Latin American, American Indian, and "other." Because there were not enough individuals in the latter three groups to reliably examine within-race predictors of drug use, participants in these categories were dropped from the sample. This measure was taken at the 12th grade.

DEMOGRAPHICS

Several other demographic variables were also examined: gender, respondents' age in years (measured with precision to the day), family income (adjusted for the number of persons in the household), and parents' educational/occupational status ($a = 0.69$). The latter averaged the highest of the two parents' Duncan occupational prestige scores (range of 8–69) (Stricker, 1988) and the highest level of education attained by either of the two parents (rated on a 1 to 9 scale; no high school diploma to advanced professional degree). The resulting scale had $\alpha = 0.69$.

For all predictor variables other than race, scale scores were imputed from available items when one or more individual items were missing. In the case of single-item measures or scales for which all contributing items were missing, other correlated variables in the data set were used for imputation (the maximum number of cases for which a given variable was imputed was 133). All items and subscales were standardized before being combined into the final scales. Scales and items with particularly skewed distributions were log transformed prior to analysis. To facilitate interpretation of parameter estimates

TABLE 2
Prevalence of Nine Forms of Drug Use at Grade 12

Drug Type	*Weighted Percentage*	*Unweighted Percentage*	*N*
Alcohol	78.6	78.2	3959
Marijuana	35.8	32.8	4026
Uppers	10.0	8.9	4060
Downers	3.1	2.8	4062
Cocaine	8.0	7.2	4062
Any hard drugs	19.1	17.1	4070
CPU	36.9	33.9	4070
Alcohol with marijuana	27.6	24.9	4070
Alcohol with downers	2.3	1.9	4070
Alcohol with uppers	6.7	5.8	4070
Cocaine and other drugs	5.3	4.8	4070
Any hard-drug SPU	9.9	8.6	4070
SPU	28.9	26.1	4070

and odds ratios, we also standardized most of the predictor variables prior to conducting the regression analyses. Variables measured dichotomously or as counts (e.g., whether the respondent had an intact nuclear family and the number of grades he or she had repeated) were left in raw form (see Appendix A).

RESULTS

The prevalence of various forms of drug use at Grade 12 is shown in Table 2. Consistent with previous work, the majority of 12th grade students had used alcohol in the past year. In addition, more than 30% had used marijuana and almost 20% had used some other illicit substance in the year preceding the study. As these high prevalence rates would suggest, concurrent polydrug use was fairly common — 37% of 12th-grade students engaged in this behavior. Simultaneous polydrug use was almost as prevalent. The weighted estimate of all those who had used two drugs on a single occasion was 29%. A cross tabulation of these two variables indicated that simultaneous polydrug users made up 76% of the population of concurrent drug users in our sample.[1]

Notably, the number of 12th graders who used alcohol and marijuana in combination (28%) was about 77% of the total number of marijuana users (36%). Seventy-four percent of those using downers had combined them with alcohol; 67% of uppers-users did so. About the same percentage of cocaine users (66%) had combined this with other drugs. Overall, polydrug use involving hard drugs was more common than the use of any single substance in the ''hard'' drug category except uppers.

We next explored the relationship between the various forms of SPU measured. As Table 2 indicates, the combined use of alcohol and marijuana was by far the most common form of SPU. Moreover, the percentage of persons engaging in any SPU was only slightly higher (1.3% more) than the percentage combining alcohol and marijuana. Clearly, few adolescents combine alcohol with downers or uppers, or use cocaine with other substances, unless they also engage in alcohol/marijuana SPU. Many

TABLE 3
Weighted Prevalence of Two Forms of SPU at Grade 12 by Gender and Ethnicity (Percentages) (N = 4,070)

Variable	*None*	*Alcohol with Marijuana (Only)*	*Hard Drugs with Other Substances*
Gender			
Male	68.66	20.92	10.41[a]
Female	73.70	17.01	9.29[a]
Ethnicity			
White	69.75[a,b]	19.20[a]	11.05[a]
African American	75.47[a,c]	22.68[a]	1.85
Mexican American	65.57[b]	20.56[a]	13.87[a]
Asian American	82.55[c]	10.76	6.69
Totals	71.1	19.0	9.9

Note. Within columns, gender groups and ethnic groups not sharing a common superscript are significantly different.
a. $p < 0.05$, $df = 1$.
b. $p < 0.05$, $df = 1$.
c. $p < 0.05$, $df = 1$.

apparently engage in alcohol/marijuana SPU without partaking of other forms of SPU. To confirm this, we cross-tabulated a variable indicating the use of any form of hard-drug SPU (based on our three related items) with the alcohol/marijuana item; 87% of those who used hard drugs in combination with other substances also combined alcohol with marijuana. In contrast, only 30% of persons who combined alcohol and marijuana also engaged in hard-drug SPU. This pattern suggested the appropriateness of distinguishing these two forms of SPU. To do so, we created a new three-level variable indicating whether an individual had, in the past year, never engaged in SPU, only combined marijuana and alcohol (never using "hard" drugs in combination with other substances, according to our three items), or engaged in one or more forms of hard-drug SPU. The weighted percentage of participants falling into each of these categories is shown in the final row of Table 3.

We then computed likelihood ratio χ^2 statistics to test for gender and race differences in these percentages. Both were significant: gender $\chi^2(2) = 10.34$, $p < 0.01$; race $\chi^2(6) = 44.34$, $p < 0.0001$. Consistent with previous studies, female adolescents were less likely to engage in SPU than were males, although not hard-drug SPU (see Table 3). For race, the picture was somewhat more complex. In general, white and Mexican American youth were more likely to be involved in polydrug use than were African and Asian Americans. However, in the case of African American youth, it appears that this difference is entirely attributable to lower rates of hard-drug SPU; rates of alcohol and marijuana combination in this group are as high as those in any other race. In contrast, Asian American youth appear less likely to engage in any form of SPU, relative to white and Mexican American adolescents (Table 3).

We had planned to use the three-level SPU categorization as the outcome in an ordinal logistic regression analysis. However, the finding that race differences follow different patterns across each form of use suggested a possible discontinuity in the predictors of different types of SPU. This was confirmed by our first multiple regression analysis. When SPU was used as if it were ordinal, a test for the assumption of parallel regression lines

TABLE 4
Predictors of Combining Alcohol and Marijuana vs. No Polydrug Use (N = 3,0660)

	Ethnicity and Gender Model			*Full Model*		
Predictor	*Odds Ratio*	*Beta*	*HSE*	*Odds Ratio*	*Beta*	*HSE*
African American	1.10	0.09	0.17	1.56*	0.45	0.20
Mexican American	1.14	0.13	0.17	1.18	0.17	0.19
Asian American	0.47***	−0.76	0.19	0.71	−0.34	0.23
Female	0.75**	−0.29	0.09	0.71**	−0.35	0.12
Drug offers				1.39***	0.33	0.08
Pro-drug beliefs				1.30***	0.26	0.07
Drug-use intentions				1.66***	0.51	0.10
Deviance				1.19**	0.17	0.07
Intact nuclear family				0.70**	−0.35	0.12

Note. All variables shown in Appendix A were entered in the full model; only significant predictors, gender and ethnicity effects are reported in this table.
*$p < 0.05$; **$p < 0.01$; **$p < 0.001$.
HSE = Huberized Standard Error.

showed significant misspecification; $\chi^2(27) = 66.88$, $p = 0.0001$. This indicates different predictors of inclusion in category one vs. two (no SPU vs. combining alcohol/marijuana only) and category two vs. three (combining alcohol/marijuana only vs. hard-drug SPU). Based on these findings, we treated the combination of alcohol with marijuana (only), and hard-drug forms of SPU as separate outcomes, conducting two sets of logistic regression analyses to address each of our remaining analytic questions.

We began by predicting the combination of alcohol and marijuana (only) vs. no polydrug involvement. In our first equation, we entered only gender and race as predictors of this behavior, with the race dummy variables coded to reflect membership in a given race category vs. being white (because whites were by far the largest group, we used them as the referent). The result is reported in the left side of Table 4. As the table indicates, being female (OR = 0.75, $p < 0.01$) and being Asian American (OR = 0.47, $p < 0.001$) were both associated with less alcohol/marijuana SPU. We then conducted a test of the full multivariate model, including other candidate predictors along with the race and gender variables. All predictors were entered simultaneously. The outcome of this analysis is displayed in the right side of Table 4. Pro-drug cognitions were among the most powerful predictors of combining alcohol and marijuana, with both pro-drug beliefs (OR = 1.30, $p < 0.001$) and drug-use intentions (OR = 1.66, $p < 0.001$) predicting this behavior. Being the recipient of drug offers was also a significant risk factor for later polydrug use (OR = 1.39, $p < 0.001$). Consistent with social bonding theory, being part of an intact nuclear family was a strong protective factor (OR = 0.70, $p < 0.01$), although religion and school variables did not enter the predictive model. In addition, we replicated earlier findings that problem behavior predicts SPU (Martin et al., 1992, 1996a). In the present case, it was measured by our deviance scale (OR = 1.19, $p < 0.01$).

Also among the best predictors of combined alcohol and marijuana use in this full model were gender (OR = 0.71, $p < 0.01$) and African American race (OR = 1.56, $p < 0.05$). The gender finding is consistent with that obtained in the smaller regression model and in our univariate test for gender differences. Examination of the odds ratios for the full model and the more circumscribed version indicate only a very small

TABLE 5
Mean Scores on Alcohol/Marijuana SPU Predictors by Race

Predictor	*African Americans (N = 330)*	*Asian Americans (N = 355)*	*Whites (N = 3,067)*
Drug offers	−0.22***	−0.42***	0.15
Pro-drug beliefs	−0.01	−0.06*	0.09
Drug-use intentions	−0.30***	−0.34***	0.13
Deviance	0.15	−0.09**	0.08
Intact nuclear family	0.35***	0.78***	0.55

Note. For comparisons of each group to Whites, *$p = 0.07$; **$p < 0.05$, ***$p < 0.001$, after Bonferroni correction.

difference in their magnitudes (0.75 vs. 0.71). This indicates that the other predictors of alcohol/marijuana SPU are unrelated to, and therefore cannot explain, the relationship between gender and this variable (Baron and Kenny, 1986).

In contrast, the odds ratios for the African American variable (1.10 vs. 1.56) and the Asian American variable (0.47 vs. 0.71) are quite different in the two equations. When other variables are accounted for, Asian American youth are no less likely than others to engage in polydrug use. This suggests that advantages among Asian American youth in regard to drug cognitions, offers, deviance, and/or family factors may explain the low drug-use prevalence we observed in this group (Baron and Kenny, 1986). Likewise, the emergence of African American status as a risk factor for alcohol and marijuana SPU in the full model suggests that African American youth are advantaged on one or more of these variables. Thus, when standing on such variables is controlled statistically (as occurs in the multivariate model), a difference between African American and other adolescents emerges, favoring the latter group.

To explore which of the five predictors of combining alcohol and marijuana might be responsible for the differences observed across our partial and full models, we computed means for each predictor by racial group. These are reported in Table 5, along with significance tests for differences between Asian Americans and whites, and African Americans and whites. The table suggests that all five variables may mediate the associations between race and alcohol/marijuana polydrug use. However, not all differences between African Americans and whites are statistically significant (pro-drug beliefs and deviance were not), and in the case of the nuclear family variable, the difference is in a direction opposite to one that might account for the shift observed between our two regression equations. African American youth in our sample were disadvantaged in this regard, and may therefore be at greater risk for polydrug use when it is not controlled statistically. Alternatively, family disruption may not influence drug use among African Americans, even though it did so for our sample as a whole. Our analyses do not allow us to resolve this issue. Asian American adolescents were significantly advantaged over Whites on all five variables.

Next, we turned to the prediction of hard-drug SPU, again conducting two logistic regression tests to explore for mediators of any gender or race effects (Baron and Kenny, 1986). The outcome variable for these tests contrasts adolescents combining alcohol and marijuana only with those using hard-drug combinations. Results are reported in Table 6. In the smaller model, only African American race emerged as a predictor of hard-drug

TABLE 6
Predictors of Hard-drug SPU vs. Combining Alcohol and Marijuana (N = 1,045)

	Ethnicity and Gender Model			*Full Model*		
Predictor	*Odds Ratio*	*Beta*	*HSE*	*Odds Ratio*	*Beta*	*HSE*
African American	0.14***	−8.09	0.44	0.13***	−8.20	1.20
Mexican American	1.18	0.00	0.24	0.81	−0.05	0.30
Asian American	1.11	0.02	0.33	1.25	0.29	0.39
Female	1.10	0.04	0.15	1.36	0.08	0.21
Drug offers	–			1.26**	0.37	0.13
Drug availability	–			1.36**	0.37	0.15

Note. All variables shown in Appendix A were entered in the full model; only significant predictors, gender, and ethnicity effects are reported in this table.
**$p \leq 0.01$, ***$p \leq 0.001$.
HSE = Huberized Standard Error.

polydrug use, exhibiting a strong negative association with this behavior, just as it had in our univariate test (OR = 0.13, $p < 0.001$). This effect was unaltered in the full model. The larger model also revealed exposure to drug offers (OR = 1.26, $p < 0.01$) and perceptions of drug availability (OR = 1.36, $p < 0.01$) as important risk factors for hard-drug SPU. The reader should note that controlling for these two variables did not affect the relative likelihood of individuals from different racial or gender groups combining hard drugs and other substances. That is, odds ratios for race and gender were similar in the small and large equations.

DISCUSSION

Results of the present study add significantly to our understanding of an important aspect of adolescent substance use: the use of two or more drugs in combination. First, they provide evidence regarding the scope of the polydrug use problem among older adolescents. More than one-third of those in our 12th-grade sample had used multiple substances in the past year, and the number engaging in SPU approached 30%. These percentages are not insubstantial. Fifty percent more youth were involved in polydrug use than use of hard drugs (19% prevalence rate). Of those who had used marijuana in the past year, more than 70% had combined it with alcohol at least once. Of those who had used other illicit drugs, more than half had used them at the same time they used another drug. Indeed, polydrug use involving hard drugs was more common than the use of any single drug in the "hard" category with the exception of uppers (to which it was equal in prevalence of use).

These data should not be taken as estimates of current polydrug prevalence in the population of U.S. 12th graders. Our data were collected in 1988 and 1990, and drug-use prevalence fluctuates over time, especially the prevalence of particular forms of use. Moreover, the RAND Adolescent Panel is not a probability sample. Although much of the data we have obtained from this group mirrors patterns and prevalence nationwide (e.g., Ellickson et al., 1996, 1997), we cannot be certain that this is the case in the present study. It is reasonable to assume, however, that our numbers are not radically different from those

in the nation as a whole, given the diverse backgrounds and locations of panel members, our tracking and inclusion of school dropouts in the sample, and the sample size. Indeed, our weighted estimate of the prevalence of SPU is identical to the 29% obtained in the California State Attorney General's Survey of 1993–1994 (Skager, personal communication, May 9, 1996). Although it has some limitations, our prevalence data strongly suggest that greater attention needs to be paid to SPU in terms of both research and prevention.

The first step in both directions is to identify the youth most at risk for polydrug use. Our results do so, providing critical policy-development information relating demographics and SPU. Consistent with previous work, we found that female adolescents were less likely to use drugs in combination, at least in the case of the most common form of alcohol/marijuana SPU. This was true even when other predictors of SPU were statistically controlled, indicating that none can account for the gender difference. Thus, it is not lower levels of deviant behavior that leads girls to combine alcohol and marijuana less often than do boys, which might have seemed a plausible explanation in the absence of data to the contrary. We also found no evidence that drug availability or cognitions mediate gender differences in alcohol/marijuana SPU. However, because we did not measure beliefs and intentions specific to SPU in our survey, we cannot rule out cognition as playing this role. Our measures reflected adolescents' attitudes and beliefs regarding the use of cigarettes, alcohol, and marijuana in general. It could be that girls view the consequences of SPU more negatively than do boys, and that this accounts for their lesser likelihood of engaging in this behavior.

We did not obtain any difference between boys and girls in their likelihood of engaging in hard-drug SPU; the combination of uppers or downers with alcohol, or the combination of cocaine with another drug. Based on other predictors of hard-drug SPU identified in our study, it is clear that this form of drug use is particularly associated with environmental factors. Those exposed to drug offers and who believed they could readily obtain drugs were the adolescents who were most likely to engage in this behavior. Thus, the kinds of differences that may protect girls from other forms of drug use, stronger social bonds and less deviance, do not appear to operate here.

In addition to these gender patterns, we found evidence of fairly strong racial differences in SPU. In a univariate test and in the smaller regression model that included only race and gender, Asian Americans were only half as likely as whites to combine the use of alcohol with marijuana. This difference was at least partly explained, as indicated in the full regression model, by five factors: receiving offers of drugs, holding positive beliefs about drug use, intending to use drugs in the future, deviant behavior, and living as part of an intact nuclear family. These factors were the best predictors of alcohol/marijuana combination in the sample as a whole, and Asian American youth were advantaged (i.e., less at risk for polydrug use) in regard to all of them. These attributes did not influence Asians' involvement with hard-drug SPU, however. They were as likely as whites to engage in this form of drug use, regardless of statistical controls.

African American youth were different from others in regard to both forms of polydrug use tested. At the univariate level, they were far less likely than any other group to engage in hard-drug SPU, and the tested difference from whites held up in the multivariate model. In regard to combining alcohol with marijuana, the picture was quite different. In this case, African Americans' use was equivalent to that of whites and Mexican Americans in univariate tests, but much higher than whites' use in the multivariate model. This pattern

of findings should not be interpreted as indicating that African American youth are particularly vulnerable to alcohol/marijuana SPU. When predictors of this type of SPU are not statistically controlled, they appear no different from other groups. It is only when African Americans' advantaged standing on SPU predictors is removed from the equation that an effect of their race emerges. Our African American sample was less likely to be offered drugs in 10th-grade, and was less likely to intend to use drugs in the future, than was the white sample. Interestingly, although African American youth were more likely than whites to live in disrupted families, and family structure was a factor in alcohol/marijuana SPU, this did not put them at greater risk. Apparently, family structure does not mediate the effect of African American race on this form of SPU.

Our findings regarding race might be seen as support for targeted interventions focusing on particular racial groups. However, the monetary and administrative costs of developing multiple interventions and identifying target audiences are not easily justified given our total pattern of results. Other predictors were able to account fully for the racial differences in SPU that we observed (the exception to this is the finding that African Americans are less vulnerable to hard-drug SPU, a finding that does not suggest the utility of targeted intervention). Thus, broad programs that address the factors putting all youth at risk for simultaneous polydrug use should be effective regardless of race, and should eventually level the playing field by reducing present differences between races regarding drug-related attitudes and drug availability. Our results concerning gender, in contrast, suggest that it may be of use to direct SPU prevention toward boys. Because we cannot account for their somewhat higher risk of combining alcohol and marijuana, however, more work would be needed to inform the content of such an intervention.

Another contribution of the present study is our identification of SPU predictors apart from gender and race. We identified five factors predicting adolescent use of alcohol in combination with marijuana. The combination of alcohol and marijuana was driven by cognitions (in the form of beliefs and intentions), environment (receiving drug offers), problem behavior (such as stealing, or acting out in school), and family structure. This model encompasses all of the major factors associated with general adolescent substance use.

The predictive importance of coming from a nuclear family suggests that adolescents with strong family bonds are less vulnerable to pro-drug social influences (e.g., exposure to drug offers and drug users) than are those with weak bonds. Although we did not directly test this pathway to drug use, earlier studies have shown that coming from a disrupted family predicts exposure to drug offers, which in turn predicts subsequent drug use (Oetting and Beauvais, 1987; Ellickson and Hays, 1992). Similarly, prior deviance may enhance the likelihood of exposure to pro-drug influences and vulnerability to those contexts.

In regard to cognition, our measures of drug-use intentions and consequences include separate items for alcohol, cigarettes, and marijuana, but not for hard drugs. Still powerful 2 years later, these expressions of intent and perceived harm or benefit predict the likelihood of simultaneous use of alcohol and marijuana. Notably, they do not predict hard-drug SPU. These results suggest cognitive factors are key predictors only when they measure beliefs and intentions about each of the substances later used in combination. Intentions and beliefs may be highly specific, tapping perceptions linked to individual drugs and not typically generalized to other substances.

In contrast, the environmental variable tapped offers of alcohol, marijuana, or cigarettes, and it promotes hard-drug SPU as well as simultaneous use of alcohol and marijuana. These results tentatively suggest that situational factors are more generalizable across substances; teenagers who are offered the first three substances are likely to be in situations where other drugs are available as well. Nevertheless, access to specific hard drugs is also important: teenagers who thought cocaine and uppers (as well as alcohol and marijuana) were relatively easy to get were more likely to engage in hard-drug SPU.

More generally, our results suggest that using hard drugs in combination with other substances is dominated by access issues. The two variables that distinguished youth who engaged in this behavior from those who only combined alcohol and marijuana were both indicators of an environment where drugs are easily obtained.

The importance of availability to predicting 12th-grade SPU is in contrast to studies of marijuana and cocaine use among youth of this age. Bachman et al. (1996) have shown that declining use of these two substances is associated with more negative attitudes toward each drug, and not with a reduction in their perceived availability. Several differences between their analysis and our own may explain the discrepancy. Most obvious is the dependent measure employed in each body of work. It may be that availability is related to combining substances, but not to their individual use. Youth who have greater difficulty obtaining drugs may use them one at a time, spreading their use out over a greater number of "highs," while those who have easy access may feel free to use multiple substances all at once. In addition, Bachman et al. (1996) looked at their data in aggregate form, tracking use among high school seniors over a 13-year period and relating it to availability in each year. Youth who felt the most able to get drugs in each year may have been most likely to use them, even if average decreases in availability did not relate to overall declines in use. We note that our results are consistent with other studies of adolescent drug use that employed the same person-level analytic strategy. In their analysis of the National Longitudinal Study on Adolescent Health, Resnick et al. (1997) found that self-reported easy access to cigarettes, alcohol, and marijuana in the home were associated with the use of each of these substances. Similar results have been obtained by Dembo et al. (1979) and by Maddahian et al. (1986).

Limitations and Future Directions

The present study has several limitations that influence the conclusions that may be drawn from the data. Our sample's representativeness of 12th-grade youth in 1999 was discussed as one limitation, above. In addition, one might question the reliability and validity of the retrospective self-reports on which our analyses rely. This problem is common to nearly all studies of young people's substance use. Fortunately, studies examining the quality of such data suggest that it is quite good (O'Malley et al., 1983), and our tests for longitudinal inconsistency in reports (described in the Method section) support this conclusion. Another potential limitation is our focus on predicting and describing any simultaneous polydrug use, rather than on polydrug-use frequency. Almost certainly, some youth engage in polydrug use very rarely, or experiment with it just once. The predictors of such behavior may differ from those associated with regular or ongoing SPU. Data regarding frequency and predictors of frequency will clearly advance our ability to prevent adolescent SPU. Nonetheless, any use of drugs in combination presents a

danger, and understanding its occurrence and identifying those at risk for such an event is also critical. A final limitation to keep in mind is our study's timeframe. The predictors we have uncovered are limited to factors present 2 years prior to reported SPU. We focused on this time period in this initial effort in order to maximize our ability to identify variables associated with SPU. Events in closer proximity to an outcome are likely to be stronger predictors of it. In future work, it will be important to test for predictors present at a much earlier age, so that at-risk youth can be targeted for intervention before problems with substance use develop.

CONCLUSION

The results have several implications for drug-use prevention with teens. It seems clear that interventions to prevent SPU should focus on motivational and environmental factors. Adolescents' beliefs about the risks and benefits of drugs and their intentions to use them play a particularly strong role in alcohol/marijuana SPU, and should be addressed. Environmental factors have a strong relationship with simultaneous polydrug use of all types. Policy-based interventions that remove drugs from the school and programs that increase supervision of social activities may therefore be particularly useful in preventing or stopping SPU, as are programs that help adolescents develop motivation to avoid drug use and the skills to resist pro-drug pressures.

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APPENDIX

Predictor Variables and Descriptive Information

Variable	*Form*[a]	*Type*	*Mean*[b]	*SD*	*Alpha*
Female Gender	Raw	Dichotomous	0.48	0.62	–
Race/Ethnicity	Raw	Categorical	–	–	–
Other Demographic Factors					
Age (on Sept. 1, Grade 10)	Raw	Computed	15.43	0.52	–
Family income (adjusted)	Std	Computed	0	1	–
Parent education/occupation	Std	2-Item Scale	0	1	0.69
Social Influences					
Parent drug use/approval of use	Log, Std	7-Item Scale	0	1	0.70
Peer drug use/approval of use	Std	7-Item Scale	0	1	0.89
Drug Availability					
Drug offers	Std	3-Item Scale	0	1	0.81
Drug availability	Std	4-Item Scale	0	1	0.80
Family, School, and Church Factors					
Intact nuclear family	Raw	Dichotomous	0.59	0.49	–
Talks over problems with parents	Raw	Dichotomous	0.40	0.49	–
Parents don't respect	Std	2-Item Scale	0		0.77
Disruptive family events	Raw	Count (0–3)	0.49	0.72	–
Poor grades	Raw	Item (1–5)[c]	2.25	0.89	–
Limited academic goals	Std	Item	0	1	–

Number of grades repeated	Raw	Count (0–3)	0.16	0.39	–
Number of schools attended	Raw	Count (0–10)	3.18	1.47	–
(Low) Religiosity	Std	2-Item Scale	0	1	0.78
Problem Behavior/Lifestyle Factors					
Deviance	Log, Std	8-Item Scale	0	1	0.82
Rebelliousness	Std	4-Item Scale	0	1	0.67
Time socializing	Std	3-Item Scale	0	1	0.70
Drug-related Cognition					
Pro-drug beliefs	Std	34-Item Scale	0	1	0.93
Drug-use intentions	Std	3-Item Scale	0	1	0.75
Resistance self-efficacy	Std	12-Item Scale	0	1	0.87
Poor Mental Health	Std	5-Item Scale	0	1	0.81

Note. a. Form when entered into regression analyses and the displayed statistics computed.
b. Means are weighted to represent the original baseline sample.
c. A grade of "A" was coded as 1, "B" as 2, "C" as 3, "D" as 4 and "F" as 5.
Log = log transformed, Std = standardized.

NOTE

1. Although all participants had sufficient data to compute CPU, 67 were missing information regarding one or more SPU variables. As a result, the number of CPUs who are SPUs is slightly less than a comparison of the separate percentages would suggest.

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