Perspectives on Adolescent Substance Use

A Defined Population Study

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We asked 1447 tenth graders to complete a survey on physical activity, nutrition, stress, and substance use and to undergo basic physical assessments. In a multiple regression analysis, increased level of substance use by both boys and girls was most strongly predicted by friends' marijuana use. For boys, this was followed by perceived safety of cigarette smoking; poor school performance; parents' education; and use of diet pills, laxatives, or diuretics for weight control, accounting for 44% of the overall variation in substance use. For girls, friends' marijuana use was followed by poor school performance; self-induced vomiting for weight control; perceived safety of cigarette smoking; use of diet pills, laxatives, or diuretics for weight control; parents' education; perceived adult attitudes about cigarettes; and nonuse of seat belts, accounting for 53% of the overall variance. Separate multiple regression analyses for each substance produced similar results. The homogeneity of the study population precluded ethnic comparisons. These findings suggest that for many purposes substance use may be considered a single behavior regardless of the specific substance(s) used and that substance use may exist as part of a syndrome of adolescent problem behaviors. In addition, the potent influence of perceived social environment suggests that a social influence resistance model may represent the most successful preventive strategy.

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THE DECLINE in adolescent drug use that began in 1980 may have come to a halt. Recent data suggest that after four years of steady decline in illicit drug use by high school seniors, prevalences of marijuana and LSD use stabilized in 1985, while cocaine, phencyclidine hydrochloride (PCP), and opiate use actually increased.[1] These data suggest that substance abuse will continue to be a significant problem among American youths and that successful preventive interventions have yet to be widely implemented. Although a large body of research literature has identified many factors associated with adolescent substance use, most studies report isolated findings that are difficult to integrate into a coherent risk factor model. Problem-behavior theory[2] represents one useful framework for studying factors that may promote adoption and maintenance of substance use. Problem behaviors are defined by their departure from social norms and their likeliness to elicit negative sanctions. Problem-behavior theory suggests that tendency to problem behaviors can be accounted for by the interaction of demographic, psychological, social environmental, and behavioral variables. Psychological variables include attitudes, values, beliefs, knowledge, and expectations relative to the behavior in question. Social environmental variables represent the influences of surrounding peers and adults. Behavioral variables represent the degree of involvement in other problem behaviors and in socially approved behaviors.

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The problem-behavior model has demonstrated efficacy in predicting cigarette smoking,[3,4] problem drinking,[5] and marijuana use[6] as well as adolescent sexual activity,[2,7] general deviant behavior,[2] and seat belt use.[8] These findings suggest that common patterns of risk factors may exist for a large group of problem behaviors. In addition, the problem-behavior model may be relevant to health risk behaviors not previously defined as problem behaviors.[9] The consideration of substance use as part of a syndrome of problem behaviors could provide a focus for the development of intervention strategies.

In a defined population study we tested the following hypotheses: (1) Substance use may be considered a single behavior regardless of the specific substance(s) used. (2) Substance use is part of a syndrome of adolescent problem behaviors. (3) Social influences represent the strongest predictors of involvement in adolescent substance use. In addition to standard problem-behavior variables, health risk variables relating to physical activity, nutrition and weight regulation, stress, and personal risk taking were included in our investigation.

SUBJECTS AND METHODS

During September 1985, tenth graders (N = 1447) enrolled in four northern California high schools were asked to complete a survey designed to detect the presence of physical characteristics and behaviors related to risk for coronary heart disease. Of these students, 1344 (92.9%) responded to items querying frequency of use of at least one substance. Response rates were between 90% and 92% for each of the individual substance use items. Average age was 15 years. Self-reported ethnic distribution was as follows: 69.0% white, 2.0% black, 13.1% Asian, 6.4% Latino, 0.3% American Indian, 0.4% Pacific Islander, and 8.9% other. Fifty percent of the students' fathers completed four or more years of college.

Assessments were performed by trained staff over two days in each of the four schools. Boys and girls were separated into two classrooms and completed self-administered questionnaires and underwent physical measurement in groups of 40 to 50. School personnel did not participate in any part of the data collection.

Predictor Variables

Predictor variables were modeled after the problem-behavior theory framework utilized in past research.[2,5,6] In addition, we extended the model by adding psychological, behavioral, and physical variables that have been theoretically or empirically related to substance use by other investigators.

Demographic Variables

Parents' education was measured as the mother's or father's education level, whichever was higher. Age is not a factor in this population, and sex was controlled for. The predomination of

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whites in our population precludes meaningful ethnic comparisons.

Psychological Variables

Five psychological variables assessed student attitudes, beliefs, knowledge, and expectations with regard to substance use. These variables all represent indexes created by calculating the mean of responses to several items. Predicted substance use under social pressure assesses the strength of peer influence on substance use behaviors. Students were provided with ten hypothetical situations involving social pressures to smoke cigarettes, drink alcohol, smoke marijuana, use stimulants, or use cocaine. To each situation they responded on a five-point scale indicating whether they would use the substance specified. To assess students' attitudes toward cigarette smoking, three variables were devised. Negative and positive attitudes about cigarette smoking were measured with students' responses to statements concerning personal beliefs and values about smoking, smokers, and the functionality of smoking. Perceived safety of cigarette smoking was assessed with responses to three statements about the health outcomes of smoking with respect to duration of smoking habit, not inhaling, and quitting. Knowledge about the physiologic effects of smoking was measured with six true/false or multiple-choice questions.

Several psychological variables that do not directly concern substance use were also assessed. Intention to attend college and importance of parental approval were each measured on five-point scales with single items. A self-esteem index was created from responses to the following three items: "Other people wouldn't like me if they knew all my faults." "I know that I am not as good as other people think I am." "I am suspicious when others tell me they like me." A depressive symptoms index was created by summing *DSM-III*[10] symptoms checked on a 13-item list. In addition, students reported the value of stress reduction, physical activity, and nutrition in their lives, producing an importance of healthful behaviors index.

Social Environmental Variables

Social environmental variables attempt to characterize the students' perceptions of their peer and adult environments. Perceived friends' cigarette smoking, drunkenness, and marijuana use assess students' perceptions of substance use by their friends by asking what proportion (five-point scale ranging from "none" to "all") smoke cigarettes, have gotten drunk at least once, and smoke marijuana. Perceived peer smoking attitudes and perceived adult smoking attitudes are indexes representing student perceptions of environmental attitudes toward cigarette smoking. These variables were assessed with items concerning the perceived images and popularity of smokers and the desires of smokers to quit.

Behavioral Variables

Self-reported behaviors were assessed to test the hypothesis that substance users also participate in other problem behaviors. Students were asked how often they smoke cigarettes, drink alcohol, smoke marijuana, or break things to cope with stress as assessments of substance use to cope with stress and destructive coping behavior. Seat belt use was assessed for students driving alone, with friends, and with family. A general risk-taking behaviors index included items relating to automobile and bicycle safety, including bicycle helmet use, willingness to ride with a driver who had been drinking or taking drugs, and ratings of their own ability to drive a car after drinking. Frequency of self-induced vomiting and use of diet pills, laxatives, or diuretics for weight control were assessed as unhealthy weight regulation practices. A dichotomous regular aerobic physical activity variable was created from reported participation in one or more of five aerobic activities for at least 20 minutes three or more times a week. Heart-healthy dietary preferences were assessed by summing the number of healthful choices made from a list of 32 food pairs. School performance was assessed on a nine-point scale for "usual school grades."

Physical Variables

As an assessment of recent cigarette smoking, expired air carbon monoxide was measured with a carbon monoxide monitor (Ecolyzer 2000, Energetics Science, Hawthorne, NY). After holding a deep breath for 10 s, students expired half of the air into the room and the remainder into a polyvinyl breath-sample bag. The bag was attached to the carbon monoxide monitor through a charcoal filter. Concentrations were recorded to the nearest part per million of carbon monoxide.

To investigate the hypothesis that unhealthy behaviors, as reflected in anthropometric and physiologic measures, are related to the level of substance use, additional physical variables were included in the analysis. Body mass index (weight/height^2) is the preferred index of relative body weight as an estimate of adiposity.[11,12] Height and weight were measured on a standard balance-beam scale, and students wore lightweight gym clothing with overgarments and shoes removed. Height was rounded down to the nearest inch, and weight was rounded down to the nearest pound. Subcutaneous skin-fold thicknesses were measured with Harpenden calipers (British Indicators Ltd, St Albans, England) according to established guidelines.[13] Two sites were measured, triceps and subscapular, on the right side of the body. Resting blood pressure and heart rate were measured with an automated blood pressure device (Cardiovan 9200, Paramed Technology Inc, Palo Alto, Calif). Before measurements were started, students sat quietly for three minutes. Measurements were made on the right arm at the approximate level of the heart. Heart rate and mean arterial, systolic, and diastolic blood pressures were measured three times at one-minute intervals. The means of the second and third measurements were used in the analyses.

Substance Use

Students reported frequencies of use for each of the following substances: tobacco cigarettes; clove cigarettes; chewing tobacco; marijuana; alcohol; cocaine; and LSD, PCP, or heroin. Six frequency levels were provided: never, at least once in my life, at least once a month, at least once a week, almost every day, and every day. Students also reported frequency of drunkenness and drinking before or during school.

There is a lack of consensus on what level of substance use constitutes problem use.[1,14] For this reason we have not attempted to define problem and nonproblem use. To test the hypothesis that all substance use can generally be considered a single behavior regardless of the substance(s) used, we grouped all substances together. We classified level of substance use as the greatest frequency of use of any single substance. This classification scheme produces six categories of users: (1) those abstaining from all substance use, (2) those who have experimented with one or more substances at least once in their lives, (3) those who use one or more substances at least once a month but less than once a week, (4) those who use one or more substances at least once a week, (5) those who use one or more substances almost every day, and (6) those who use one or more substances every day.

Statistical Methods

All predictor variables were subjected to a factor analysis to help in the selection of orthogonal variables for the multiple regression procedure. Rotated

factor analysis of variables grouped as psychological, social environmental, behavioral, and physical produced 12 significant factors. Representative variables were then selected from each factor for inclusion in a multiple regression model to explain variations in level of substance use. It was our goal to identify variables that may be useful to clinicians and educators. For example, negative attitudes about cigarette smoking, positive attitudes about smoking, perceived safety of smoking, and knowledge of the effects of cigarette smoking all loaded maximally on the same factor, indicating the intercorrelation of these variables. Of these four variables, perceived safety of cigarette smoking, was selected for use in the regression analysis. Similarly, perceived friends' use of marijuana, cigarette smoking, and drunkenness also loaded as a single factor. In this case, friends' marijuana use was chosen for the analysis. Predicted substance use under social pressure, substance use for coping with stress, and expired air carbon monoxide were not included in factor or regression analyses because their similarities to the dependent variable make assessment difficult in nonanonymous clinical and community settings. Stepwise multiple regression procedures were performed separately for boys and girls and for all subjects together. Spearman correlation coefficients were calculated between all variables and level of substance use.

RESULTS

Prevalence of Substance Use

Self-reported rates of substance use are presented in Table 1. Alcohol is the most commonly used substance in this population, with 47% of the boys and 45% of the girls reporting current use to be monthly or more frequent. In addition, 32% of boys and 29% of girls report getting drunk at least monthly, although fewer than 2% of boys and 1% of girls report drunkenness almost every day or more. Drinking before or during school is reported by about 5% of the boys and 4% of the girls. Tobacco cigarettes are the next most commonly used substance overall. About 22% of boys report smoking tobacco cigarettes, while 30% of girls report smoking at least monthly, with half of them smoking every day or almost every day. A slightly greater percentage of boys smoke marijuana than tobacco cigarettes. Other substances are being used by less than 10% of the population overall.

Students were assigned to one of six levels of substance use based on the criteria outlined above. The results are displayed in Table 2. Classification to levels of substance use does not differ significantly between boys and girls ($\chi^2 = 5.6$, $P = .34$). Of those who use one or more substances every day, 71% smoke tobacco cigarettes, 20% smoke marijuana, 12% smoke clove cigarettes, 7% drink alcohol, and 4% or fewer use chewing tobacco, cocaine, LSD, PCP, or heroin. Among those who use one or more substances almost every day, 55% smoke cigarettes, 36% smoke marijuana, 11% smoke clove cigarettes, 7% drink alcohol, and 4% or fewer use chewing tobacco, cocaine, LSD, PCP, or heroin. The group of those who use one or more substances at least once a month but less than once a week consists of 68% alcohol drinkers, 33% cigarette smokers, 20% marijuana smokers, 9% chewing tobacco users, 6% who smoke clove cigarettes, and 2% or fewer who use cocaine, LSD, PCP, or heroin. The remaining categories include increasing percentages of alcohol drinkers.

Table 1.—Self-reported Substance Use for Boys and Girls

Substance	No. of Respondents	Use, % Never	At Least Once	At Least Monthly	Almost Daily or Every Day	P*
Tobacco cigarettes						
Boys	673	34.5	43.4	13.6	8.5	.0003
Girls	599	34.9	34.7	15.2	15.2	
Marijuana						
Boys	672	54.2	22.8	14.4	8.6	.003
Girls	601	57.9	22.5	15.9	3.7	
Alcohol						
Boys	665	13.1	40.3	44.3	2.3	.32
Girls	604	14.4	40.9	43.7	1.0	
Cocaine						
Boys	672	85.9	9.2	4.4	0.5	.97
Girls	603	85.2	10.0	4.3	0.5	
LSD, phencyclidine hydrochloride, or heroin						.02
Boys	668	90.4	7.3	1.2	1.1	
Girls	607	93.3	6.4	0.3	0.0	
Chewing tobacco						
Boys	680	64.3	25.0	6.8	3.9	<.0001
Girls	612	95.7	4.1	0.2	0.0	
Clove cigarettes						
Boys	677	71.7	19.9	7.4	1.0	.008
Girls	609	62.9	26.4	9.9	0.8	

*Differences between patterns of use by boys and girls were measured by χ^2 tests, $df = 3$.

Table 2.—Levels of Substance Use*

Level of Use	Greatest Reported Level of Use of One or More Substances, % Boys (n=693)	Girls (n=613)
Never	9.8	13.1
At least once (but less than monthly)	37.3	36.5
At least monthly (but less than weekly)	22.1	22.2
At least weekly (but less than almost daily)	13.4	12.6
Almost every day (but less than daily)	7.8	5.7
Every day	9.6	9.9

*$\chi^2 = 5.6$, $P = .34$.

Correlates of Substance Use

Spearman rank correlation coefficients were calculated between all predictor variables and level of substance use. Statistically significant correlations are reported in Table 3. Variables that do not correlate significantly with level of substance use include self-esteem; participation in regular aerobic physical activity; heart-healthy dietary preferences; resting heart rate and mean arterial, systolic, and diastolic blood pressures; and triceps and subscapular skin-fold thicknesses. Expired air carbon monoxide levels correlate ($r = .44$) with reported daily or almost daily tobacco cigarette smoking.

Intercorrelations of Behaviors

To test the hypothesis that problem behaviors covary, Spearman rank correlation coefficients were calculated between all pairings of the behavioral variables included in Table 3. Significant intercorrelations ($r = .07$ to $.35$, $P < .05$) exist between all variables except for the following three pairs: self-induced vomiting and school performance; self-induced vomiting and breaking things to cope with stress; and diet pill, laxative, or diuretic use and seat belt use.

Prediction of Level of Substance Use

A stepwise multiple regression analysis was performed to test the hypothesis that a selection of the above variables

Table 3.—Correlations of Demographic, Psychological, Social Environmental, Behavioral, and Physical Variables With Reported Level of Substance Use

Variable	r*
Demographic	
Parents' education level	−.05†
Psychological	
Predicted substance use under social pressure	.73
Negative attitudes about cigarette smoking	−.41
Positive attitudes about cigarette smoking	.40
Intention to attend college	−.24
Perceived safety of cigarette smoking	.22
Importance of parental approval	−.22
Knowledge of effects of cigarette smoking	−.11
Depressive symptoms	.11
Importance of healthful behaviors	−.08‡
Social environmental	
Perceived friends' drunkenness	.63
Perceived friends' use of marijuana	.61
Perceived friends' cigarette smoking	.53
Perceived peers' negative smoking attitudes	−.25
Perceived adult negative smoking attitudes	−.06†
Behavioral	
Substance use to cope with stress	.71
School performance	−.35
Risk-taking behaviors	.31
Destructive stress coping behavior	.24
Use of diet pills, laxatives, or diuretics for weight control	.22
Seat belt use	−.20
Self-induced vomiting for weight control	.15
Physical	
Expired air carbon monoxide	.34
Body mass index (weight/height²)	.12

*Spearman rank correlation coefficients. $P \leq .0001$ except where noted.
†$P < .05$.
‡$P < .005$.

Table 4.—Stepwise Regression of Variables as Predictors of Level of Substance Use

Variable	Multiple R^2
Boys	
Friends' use of marijuana	0.39
Perceived safety of cigarette smoking	0.41
School performance	0.43
Parents' education	0.44
Use of diet pills, laxatives, or diuretics for weight control	0.44
Girls	
Friends' use of marijuana	0.44
School performance	0.48
Self-induced vomiting for weight control	0.49
Perceived safety of cigarette smoking	0.50
Use of diet pills, laxatives, or diuretics for weight control	0.51
Parents' education	0.52
Perceived adult attitudes about cigarette smoking	0.52
Seat belt use	0.53

could account for a large fraction of the variation in level of substance use. Regressions were performed separately for boys and girls (Table 4). A stepwise regression performed for boys and girls together results in a similar model. Perceived friends' marijuana use enters the model first, accounting for 41% of the variance, followed by school performance; perceived safety of cigarette smoking; use of diet pills, laxatives, or diuretics for weight control; parents' education; seat belt use; and self-induced vomiting for weight control. These seven variables account for 48% of the variance in level of substance use for boys and girls together. Separate regressions were also performed to identify predictors of levels of use of individual substances. The results were very similar to those for level of overall substance use.

COMMENT

Over 50% of the tenth graders in this population report current monthly or more frequent substance use. However, while 46% of the students report drinking alcohol, only 5% are using cocaine, and fewer than 2% report using LSD, PCP, or heroin. Despite these large prevalence differences, we found that overall level of substance use, irrespective of the specific substances used, could be predicted by a model previously used to predict involvement with single substances. The ability to account for 48% of the variation in level of substance use is comparable to results for single substances.[5,6,15] These findings are consistent with those of investigators using other composite indexes of substance use.[16,17] In addition, the variables found to predict levels of use of individual substances were almost identical to those predictive of overall level of use. Although we do not deny that involvement with any single substance may be associated with unique risk factors, our findings do suggest that all substance-use behaviors may share a common set of risk factors. Our findings support the hypothesis that for many purposes substance use may be considered a single behavior regardless of the particular substance(s) used.

In this adolescent population, destructive coping behavior; risk-taking behaviors; school performance; use of diet pills, laxatives, or diuretics for weight control; self-induced vomiting for weight control; and seat belt use all correlate significantly with level of substance use. In addition, significant intercorrelations exist between nearly all pairs of these behavioral variables. These results support the suggestion that substance use is part of a syndrome of adolescent problem behaviors. Adolescents at risk for involvement with substance use might also be at risk for participating in other problem behaviors; this is the case in our population.

Level of substance use is associated most strongly with perceptions of friends' substance use. This finding is consistent with those from almost all studied adolescent populations,[6,18,19] including samples of adolescents out of school.[16,20] In addition, adolescents most often cite social factors as their reasons for using substances.[1] The importance of perceived substance use among peers is also reflected in the strong association found between level of substance use and predicted use in hypothetical social pressure situations. A single reported perception of how many friends use marijuana was able to account for about 40% of the variance in substance use among both boys and girls. Additional variables that contribute significantly to the regression models explain no more than 9% of additional variance. These findings strongly support the hypothesis that social environmental factors exert the most profound influence on substance use involvement.

The influence of the social environment also provides an explanation for the vastly different use prevalences observed for different substances. Risk for involvement with a particular substance is primarily due to perceptions of social pressures for use and the number of environmental models using that substance. Under this construct, changes in use prevalences for individual substances over time or between substances at one point in time are not responses to unique characteristics of the users but to social influences in the environment. This model is consistent with the hypothesis that substance use can be considered a single behavior regardless of the specific substance(s) used. Furthermore, a common set of psychosocial risk factors may exist for all problem behaviors, but actual participation in those behaviors may be primarily the result of social influences.

The only psychological variable that contributed significantly unique variance to the regression models was perceived safety of cigarette smoking. This variable entered early into both the boys' and girls' models. This finding is consistent with those from analyses of single substances.[5,6,15] In addition, trends in perceived safety have previously been found to correspond to trends in substance use prevalences.[1]

Although increased substance use has been previously noted among adolescents utilizing unhealthful weight-control strategies,[21] the appearance of diet pill, laxative, or diuretic use in the regression model for both girls and boys and self-induced vomiting in the girls' model was unexpected. These results, in addition to the finding that seat belt use contributes unique variance to the model for girls, represent the identification of significant new risk factors in the substance use literature. These findings may encourage others to search for ad-

ditional risk factors that are consistent with the problem-behavior model.

The usefulness of our findings is dependent on the validity of self-reports of substance use. Although questions inevitably arise about the validity of adolescent self-reports, strong correlations with biochemical and observational measures have been consistently reported.[22-24] Extensive efforts were undertaken to assure confidentiality to all participating students. This is reflected in the high response rate to all substance use items. We also included a validation measure in the form of expired air carbon monoxide, a useful measure of recent tobacco cigarette use.[25,26] The correlation between expired air carbon monoxide levels and frequent cigarette smoking suggests generally accurate reporting. In addition, similarities between our results and those from other national or regional samples[1,15,27] strengthen the persuasiveness of our findings.

Due to the cross-sectional design of our analysis we cannot make causal inferences regarding adoption of substance use. However, strong associational relationships suggest that perceived social influences have a strong impact on adolescents' participation in substance use and other problem behaviors. The overwhelming influence of the perceived social environment suggests that interventions concentrating on self-esteem and other psychological variables may not be effective in producing desired large-scale changes in substance use by adolescents. The most effective preventive strategy may consist of skills training for resisting social influences. This strategy concentrates on helping adolescents identify and resist specific social pressures to adopt behaviors by informing them about health and social consequences; identifying peer, media, and other environmental influences; modeling responses to these influences; role playing; and goal setting. This strategy has already proven successful in preventing adolescents from adopting cigarette smoking.[28-30] In addition, the high prevalence of substance use reported in this population underscores the importance of starting preventive interventions prior to the tenth grade.

In this study we have also identified a set of easily assessable self-report variables as independent correlates of level of substance use: friends' marijuana use, school performance, perceived safety of cigarette smoking, parents' education, and seat belt use. The additional variables, use of diet pills, laxatives, and diuretics for weight control and self-induced vomiting for weight control, may prove most useful in clinical settings. When encountered in a teenager, these characteristics should trigger one's awareness of possible drug use. Substance use is frequently underdiagnosed by physicians.[31,32] Formal screening instruments have been developed,[33,34] and recommendations for assessment, treatment, and referral of adolescent substance users are available.[35-38] We encourage all physicians caring for adolescents to consult these resources and actively promote community-based prevention efforts.

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