

# Long-term Follow-up Results of a Randomized Drug Abuse Prevention Trial in a White Middle-class Population

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**Objective.**—To evaluate the long-term efficacy of a school-based approach to drug abuse prevention.

**Design.**—Randomized trial involving 56 public schools that received the prevention program with annual provider training workshops and ongoing consultation, the prevention program with videotaped training and no consultation, or "treatment as usual" (ie, controls). Follow-up data were collected 6 years after baseline using school, telephone, and mailed surveys.

**Participants.**—A total of 3597 predominantly white, 12th-grade students who represented 60.41% of the initial seventh-grade sample.

**Intervention.**—Consisted of 15 classes in seventh grade, 10 booster sessions in eighth grade, and five booster sessions in ninth grade, and taught general "life skills" and skills for resisting social influences to use drugs.

**Measures.**—Six tobacco, alcohol, and marijuana use self-report scales were recoded to create nine dichotomous drug use outcome variables and eight polydrug use variables.

**Results.**—Significant reductions in both drug and polydrug use were found for the two groups that received the prevention program relative to controls. The strongest effects were produced for individuals who received a reasonably complete version of the intervention—there were up to 44% fewer drug users and 66% fewer polydrug (tobacco, alcohol, and marijuana) users.

**Conclusions.**—Drug abuse prevention programs conducted during junior high school can produce meaningful and durable reductions in tobacco, alcohol, and marijuana use if they (1) teach a combination of social resistance skills and general life skills, (2) are properly implemented, and (3) include at least 2 years of booster sessions.

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DRUG abuse is a major public health problem in the United States and its reduction continues to be a national priority. National survey data indicate that drug use among American youth is the highest in the industrialized world.<sup>1</sup> Although the use of most drugs declined somewhat during the past decade, recent national data show a reversal of that downward trend starting with 8th and 10th graders in 1992 and continuing with 12th graders in 1993.<sup>2</sup> The recent

increase in adolescent drug use not only raises the specter of a new drug epidemic, but serves as an urgent reminder of the need to develop more effective prevention and treatment approaches.

One promising line of research involves efforts to develop drug abuse prevention approaches that can be implemented in school settings and can target a large number of individuals at a relatively modest cost. Significant progress has been made in recent years using approaches focusing on the social and psychological factors now believed to promote drug use initiation.<sup>3-7</sup> These approaches are designed to alter norms concerning the prevalence and acceptability of drug use, increase awareness of the social influences promoting drug use, and teach skills for resisting those influences. In addition, some approaches also teach an array of general "life skills" to enhance individual competence and reduce vulnerability to drug use influences. These approaches have typically produced reductions (relative to controls) in drug use of 30% to 50% at the end of the primary year of intervention.<sup>3-4</sup>

However, there are important gaps in the existing research. First, much of the literature supporting the effectiveness of these prevention approaches is based on studies focusing on cigarette smoking. While prevention effects have also been found for alcohol and marijuana use, sound empirical evidence for the effectiveness of school-based interventions on these drugs is limited. Second, most school-based prevention studies have examined intervention effectiveness primarily in terms of relatively minor forms of drug use such as life-

time, annual, or 30-day prevalence. Little or no evidence exists concerning the impact of these prevention approaches on more serious forms of drug involvement such as heavy use or polydrug use. Third, many drug abuse prevention studies have been criticized for methodological weaknesses such as inappropriate research designs, nonequivalence of comparison groups at baseline, differential attrition, inadequate or inappropriate data analysis methods, inappropriate units of analysis, and concerns about the validity of self-report data.<sup>8-12</sup> Fourth, because prevention studies typically have not taken into account the fidelity of program implementation, the results of most studies are imprecise and may underestimate prevention effects.

Another major limitation of previous prevention research is the paucity of studies with long-term follow-up data. A number of short-term follow-up studies have demonstrated the presence of positive behavioral effects for up to 2 years after the conclusion of programs for cigarette smoking.<sup>13-15</sup> Although some studies have demonstrated that prevention effects can last as long as 4 years,<sup>16</sup> others have generally found that effects decayed much sooner,<sup>17</sup> and once they dissipate they do not emerge again later.<sup>18</sup> The few longer-term follow-up studies available have found that the initial effects of interventions conducted with junior high school students decay before the end of high school.<sup>19,20</sup> However, the failure of past studies to demonstrate long-term effects may have occurred for several reasons, including (1) the length of the initial interventions was inadequate, (2) booster interventions either were not included or were inadequate, (3) the interventions were not implemented with sufficient fidelity to the intervention model, and/or (4) the intervention models were based on faulty assumptions, were incomplete, or were otherwise deficient.<sup>21</sup>

This article reports long-term follow-up data from a large-scale randomized trial of a prevention program based on a broad-spectrum, multicomponent approach during the seventh grade with booster sessions in the eighth and ninth grades. The present study was designed to overcome the methodological criticisms of previous studies and provide data concerning the following: (1) the effectiveness of this approach both with and without taking implementation fidelity into account, (2) the durability of effects over a critical period for drug use initiation, (3) the generalizability of this prevention approach from tobacco use to alcohol and marijuana use, and (4) the impact of this approach on both occasional drug use and more serious levels of drug involvement such as heavy drug use and polydrug use.

## METHODS

### Sample

The sample consisted of 3597 adolescents from 56 schools that provided data in 1991. This represents 60.4% of the original 5954 students who participated in the study during the fall of 1985 while in the seventh grade. Results were previously reported for 4466 adolescents (75%) who provided data at the end of the ninth grade.<sup>22</sup> The present follow-up sample was 52% male 91% white and had a mean age of 18.05 years. Approximately half of the adolescents reported that their fathers and/or mothers attended at least 1 year of college, and 85% lived in two-parent families. The demographic characteristics of this sample were the same as those of the original sample. Participating individuals lived in three geographic areas of New York State and attended predominantly middle-class suburban and rural schools clustered around Albany and Syracuse in upstate New York and on Long Island in downstate New York. The research protocol and consent procedure for this study was reviewed and approved by the Institutional Review Board at Cornell University Medical College.

### Design

In the spring of 1985 (prior to the initial pretest), participating schools were surveyed to determine existing cigarette smoking levels. Based on these data, schools were divided into tertiles consisting of schools with either high, medium, or low cigarette smoking prevalence rates. From within groups of schools with similar levels of cigarette smoking, schools were randomly assigned to the following groups within each of the geographic areas: (1) prevention program with a formal 1-day training workshop and implementation feedback by project staff (E1); (2) prevention program with training provided by videotape and no implementation feedback (E2); and (3) a "treatment as usual" control group. Eighteen schools were assigned to the E1 group, 16 schools were assigned to the E2 group, and 22 schools were assigned to the control group. The uneven number of schools per group was the result of the combination of many factors, including an uneven number of schools in the original assignment blocks, the loss of one school after random assignment was completed but before the study began, and intentional oversampling of control schools.

### Prevention Program

The prevention program consisted of 15 class periods taught in the seventh grade, with a major goal for each class

and measurable student objectives. This program was developed for middle/junior high school students and was designed so that it could be integrated into any academic area. The main focus of the intervention was on the teaching of information and skills for resisting social influences to use drugs and generic personal and social skills for increasing overall competence and promoting the development of characteristics associated with decreased risk for using drugs.

More specifically, the intervention was designed to teach students cognitive-behavioral skills for building self-esteem, resisting advertising pressure, managing anxiety, communicating effectively, developing personal relationships, and asserting rights. The intervention was also designed to teach skills and knowledge specifically related to resisting social influences to use tobacco, alcohol, or other drugs. For example, students were taught the application of general assertive skills to situations in which they might experience direct interpersonal pressure to smoke. These skills were taught using a combination of teaching techniques including demonstration, behavioral rehearsal, feedback and reinforcement, and behavioral "homework" assignments for out-of-class practice. Unlike traditional prevention approaches, only minimal information concerning the long-term health consequences of drug use was provided. Instead, information salient to adolescents and relevant to prevention was taught, including information concerning the immediate negative consequences of drug use, the decreasing social acceptability of use, and actual prevalence rates among adults and adolescents.

Students in the two prevention groups were also provided with additional intervention sessions in the eighth grade (10 class sessions) and ninth grade (five class sessions). No intervention was provided during grades 10, 11, or 12. These maintenance or "booster" interventions were designed to review and reinforce the material covered during the first year of intervention. Previous studies testing this prevention approach have shown that providing students with ongoing intervention in the form of booster sessions can help maintain and even enhance initial prevention effects.<sup>23,24</sup> Prevention program materials included a teacher's manual for each year of the intervention, a student guide for the first year, and a 15-minute relaxation audiotape. A more detailed description of the prevention strategy and materials can be found elsewhere.<sup>25,26</sup>

### Procedure

The prevention program was implemented in both intervention groups by

regular classroom teachers who were selected by each participating school. Prior to program implementation, all teachers for the E1 group attended a 1-day training workshop conducted by project staff and were provided with prevention program materials. The purposes of the workshop were to provide teachers with the rationale for this prevention approach, to describe the curriculum materials, and to provide a session-by-session review of the curriculum.<sup>27</sup> In addition, following the collection of classroom observational data, members of the project staff met with teachers assigned to the E1 group for approximately 15 minutes, during which they were provided with implementation feedback and reinforcement in order to increase the quality and completeness of program implementation.

Prior to program implementation, teachers for the E2 group were provided with a 2-hour training videotape, accompanied by written instructions and curriculum materials. The videotape was intended to serve the same purpose as the training workshop, and the content and structure of both the videotape and workshop were as similar as possible. No special arrangements were made with participating schools to provide release time for viewing the training tape, and no feedback or reinforcement was given to the E2 teachers by project staff.

All individuals in the study were assessed by surveys immediately before the implementation of the prevention program. Several steps were taken to ensure the accuracy of the data collected. First, in an effort to enhance the validity of drug use self-reports, breath samples were collected at each data point using procedures found to increase the validity of self-report data.<sup>28-31</sup> Previous research suggests that collecting biochemical data from adolescents can increase the validity of self-reports concerning alcohol and marijuana use, even if the biochemical data collected are specific to cigarette smoking.<sup>30</sup> Second, machine-readable questionnaires with unique identification codes lithocoded on each questionnaire were used to preserve confidentiality as well as to eliminate coding errors, and the confidential nature of the data was emphasized prior to asking students to complete the study questionnaires. Third, data collection was standardized across groups and over the course of the study by using the same assessment instruments and procedures. Fourth, data were collected by project staff rather than teachers to minimize underreporting due to a desire to please the prevention providers or concerns about confidentiality.

Study participants were tracked using information obtained from school rec-

ords, directory assistance, the post office, reverse directories, and the New York State Department of Motor Vehicles. Follow-up surveys were administered by project staff using procedures identical to those used at baseline and during junior high school.<sup>22</sup> One class period (40 to 45 minutes) was allocated for data collection. Individuals who were not available for the data collection conducted in school classrooms at the end of the 12th grade were surveyed either by telephone (n=812) or by mail (n=211). The length of time between the initial baseline assessment and the final follow-up was 6 years when averaged across methods; the length of follow-up was 5.75 years for the data collected in school, 6.5 years for the telephone surveys, and 6.75 years for the mail surveys.

### Assessing Implementation Fidelity

Program implementation was monitored by project staff in randomly selected classes taught by the teachers in each of the two intervention groups. Interobserver reliability was 0.80 both within and across intervention sites. Using observation forms developed for each prevention session, the observer recorded how much of the material allocated for each intervention session was actually covered. Program implementation was observed during all 3 years of the intervention. Fifty-one teachers were observed during an average of 2.80 classes per teacher during the first year of intervention, 89 teachers were observed during 2.85 classes in the second year, and 87 teachers were observed during 2.16 classes in the third year.

A quantitative assessment of the completeness of program implementation was calculated on the basis of the proportion of the prevention objectives covered during each class session observed.<sup>22</sup> Quantitative implementation scores were calculated for each observation session, and an average was computed for each group. Weighted averages were then calculated for each year of intervention and combined for the 3 years of intervention. These weightings were based on the length of the intervention during each year with a weighting of three for seventh grade (15 sessions), two for eighth grade (10 sessions), and one for ninth grade (five sessions). This resulted in a 3-year cumulative implementation score for each student in the two intervention groups.

### Assessing Drug Use

Participating students were assessed by six survey items to determine self-reported tobacco, alcohol, and marijuana use. The frequency (how often) individuals smoked cigarettes, drank alcohol, or

used marijuana was assessed by three scales (one for each drug) to determine current use status. The amount (how much) individuals smoked and drank was assessed by two scales. Frequency of getting drunk was assessed by one scale to determine how often individuals drank to the point of intoxication.

Cigarette smoking frequency was assessed using an 8-point scale with possible responses ranging from "never" to "a few times most days." Cigarette smoking amount was assessed using a 7-point scale with possible responses ranging from "never" to "more than a pack a day." The frequency of drinking alcoholic beverages was measured using a 9-point scale with possible responses ranging from "never" to "more than once a day." The amount of alcohol consumed per drinking occasion was measured using a 6-point item with possible responses ranging from "don't drink" to "more than 6 drinks" per occasion. The frequency of getting drunk was measured on a 9-point scale with possible responses ranging from "don't drink" to "more than once a day." Frequency of marijuana use was measured using a 9-point scale with possible responses ranging from "never tried it" to "more than once a day."

The six drug use measures were recoded to form nine dichotomous (1=yes, 0=no) variables. The tobacco, alcohol, and marijuana use frequency measures were dichotomized into two binary variables each to assess the impact of the intervention on monthly and weekly use. The cigarette smoking and alcohol consumption measures were partitioned into one binary variable each to assess the prevalence of "heavy" cigarette smoking (a pack or more of cigarettes a day) and "heavy" alcohol use (more than three drinks per drinking occasion). Finally, the drunkenness measure was partitioned into a single binary variable to assess the prevalence of monthly drunkenness (getting drunk one or more times per month). To assess polydrug use, eight additional binary variables were created using combinations of the tobacco, alcohol, and marijuana use frequency variables. This yielded four polydrug variables (tobacco and alcohol, tobacco and marijuana, alcohol and marijuana, and all three drugs) assessed in terms of monthly and weekly use.

### Data Analysis

Data were analyzed to determine the long-term effectiveness of the prevention program at the follow-up by testing for differences between each of the intervention groups and the control group with respect to drug use prevalence. Follow-up data were first analyzed to

test for baseline equivalence and differential attrition using the general linear models procedure of SAS software, version 6.08.<sup>32</sup> Next, mean proportions for each drug use and polydrug use variable were computed by aggregating across the individuals in each participating school. School means for each drug use variable were then analyzed using the ordinary least-squares regression statistical procedures contained in SAS software, version 6.08<sup>32</sup> with the school being used as the unit of analysis.<sup>33-35</sup> The regression model used for these analyses included baseline use, assignment block, and experimental group. Separate analyses were conducted for each of the nine drug use variables as well as for eight polydrug use variables. Analyses were first conducted for the full sample (all of the individuals available both at baseline and the end of the study,  $n=3597$ ) and then for the high-fidelity sample (individuals who received at least 60% of the intervention,  $n=2752$ ). Since specific a priori directional hypotheses derived from previous research with this approach were being tested in this study, inferences were based on one-tailed significance tests.<sup>36</sup>

## RESULTS

### Baseline Equivalence and Attrition

Past studies have found differences in attrition with respect to drug use status, with drug users or high-risk individuals being less likely to be included in follow-up samples.<sup>5,22</sup> Therefore, prior to conducting analyses to determine the effectiveness of the intervention on drug use, several analyses were conducted to rule out the possibility that the study was compromised by either baseline non-equivalence or differential attrition over the course of the study. Table 1 presents a comparison of the treatment and control groups by demographic characteristics and baseline drug use. A series of regressions were conducted on the drug use variables. No significant pretest differences were found for either the full sample or the high-fidelity sample.

Over the 6 years of this study, approximately 40% of the original sample was unavailable for follow-up. Sample attrition was the result of absenteeism, transfers, and dropouts. Both the rate and causes of attrition for this study are comparable with those of similar longitudinal studies.<sup>37</sup> *F* tests were computed for each drug use variable and for both follow-up samples using general linear model analysis of variance procedures to determine the impact of attrition on the two final analysis samples. Using attrition rates as the dependent variable, the potential presence of differen-

Table 1.—Demographic Characteristics and Baseline Drug Use\*

Characteristics	Group†			Combined (N=3597)
	E1 (n=1128)	E2 (n=1327)	Control (n=1142)	
Males	50	52	54	52
White	92	90	90	91
Father's education (some college)	53	53	52	53
Mother's education (some college)	46	46	51	48
Two-parent family	86	83	86	85
Cigarette smoking				
Monthly	6	8	7	7
Weekly	4	5	4	4
Alcohol use				
Monthly	23	15	15	18
Weekly	7	5	5	5
Marijuana use				
Monthly	1	2	1	1
Weekly	1	0	0	0

\*Data are percentages.

†E1 indicates prevention program with a formal 1-day training workshop and implementation feedback by project staff; E2, prevention program with training provided by videotape and no implementation feedback; and control, "treatment as usual."

Table 2.—Adjusted Drug Use Prevalence Rates by Condition for the Full Sample (N=3597)\*

Variable	Group		
	E1	E2	Control
Cigarette smoking			
Monthly	0.27† (0.02)	0.26‡ (0.02)	0.33 (0.02)
Weekly	0.23† (0.02)	0.21† (0.02)	0.27 (0.02)
Pack-a-day	0.10 (0.01)	0.09† (0.01)	0.12 (0.01)
Alcohol use			
Monthly	0.61 (0.03)	0.57 (0.03)	0.60 (0.02)
Weekly	0.29 (0.02)	0.24 (0.02)	0.29 (0.02)
3 or more drinks per occasion	0.57 (0.02)	0.55 (0.05)	0.59 (0.02)
Drunk	0.34† (0.02)	0.33‡ (0.03)	0.40 (0.02)
Marijuana use			
Monthly	0.13 (0.02)	0.13 (0.02)	0.14 (0.02)
Weekly	0.06 (0.01)	0.06 (0.02)	0.09 (0.01)

\*Data are mean (SE) rates. See Table 1 for explanation of groups.

† $P < .05$ , based on one-tailed tests.

‡ $P < .01$ , based on one-tailed tests.

tial attrition was tested by examining main effects for condition and interaction effects for condition and baseline drug use status. No differential attrition effects were found for any of the drug use variables in either the full sample or the high-fidelity sample.

### Full Sample

The results of analyses with all students who participated in the pretest and provided follow-up data ( $N=3597$ ) are presented in Tables 2 and 3. Prevention effects were found for variables assessing the prevalence of both drug use and polydrug use. Carbon monoxide levels in expired air were significantly correlated with self-reported cigarette smoking ( $r=0.35$ ;  $P < .001$ ) across groups, providing presumptive evidence for the validity of the self-report data.

**Drug Use.**—The school-level pretest-adjusted drug use prevalence rates (mean proportions) and SEs for the intervention and control groups are presented in

Table 2. The prevalence of cigarette smoking was significantly lower for the adolescents in the intervention groups for monthly (E1 and E2) and weekly (E2) cigarette smoking than in the control group. Moreover, the prevalence of heavy cigarette smoking was significantly lower for the E2 group and approached significance for the E1 group. Finally, the prevalence of problem drinking was significantly lower for the adolescents in both intervention groups.

**Polydrug Use.**—Table 3 presents the pretest-adjusted polydrug use prevalence rates and SEs for intervention and control groups. The prevalence of monthly cigarette smoking and alcohol use was significantly lower for the adolescents in the two intervention groups than in the control group. The prevalence of weekly cigarette smoking and alcohol use was significantly lower for the E2 group than for controls and approached significance for the E1 group. Similar trends approaching significance were evident for monthly

Table 3.—Adjusted Polydrug Use Rates by Condition for the Full Sample (N=3597)\*

Variable	Group		
	E1	E2	Control
Cigarette smoking and alcohol use			
Monthly	0.21† (0.02)	0.21† (0.02)	0.29 (0.01)
Weekly	0.11 (0.02)	0.10‡ (0.02)	0.14 (0.02)
Cigarette smoking and marijuana use			
Monthly	0.08 (0.02)	0.08 (0.02)	0.12 (0.02)
Weekly	0.04† (0.01)	0.04† (0.01)	0.08 (0.01)
Alcohol use and marijuana use			
Monthly	0.12 (0.02)	0.12 (0.02)	0.13 (0.01)
Weekly	0.05 (0.01)	0.05 (0.01)	0.08 (0.01)
Cigarette smoking, alcohol use, and marijuana use			
Monthly	0.08 (0.02)	0.08 (0.02)	0.12 (0.01)
Weekly	0.03‡ (0.01)	0.03‡ (0.01)	0.06 (0.01)

\*Data are mean (SE) rates. See Table 1 for explanation of groups.

†P < .01, based on one-tailed tests.

‡P < .05, based on one-tailed tests.

Table 4.—Adjusted Drug Use Prevalence Rates by Condition for the High-Fidelity Sample (n=2752)\*

Variable	Group		
	E1 (n=762)	E2 (n=848)	Control (n=1142)
Cigarette smoking			
Monthly	0.24† (0.03)	0.23† (0.03)	0.33 (0.02)
Weekly	0.20‡ (0.02)	0.19‡ (0.02)	0.27 (0.02)
Pack-a-day	0.09‡ (0.02)	0.08‡ (0.02)	0.12 (0.01)
Alcohol use			
Monthly	0.58 (0.03)	0.54† (0.03)	0.60 (0.02)
Weekly	0.24† (0.02)	0.20† (0.02)	0.29 (0.02)
3 or more drinks per occasion			
Drunk	0.53† (0.03)	0.52† (0.02)	0.59 (0.02)
Drunk	0.31‡ (0.03)	0.28† (0.03)	0.40 (0.02)
Marijuana use			
Monthly	0.10‡ (0.02)	0.11 (0.02)	0.14 (0.01)
Weekly	0.05‡ (0.02)	0.05‡ (0.02)	0.09 (0.01)

\*Data are mean (SE) rates. See Table 1 for explanation of groups.

†P < .01, based on one-tailed tests.

‡P < .05, based on one-tailed tests.

Table 5.—Adjusted Polydrug Use Rates by Condition for the High-Fidelity Sample (n=2752)\*

Variable	Group		
	E1	E2	Control
Cigarette smoking and alcohol use			
Monthly	0.19† (0.02)	0.19† (0.02)	0.27 (0.02)
Weekly	0.10 (0.02)	0.09† (0.02)	0.13 (0.02)
Cigarette smoking and marijuana use			
Monthly	0.05† (0.03)	0.07† (0.02)	0.12 (0.02)
Weekly	0.02† (0.02)	0.03† (0.02)	0.08 (0.01)
Alcohol use and marijuana use			
Monthly	0.09‡ (0.02)	0.10 (0.02)	0.13 (0.01)
Weekly	0.03† (0.01)	0.04† (0.01)	0.07 (0.01)
Cigarette smoking, alcohol use, and marijuana use			
Monthly	0.05† (0.02)	0.07 (0.02)	0.10 (0.01)
Weekly	0.02† (0.01)	0.02† (0.01)	0.06 (0.01)

\*Data are mean (SE) rates. See Table 1 for explanation of groups.

†P < .01, based on one-tailed tests.

‡P < .05, based on one-tailed tests.

tobacco and marijuana use, while weekly tobacco and marijuana use were significantly lower for both intervention groups than for controls. Finally, the prevalence of weekly polydrug use involving all three drugs was significantly lower among the

adolescents in both intervention groups than in the control group.

#### High-Fidelity Sample

To more precisely assess prevention effects, a second series of analyses was

conducted on a subsample of individuals who received a relatively complete version of the prevention program. The inclusion criteria were the same as those used in a previous article reporting the first 3 years of intervention data from this study.<sup>22</sup> Included in the high-fidelity sample were those individuals who, based on classroom observation data, were judged to have received at least 60% of the intervention during the seventh, eighth, and ninth grades, while excluding those individuals who received only part of the prevention program. The resulting sample consisted of 2752 students from 50 schools (14 schools and 762 students in the E1 group, 14 schools and 848 students in the E2 group, and 22 schools and 1142 students in the control group). The demographic characteristics of this sample were virtually identical to those of the full follow-up sample and the original sample reported in an earlier article.<sup>22</sup> The high-fidelity sample was 51% male and 91% white, with 85% of the students living with both parents and 53% of the fathers having attended at least 1 year of college.

**Drug Use.**—As expected, these analyses yielded even stronger prevention effects than the analyses for the full sample. Table 4 presents the drug use prevalence rates for the prevention and control groups for the high-fidelity sample. Prevention effects were found for both groups and for all three drugs assessed. Adolescents in the two intervention groups had significantly lower prevalence rates for monthly and weekly cigarette smoking as well as for heavy (pack-a-day) cigarette smoking. Both intervention groups had significantly lower prevalence rates for weekly drinking, heavy drinking, and problem drinking. The adolescents in the E2 group also had significantly lower monthly drinking rates. Prevalence rates for monthly marijuana use were significantly lower than the controls for the E1 group; both intervention groups had significantly lower prevalence rates for weekly marijuana use.

**Polydrug Use.**—Table 5 presents the polydrug use prevalence rates for the intervention and control groups. Adolescents who received the prevention program had significantly lower rates of polydrug use than controls for nearly all combinations of tobacco, alcohol, and marijuana use and for both monthly and weekly levels of use. More specifically, there were significantly fewer individuals in the two intervention groups than in the control group who reported tobacco and alcohol use at least once a month, and significantly fewer individuals in the E2 group who reported using both drugs at least once a week. Both intervention

groups had a significantly lower prevalence of monthly cigarette smoking and marijuana use as well as weekly use of both drugs. The monthly use of both alcohol and marijuana was also significantly lower for the individuals in the E1 group than for controls, and the weekly use of alcohol and marijuana was significantly lower for both intervention groups. Finally, there were significantly fewer individuals in the E1 group than in the control group who used all three drugs once a month or more, and significantly fewer individuals in both intervention groups who used all three drugs one or more times per week. The magnitude of reduction in weekly polydrug use was relatively large, with both intervention groups having 66% fewer adolescents who used all three drugs at least weekly.

## COMMENT

The results of this 6-year randomized trial provide additional evidence that school-based drug abuse prevention programs in general and this approach in particular can reduce the prevalence of drug use. These results provide the first evidence that a school-based intervention conducted by regular classroom teachers can produce reductions in tobacco, alcohol, and marijuana use that last until the end of high school. This study also provides the first evidence that prevention programs can affect more serious levels of drug use, whether conceptualized as heavier consumption of a single substance or as polydrug use (in this case, the use of all three of the gateway drugs). The strongest effects were produced for individuals in the intervention groups who received a reasonably complete implementation of the intervention. Although the absolute differences between treatment and control groups may appear small, their public health significance is large when viewed from the perspective of potential decreases in mortality. For example, monthly and weekly cigarette smoking were 15% to 27% lower and heavy cigarette smoking was 25% lower in intervention subjects. Effects of this magnitude could prevent 60 000 to 100 000 tobacco-related deaths each year.

The present study was designed to overcome the methodological criticisms of previous prevention studies. Particular attention was paid to issues such as the appropriateness of the study design, baseline equivalence of groups, possible sample biases resulting from attrition, the validity of self-report data, and the proper unit of assignment and analysis. The research design of the study, which used random assignment of a large number of schools after blocking on school-wide cigarette smoking rates, eliminates many com-

mon threats to internal validity. The assignment procedure successfully produced equivalent groups at the baseline for both the initial sample<sup>22</sup> and for the follow-up sample, ruling out baseline non-equivalence as an explanation for the findings of this study. Moreover, careful analysis of data loss over the course of the study failed to reveal any pattern of differential attrition that would undermine either internal or external validity.<sup>33</sup> To provide a conservative test of this prevention approach and avoid problems arising from intracluster correlations, the school was used as the unit of analysis.<sup>33-35</sup>

These data also indicate that this prevention strategy is both feasible and effective when implemented under "real world" conditions where teachers are the program providers, schools use their own criteria for teacher selection and scheduling, and limited resources and competing priorities may make it difficult to implement the intervention exactly as planned.

In an effort to understand why prevention effects from other promising approaches have decayed over time, several explanations have been offered.<sup>21</sup> One relates to intervention "dosage." Many past prevention studies tested interventions consisting of six to eight sessions during the initial year of intervention, which may simply be inadequate. The intervention being evaluated in this study, by contrast, was considerably longer since it contained 15 sessions during the primary year of intervention. A second possible reason that prevention effects have not been more durable in other studies is that the interventions tested either did not contain any booster sessions or the number of booster sessions was inadequate. The interventions tested by both Ellickson and Bell<sup>17</sup> and Flay et al<sup>19</sup> included only three booster sessions. The intervention tested in this study contained 15 booster sessions over 2 additional years.

A third possible explanation for the long-term weakness of past preventive interventions is that implementation fidelity was not taken into account. Without assessing implementation fidelity, it is impossible to know how thoroughly the intervention was implemented or if it was implemented in a manner consistent with the intervention protocol. If a prevention program was only partially implemented in some classrooms, one might reasonably expect its effectiveness would be substantially diluted. Indeed, this study shows that stronger results were found when the evaluation analysis was limited to individuals who received a more complete version of the intervention over the 3 intervention years. This has important implications

for prevention research and suggests that studies that do not take implementation fidelity into account run the risk of underestimating prevention effects.

A final possible explanation for why previous studies have not detected prevention effects at the end of high school is that the intervention models may have been deficient in some way. The prevention program used in this study was more comprehensive than those tested in previous long-term, school-based drug abuse prevention studies. The results of this follow-up study suggest that, to be effective, drug abuse prevention approaches may need to include an emphasis on increasing general personal competence as well as teaching social resistance skills. This may be particularly important for reducing the proportion of individuals who develop more serious patterns of drug use. Further research is necessary to determine the relative effectiveness of competing prevention approaches as well as to identify the mediating mechanisms of effective approaches.

A limitation of this study is that it involved predominantly white, middle-class students. While other studies have demonstrated the effectiveness of this prevention approach with African-American<sup>28</sup> and Hispanic students,<sup>39,40</sup> they focused on cigarette smoking and the length of follow-up was considerably shorter. Research is necessary to determine the long-term effectiveness of this approach on the alcohol and drug use of inner-city minority students. Research is also necessary to assess the impact of prevention programs on high-risk individuals who tend to be unavailable for follow-up in school-based studies and to determine the impact of this prevention approach on illicit drugs other than marijuana.

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