Journal of Consulting and Clinical Psychology
2004, Vol. 72, No. 3, 535–542

0022-006X/04/$12.00 DOI: 10.1037/0022-006X.72.3.535

Brief Family Intervention Effects on Adolescent Substance Initiation: School-Level Growth Curve Analyses 6 Years Following Baseline

Richard Spoth, Cleve Redmond, Chungyeol Shin, and Kari Azevedo
Iowa State University

This study examines the effects of 2 brief family-focused interventions on the trajectories of substance initiation over a period of 6 years following a baseline assessment. The 2 interventions, designed for general-population families of adolescents, were the 7-session Iowa Strengthening Families Program (ISFP) (Molgaard & Spoth, 2001) and the 5-session Preparing for the Drug Free Years Program (PDFY) (Catalano, Kosterman, Haggerty, Hawkins, & Spoth, 1999). Thirty-three rural public schools were randomly assigned to the ISFP, the PDFY, or a minimal-contact control condition. The authors evaluated the curvilinear growth observed in school-level measures of initiation using a logistic growth curve analysis. Alcohol and tobacco composite use indices—as well as lifetime use of alcohol, cigarettes, and marijuana—and lifetime drunkenness, were examined. Significant intervention–control differences were observed, indicating favorable delays in initiation in the intervention groups.

Although the use of alcohol, tobacco, and marijuana among adolescents in this country has leveled off, prevalence rates remain high. Recently, among 12th graders, the prevalence rate of lifetime alcohol use was 80%, the prevalence rate of lifetime cigarette use was 65%, and the prevalence rate of lifetime marijuana use was 50% (Johnston, O'Malley, & Bachman, 2000). Early initiation and use of substances have been associated with a broad range of problems, including reduced levels of competent, prosocial adult behavior (Ackerman, Zuroff, & Moskowitz, 2000); lower levels of educational and occupational attainment (Koestner, 1991); risky sexual practices (Duncan, Strycker, & Duncan, 1999); and impaired mental health functioning (e.g., depression; Windle & Windle, 2001).

The consequences of initiation and early substance use suggest a number of public health and other societal benefits of broad diffusion of interventions designed to delay initiation and transition to more serious types of use. Universal family-focused intervention is one type that appears to hold some promise in this regard. Earlier reports have summarized the conditions under which this type of intervention can be expected to produce positive results. Central among these conditions is the use of a theory-based intervention addressing established risk and protective factors, appropriate developmental timing, application of empirically supported skills-training techniques, and effective strategies for engaging families (see National Institute on Drug Abuse, 1997; Spoth, Redmond, & Shin, 2001).

Richard Spoth, Cleve Redmond, Chungyeol Shin, and Kari Azevedo, Partnerships in Prevention Science Institute, Iowa State University.

Work on this article was supported by National Institute on Drug Abuse Grant DA 070 29-01A1 and by National Institute of Mental Health Grant MH 49217-01A1. We gratefully acknowledge the valuable comments and editorial assistance of David Hawkins, Alex Masen, Rick Kosterman, Kevin Haggerty, and Linda Trudeau in the preparation of this article.

Correspondence concerning this article should be addressed to Richard Spoth, Director, Partnerships in Prevention Science Institute, Iowa State University, ISU Research Park, Building 2, 2625 North Loop Drive, Suite 500, Ames, IA 50010-8296. E-mail: rlspoth@iastate.edu

Collectively, earlier reports from four randomized studies examining two universal family-focused interventions, Preparing for the Drug Free Years (PDFY; Catalano, Kosterman, Haggerty, Hawkins, & Spoth, 1999) and the Iowa Strengthening Families Program (ISFP; Molgaard & Spoth, 2001), including an ISFP revision, have shown positive results on family factors associated with delayed substance initiation and progression (parenting behaviors, child management, parent–child affective quality), as well as young adolescent use and progression in use (Redmond, Spoth, Shin, & Lepper, 1999; Spoth, Guyll, Chao, & Molgaard, 2003; Spoth, Redmond, Haggerty, & Ward, 1995; Spoth, Redmond, & Shin, 2000; Spoth, Redmond, Trudeau, & Shin, 2002). Positive outcomes for both interventions in reducing initiation and use of alcohol have been sustained through a follow-up 2.5 years past baseline (Spoth, Reyes, Redmond, & Shin, 1999) and 4 years past baseline (Spoth et al., 2001). The longest ongoing longitudinal study has recently yielded a wave of substance use data collected at 6 years past baseline, the analyses of which are reported here.

A key feature of the present outcome assessment follows from the random assignment of schools, rather than individuals, to experimental conditions. To simultaneously address both clustered sampling and curvilinear growth, we developed a logistic growth curve technique to test for intervention effects on growth in substance initiation and use that accounted for the school-level assignment to experimental conditions (see, e.g., Lindstrom & Bates, 1990; Myers, 1989). It was used to test the following hypothesis: Adolescents in PDFY and ISFP intervention-group schools will demonstrate slower growth in initiation of alcohol, tobacco, and marijuana from the 6th to the 12th grades than will adolescents in control group schools.[1]

[1] In some instances, it may be more appropriate to model all groups together in a single model with terms for treatment versus control comparisons. However, we have data from only six time periods, limiting the number of degrees of freedom for estimating model parameters. Therefore, we fit simpler, more parsimonious two-group models examining pairs of treatment and control groups in separate models.

Method

Sample

When the study was initiated, participants were families of sixth graders enrolled in 33 rural schools in 19 contiguous counties in a Midwestern state. Eleven schools were randomly assigned to one of three experimental conditions: the seven-session ISFP, the five-session PDFY, or a minimal-contact control condition. All families of sixth graders in participating schools were recruited for participation. Of the 1,309 eligible families recruited for this study from the 33 schools, 667 (51%) completed pretesting (238 ISFP group families, 221 PDFY group families, and 208 control group families). Among the 667 families in the study at Wave 1, there was an average of 3.1 children. The majority of families (86%) were dual-parent families (70% of targets were living with both biological parents), which was representative of families of sixth graders in the study region. Nearly all participants were White (98%).

Sample Quality

Earlier reports provide detailed descriptions of tests conducted to establish sample representativeness and pretest equivalence as well as to rule out differential attrition across prior study waves (see Spoth, Goldberg, & Redmond, 1999; Spoth, Redmond, & Shin, 1998, 2001). For purposes of this study, analyses examining differential attrition across experimental conditions were extended to the 12th-grade follow-up assessment. Two-factor analyses of variance were conducted for both PDFY–control and ISFP–control comparisons for each outcome measure in this article. In addition, the following sociodemographic variables were assessed: household income, parent education, parent age, child age, child gender, parent marital status, and number of children in the household. No significant Condition × Attrition interaction effects were found for any of the variables between the pretest and the 12th-grade follow-up. Some evidence of increased attrition among alcohol-using adolescents was found; however, the effects were consistent across all conditions.

Interventions

Both interventions were designed to strengthen parent and child skills that have been found to delay the onset or to reduce the use of substances (e.g., Hawkins, Catalano, & Miller, 1992; Mrazek & Haggerty, 1994; Spoth, 1999; Taylor & Biglan, 1998; Weissberg & Greenberg, 1998). The PDFY intervention was delivered in five 2-hour training sessions held on weekday evenings once per week for 5 consecutive weeks. Four sessions were for parents only; children and parents both attended a session focusing on peer-resistance skills. Fifteen 2-person group leader teams conducted 19 groups in the 11 PDFY-condition schools. A total of 124 pretested families participated in the PDFY. The average number of families per group was 10, and the average number of individual participants per session was 16 (25 for the session including children). More detail about the PDFY and its implementation and fidelity is provided elsewhere (Spoth et al., 1998, 2001).

The ISFP included seven sets of sessions offered once per week over a period of 7 consecutive weeks in the evenings. ISFP included separate, concurrent 1-hour training sessions for parents and children, followed by a joint 1-hour family session (see Spoth et al., 1998, 2001, for additional detail). For the ISFP intervention, 21 three-person leader teams conducted 21 groups in the participating schools. A total of 117 families who had completed the in-home pretest assessment participated. There was an average of 8 families, or 20 individuals, per weekly session.

Families participating in the control group were mailed four leaflets describing aspects of adolescent development (e.g., physical and emotional changes as well as parent–child relationships), concurrent with the implementation of the PDFY and ISFP interventions. To preserve random assignment and to avoid a self-selection bias in the results, we included in the analyses all assessed intervention-group students, whether or not their families attended an intervention.

Measures

Data were collected through a written questionnaire administered to family members in their homes by trained interviewers. Substance use was assessed in two ways. First, composite measures of alcohol and tobacco use were constructed and evaluated. Second, five measures of specific lifetime use behaviors (lifetime alcohol use, lifetime alcohol use without parental permission, lifetime drunkenness, lifetime cigarette use, and lifetime marijuana use) were evaluated individually.[2]

The alcohol composite use index (ACUI) consisted of four items (lifetime use, lifetime use without parental permission, lifetime drunkenness, and past month use; see Spoth, Redmond, & Lepper, 1999). The tobacco composite use index (TCUI) included four items (lifetime use of cigarettes, lifetime use of chewing tobacco, past month use of cigarettes, and past month use of chewing tobacco). All items in the two composite use indices were coded 0 (*no use/no recent use*) or 1 (*use/recent use*). Scores for index items were averaged, yielding scale ranges of 0–1. The average alpha reliabilities across the six waves of data collection were .79 and .70 for the alcohol and tobacco indices, respectively. All outcome variables represented the average across individuals within each school.

Data Analyses

Nonlinear growth curve analyses were conducted with school-level outcome variables aggregated over the available respondents in each school, enabling us to address both the S-shaped trajectories observed in cumulative substance initiation as well as the school-level assignment to experimental condition. The focus of this analysis was on the parameters describing the curve, rather than on point-in-time levels of an outcome variable. This type of modeling describes each condition's developmental trajectory, including changes in trajectories over time, while incorporating school in the model as a random effect. Time was incorporated in the model as the school-level average amount of time to a particular assessment from baseline (i.e., the average time to assessment for all assessed families within a school). The pretest (Wave 1) values of time were set at 0, and the number of months from pretest were calculated for each subsequent data-collection wave for each school.

We computed school-based means using data from respondents who provided information at all six waves of the study. We used listwise deletion of cases with missing data to ensure that school-level substance initiation estimates exhibited a nondecreasing, monotonic pattern over time. Because of the small size of schools targeted in the project, there was a limited number of students providing data within each school. To assure valid and stable school-level substance outcome estimates, we excluded schools in which data were available from 5 or fewer students from the analysis.[3] The resulting sample included 304 students from 23 schools

[2] Inconsistencies in lifetime substance use reports were corrected. In instances in which a subject reported a lifetime use behavior at one data collection point but failed to report that behavior at a later data collection point the later report was corrected to reflect the previously reported initiation of that behavior.

[3] Analyses were replicated, including all schools represented by 3 or more reporters (a total of 30 schools); findings were similar to those reported here. Significance levels for individual parameters, however, were generally stronger because of the increased degrees of freedom, whereas overall model fits were slightly worse because of decreased stability in school-level estimates for schools with small *n*s.

(8 PDFY schools, 7 ISFP schools, and 8 control schools). The mean number of students participating in each school was 13 (with a range of 6 to 30).

For each pair of conditions (ISFP–control and PDFY–control), results from logistic growth curve analyses yielded estimates of the parameters describing the general patterns of growth in the substance initiation behaviors examined, as well as parameters representing differences between the intervention and control groups (see the Results section and the Appendix). The primary parameters describing the growth curves are α_0, β_0, and γ_0. The parameter most directly characterizing the shape of the growth trajectory (the general form and rate of growth) is γ_0; positive values of γ_0, observed for each outcome examined, reflect increasing levels of substance use across time. The upper tail of the curve (and upper asymptote) is determined by α_0; it should be noted that the maximum levels of substance outcomes were not yet reached at the end of the study period. The lower tail (and lower asymptote) of the curve is determined by β_0. Although β_0 and α_0 primarily determine the estimated minimum and maximum values of the growth curves, respectively, these values are not independent of the overall rate of growth (trajectory) between baseline and ending measurement points; they also exert some influence on the overall shape of the curve.

The effects of the interventions on the growth trajectories are indicated by the values of α_1, β_1, and γ_1, indicating experimental condition differences in α_0, β_0, and γ_0, respectively. Intervention–control group differences in the general shape of the trajectory are indicated by γ_1. Additional intervention effect tests were derived from model results. In the first of these, group differences at pretest were evaluated, on the basis of the model fitting. In the second, intervention–control differences in the length of time (since baseline) to the growth curve inflection point were tested. The inflection point is the point at which the growth rate is at its maximum. Finally, to provide an indication of the practical significance of intervention effects, we tested group differences in time from baseline to the point at which substance initiation levels reached approximately half of their 12th grade levels (on the basis of control group values).

Results

Parameter estimates for each substance use outcome for ISFP–control and PDFY–control analyses are presented in Table 1. Results of model fitting for the ISFP and control groups showed significant condition differences in the rates of growth for three of the seven substance use outcomes examined. For lifetime use of alcohol, lifetime cigarette use, and lifetime use of marijuana, significant negative values of γ_1 indicate slower overall growth in substance use among ISFP-condition adolescents relative to controls. In addition, a significant pretest difference was observed for lifetime use of alcohol without parental permission: a parameter indicating a significantly different lower tail of the curve (β_1) for this measure. In this case, the significant negative value of β_1—observed in conjunction with the significant pretest difference and nonsignificant value of γ_1—indicates an initially lower level of alcohol use without parental permission within the ISFP group relative to controls (and a slower initial growth period) followed by a growth rate similar to controls (see Figure 1), yielding a growth rate lagging behind that of the control group over the course of the study. Finally, there were significant differences in times to inflection points for three outcomes, the ACUI, lifetime drunkenness, and lifetime cigarette use. In all instances, control group growth rates reached their maximum values at an earlier point in time than in the ISFP group. Condition differences in general growth trajectory and delayed onset are most clearly illustrated by lifetime cigarette use (see Figure 2).

Four outcomes showed significantly delayed growth rates to specific use levels (levels approximately half that of control-group 12th-grade rates). This delayed growth was evident for initiation of

Table 1
Parameter Estimates for Logistic Growth Curves

Outcome	Primary growth curve parameters			Intervention effect parameters			Difference at pretest (treatment–control)	Difference in inflection points (treatment–control, in months)
	α_0	β_0	γ_0	α_1	β_1	γ_1		
ISFP vs. control								
Alcohol composite use index	.67**	−2.63**	0.077**	−.01	−1.01	0.001	.028	12.8*
Tobacco composite use index	.34**	−3.09**	0.079**	.04	0.14	−0.018	−.002	11.4
Lifetime alcohol use	.77**	−2.15**	0.088**	.11	−0.50	−0.023*	.023	16.5
Lifetime alcohol use without parental permission	.78**	−3.08**	0.091**	−.14	−1.84*	0.024	.030*	8.7
Lifetime drunkenness	.65**	−4.29**	0.098**	.01	−0.56	−0.013	.004	13.3*
Lifetime cigarette use	.62**	−2.95**	0.094**	.07	0.11	−0.047**	−.007	29.1*
Lifetime marijuana use	.20**	−4.82**	0.100**	.06	1.01	−0.047*	−.004	23.9
PDFY vs. control								
Alcohol composite use index	.67**	−2.63**	0.077**	.02	0.02	−0.011	−.002	5.2
Tobacco composite use index	.32**	−3.18**	0.084**	.07	0.71	−0.027*	−.017	5.2
Lifetime alcohol use	.77**	−2.16**	0.087**	.08	0.27	−0.019	−.032	2.8
Lifetime alcohol use without parental permission	.76**	−3.06**	0.091**	−.05	0.28	−0.007	−.007	−0.5
Lifetime drunkenness	.65**	−4.33**	0.099**	−.04	0.62	−0.003	−.006	−5.1
Lifetime cigarette use	.62**	−2.94**	0.093**	.07	0.59	−0.028*	−.029	4.3
Lifetime marijuana use	.20**	−4.93**	0.103**	−.02	0.17	0.165	−.001	−1.6

Note. ISFP = Iowa Strengthening Families Program; PDFY = Preparing for the Drug Free Years.
* $p < .05$. ** $p < .01$.

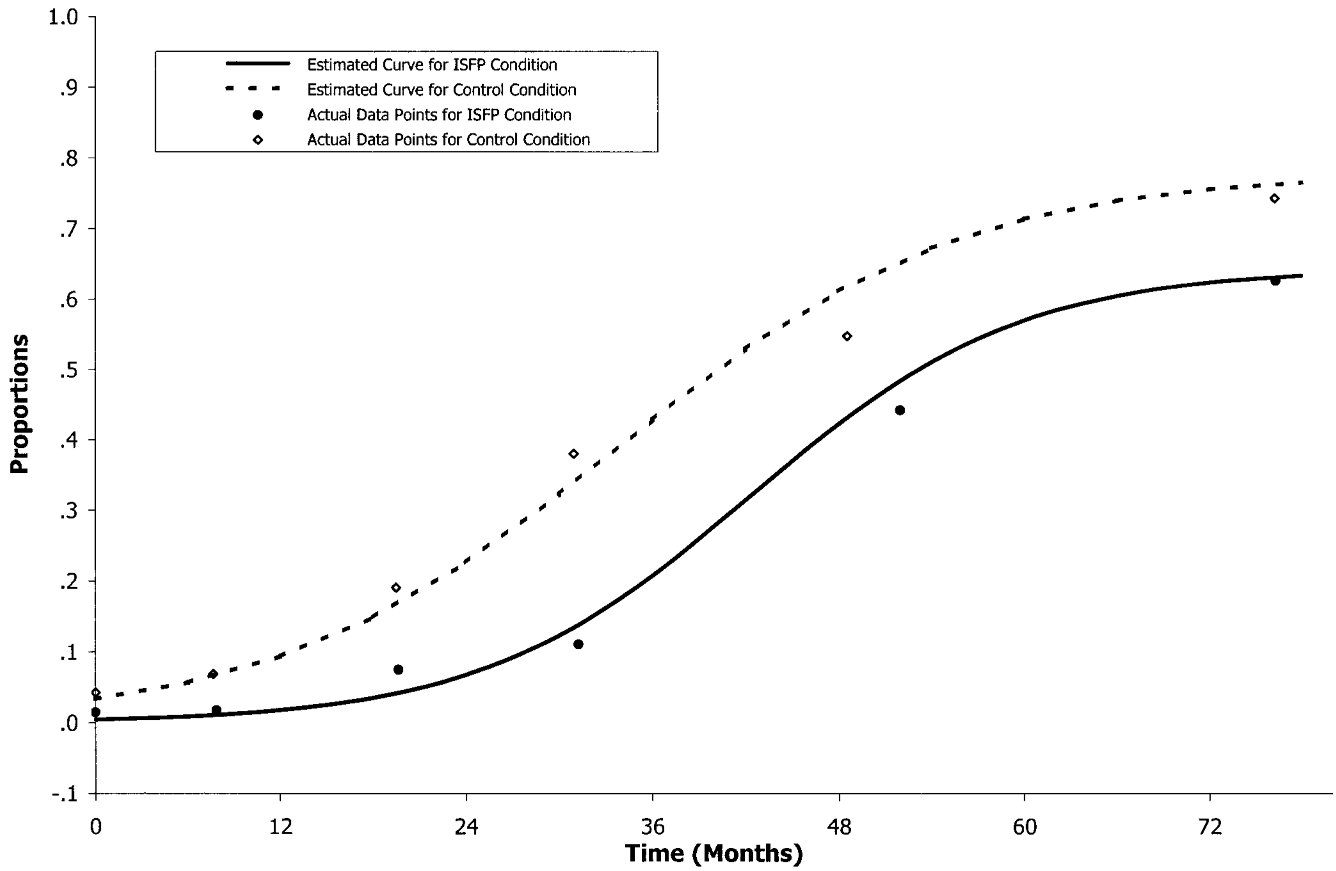

Figure 1. Lifetime alcohol use without parental permission—Estimated growth curves for ISFP- and control-condition schools. ISFP = Iowa Strengthening Families Program.

alcohol use without parental permission, drunkenness, and cigarette use (see Table 2). In addition, a similar, statistically significant effect was observed for the ACUI; a mean ACUI score of .35 was reached in ISFP schools 13.1 months later than in control-group schools.

There were significant PDFY–control differences in the general shapes (indicating rates of growth) of the growth curves for the two tobacco outcomes (the TCUI and lifetime cigarette use). In each instance, growth in substance use among PDFY-group adolescents lagged behind that of control-group adolescents. There were no other significant PDFY–control group differences found.

Discussion

The results of this study suggest that both family-focused interventions slowed the growth in initiation of some substances over a 6-year period following the baseline assessment, during which the mean age of participants increased from 11.8 years to 18.2 years. It is important to note that these outcomes were observed in analyses conducted at the school level. A greater number of delayed growth effects were in evidence for the ISFP, with PDFY effects shown only on tobacco use growth rates. Results from this study are noteworthy because, despite broad implementation, there has been only limited rigorous study of universal family-focused intervention long-term outcomes. This is the case despite the potential public health benefits of the diffusion of efficacious universal family-focused interventions in the general population (Biglan, 1995; Spoth, Greenberg, Bierman, & Redmond, in press).

One way to highlight the practical relevance of the findings is to demonstrate the degree to which the preventive interventions have improved participants' status relative to the "normal" population represented by the control-group sample. The improvement in status is illustrated by differences in the intervention and control-group growth curve trajectories. A numerical representation is given by the specification of the differences in the age at which participants in the intervention and control groups reach a certain milestone. This can be expressed in relative reduction terms. One example concerns the onset of drinking without parental permission. Using the results presented in Table 2 in conjunction with the results illustrated in Figure 1 and the age of students at the first wave of data collection, we calculated that 40% of the control-group participants had initiated drinking without parental permission at 14.7 years of age. At the same age, the ISFP group was showing an initiation rate of 18%, for a relative reduction rate of 55%. If generalizable, this rate suggests that for every 100 normal- or general-population adolescents who had initiated use by that age, only 45 intervention group adolescents will likely have initiated the same behavior by that age. Finally, benefit–cost analyses translate this type of intervention–control difference in initiation in

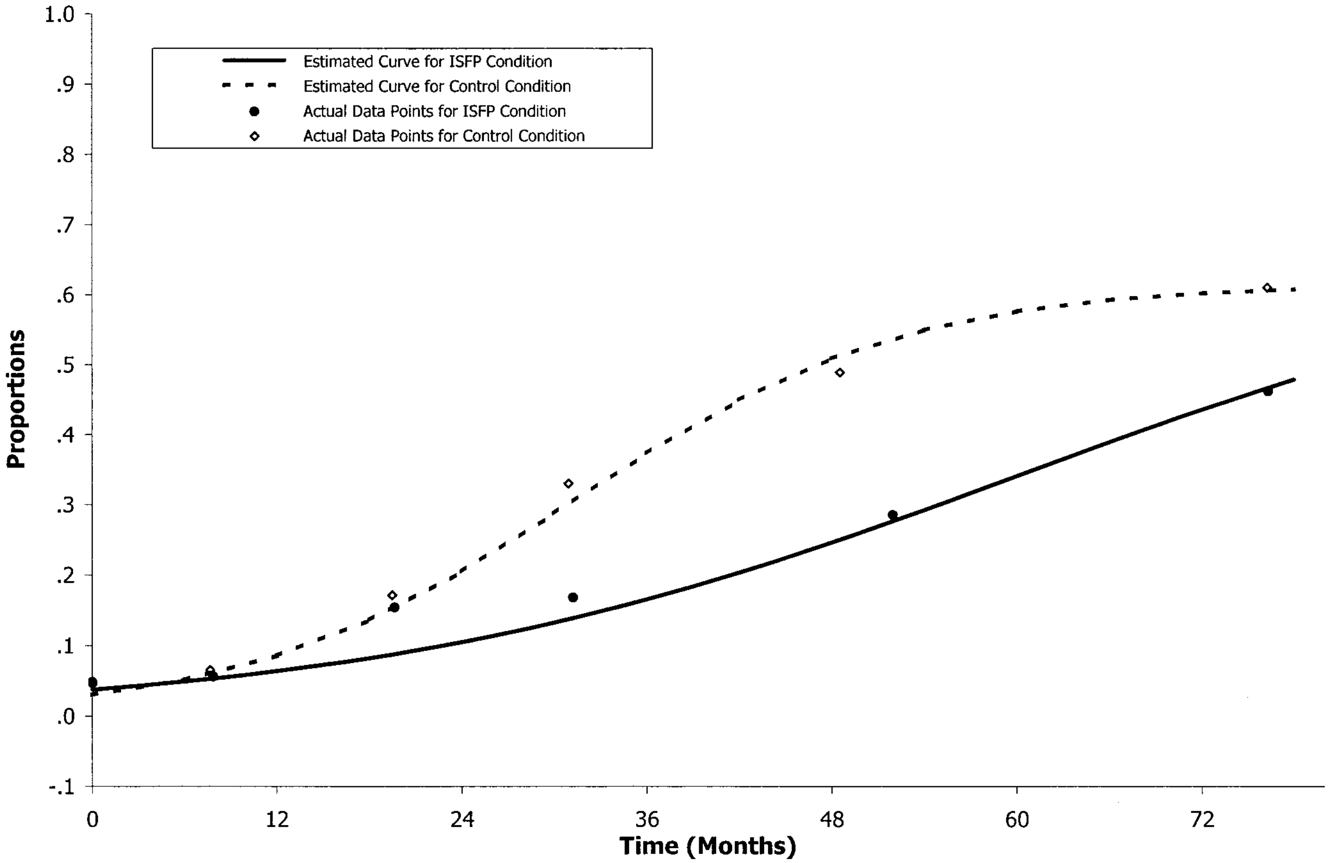

Figure 2. Lifetime cigarette use—Estimated growth curves for ISFP- and control-condition schools. ISFP = Iowa Strengthening Families Program.

economic terms. For example, the delayed initiation of alcohol use observed when the ISFP-intervention participants were in the 6th–10th grades suggests a return of $9.60 per $1.00 invested, concerning the avoidance of alcohol-use disorders alone (Spoth, Guyll, & Day, 2002).

It is reasonable to question the mechanisms by which brief universal family-focused interventions would demonstrate the long-term growth curve results and the concomitant practical benefits reported here. In addition to efforts to rule out rival hypotheses, such as that represented by differential attrition, it is important to specify factors that likely contributed to the observed long-term outcomes. Notably, the interventions were theory based, directly addressing a number of empirically supported risk and protective factors. A number of earlier outcome studies showed that proximal risk and protective factors (e.g., those concerning effective parenting and student competencies) were positively affected by the interventions and that they, in turn, positively affected more distal outcomes (e.g., Redmond, Spoth, & Shin, 1998; Redmond et al., 1999; Spoth et al., 1998; Spoth, Reyes, et al., 1999).

In the context of assessing mechanisms of brief universal intervention effects, the differences between ISFP and PDFY outcomes are salient. Earlier articles have addressed reasons why differences in outcomes between these two programs are to be expected, in part as a result of the greater number of sessions in the ISFP, along with its higher level of young adolescent involvement in the program sessions (see Spoth et al., 2000; Spoth, Reyes, et al., 1999). Although the PDFY failed to show significant time to initiation and inflection point differences with the control group in these analyses, it is important to consider all growth model parameters in reaching conclusions about PDFY results. In this case, there were significant differences in the rates of growth for the two PDFY tobacco outcomes. These findings highlight the need to further examine the pattern of longitudinal outcomes for the PDFY vis-à-vis ISFP, particularly in consideration of previously reported positive longitudinal substance outcomes from the prior wave of data collection (e.g., concerning frequency of past month alcohol use; Spoth et al., 2001) that were not analyzed as part of the curvilinear growth and substance initiation focus of the current report.

It is important to note that the delivery of the interventions was developmentally well-timed, occurring at the point at which participants were beginning to experiment with substance use but before adoption of more frequent or varied use. Coupled with these considerations, another intriguing and complementary explanation of the pattern of outcomes concerns a type of positive diffusion effect (see Spoth et al., 2001). That is, along with the fact that very limited substance initiation had occurred at the time the interventions were implemented (sixth grade), it would seem plausible that with participating students applying substance-reduction related

Table 2
Intervention–Control Differences in Time to Initiation Rates

Outcome	Initiation proportion	Estimated time in months from pretest		
		Treatment	Control	Difference
ISFP vs. control				
Lifetime alcohol use	.40	38.2	25.3	12.9
Lifetime alcohol use without parental permission	.40	46.8	34.4	12.4*
Lifetime drunkenness	.35	58.6	45.3	13.3*
Lifetime cigarette use	.30	54.9	30.8	24.1*
Lifetime marijuana use	.10	63.7	48.6	15.1
PDFY vs. control				
Lifetime alcohol use	.40	25.8	25.5	0.3
Lifetime alcohol use without parental permission	.40	35.9	34.6	1.4
Lifetime drunkenness	.35	41.6	45.1	−3.5
Lifetime cigarette use	.30	31.8	31.0	0.8
Lifetime marijuana use	.10	48.4	48.2	0.2

Note. ISFP = Iowa Strengthening Families Program; PDFY = Preparing for the Drug Free Years.
* $p < .05$.

skills (e.g., peer refusal) and demonstrating a disinclination to use substances, there would be an overall reduction in peer pressure to use substances in intervention schools. This speculation is consistent with empirical results in earlier studies (i.e., dosage effects tend to diminish over time), with nonintervention peers of intervention participants showing effects similar to participants over time (Spoth, Redmond, & Lepper, 1999).

In interpreting the results, we should note some limitations of this study. Analyses relied on self-report data of substance use. Although self-report measures may be susceptible to social desirability biases, previous work has supported the validity of substance use and related problem behavior self-reports (Elliott, Ageton, Huizinga, Knowles, & Canter, 1983; Smith, McCarthy, & Goldman, 1995; Williams et al., 1995). In addition, we consider it unlikely that differential biases associated with experimental condition (e.g., experimenter demand effects) would still be operating nearly 6 years after the intervention. Although the sample attrition rate was appreciable, it was comparable with that in other longitudinal prevention studies conducted around the time the current study was initiated, and differential attrition was ruled out. Also, data collected from 90% of families in the sampling frame indicated that the families participating in the intervention study were representative of families in the sampling frame; these families were rural and virtually all were White. Thus, the degree to which the study findings generalize to more diverse or urban populations is unclear. There is evidence, however, of worsening substance-related problems among rural adolescents and higher levels of many types of use in rural areas, as compared with urban areas. Therefore, special attention to rural populations is warranted.

References

Ackerman, S., Zuroff, D. C., & Moskowitz, D. S. (2000). Generativity in midlife and young adults: Links to agency, communion, and subjective well-being. *International Journal of Aging and Human Development, 50,* 17–41.

Biglan, A. (1995). *Changing cultural practices: A contextual framework for intervention research.* Reno, NV: Context Press.

Catalano, R., Kosterman, R., Haggerty, K., Hawkins, D., & Spoth, R. (1999). A universal intervention for the prevention of substance abuse: Preparing for the drug free years. In R. Ashery, E. Robertson, & K. Kumpfer (Eds.), *NIDA research monograph on drug abuse prevention through family interventions* (pp. 130–159). Rockville, MD: National Institute on Drug Abuse.

Duncan, S. C., Strycker, L. A., & Duncan, T. E. (1999). Exploring associations in developmental trends of adolescent substance use and risky sexual behavior in a high-risk population. *Journal of Behavioral Medicine, 22,* 21–34.

Elliott, D. S., Ageton, S. S., Huizinga, D., Knowles, B. A., & Canter, R. J. (1983). *The prevalence and incidence of delinquent behavior: 1976–1980.* Boulder, CO: Behavioral Research Institute.

Hawkins, J. D., Catalano, R. F., & Miller, J. Y. (1992). Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance abuse prevention. *Psychological Bulletin, 112,* 64–105.

Johnston, L., O'Malley, P., & Bachman, J. (2000). *Monitoring the future: National survey results on drug use, 1975–1999: Vol. 1. Secondary school students* (NIH Publication No. 00-4802). Washington, DC: U.S. Department of Health and Human Services.

Koestner, R. (1991). The effect of illicit drug use on the wages of young adults. *Journal of Labor Economics, 9,* 381–412.

Lindstrom, M. J., & Bates, D. M. (1990). Nonlinear mixed effects models for repeated measures data. *Biometrics, 46,* 673–687.

Molgaard, V., & Spoth, R. (2001). Strengthening families program for young adolescents: Overview and outcomes. In S. I. Pfeiffer & L. A. Reddy (Eds.), *Innovative mental health programs for children: Programs that work* (pp. 15–29). Binghamton, NY: Haworth Press.

Mrazek, P., & Haggerty, R. (Eds.). (1994). *Reducing risks for mental disorders: Frontiers for preventive intervention research.* Washington, DC: National Academy Press.

Myers, R. H. (1989). *Classical and modern regression with applications* (2nd ed.). Boston, MA: PSW-Kent.

National Institute on Drug Abuse. (1997). *Preventing drug use among children and adolescents: A research-based guide* (NIH Publication No. 97-4212). Rockville, MD: Author.

Redmond, C., Spoth, R., & Shin, C. (1998, June). *Adolescent propensity to use alcohol: Long-term outcomes of a universal family-focused preventive intervention.* Symposium paper presented at the Society for Prevention Research Sixth Annual Meeting, Park City, UT.

Redmond, C., Spoth, R., Shin, C., & Lepper, H. (1999). Modeling long-term parent outcomes of two universal family-focused preventive interventions: One year follow-up results. *Journal of Consulting and Clinical Psychology, 67,* 975–984.

Smith, G. T., McCarthy, D. M., & Goldman, M. S. (1995). Self-reported drinking and alcohol-related problems among early adolescents: Dimensionality and validity over 24 months. *Journal of Studies on Alcohol, 36,* 383–394.

Spoth, R. (1999). Family-focused preventive intervention research: A pragmatic perspective on issues and future directions. In R. Ashery, E. Robertson, & K. Kumpfer (Eds.), *NIDA Research Monograph on drug abuse prevention through family interventions* (pp. 459–510). Rockville, MD: National Institute on Drug Abuse.

Spoth, R., Goldberg, C., & Redmond, C. (1999). Engaging families in longitudinal preventive intervention research: Discrete-time survival analysis of socioeconomic and social-emotional risk factors. *Journal of Consulting and Clinical Psychology, 67,* 157–163.

Spoth, R., Greenberg, M., Bierman, K., & Redmond, C. (in press). PROSPER partnership model for state public education systems: Capacity-building for evidence-based, competence-building prevention. *Prevention Science.*

Spoth, R., Guyll, M., Chao, W., & Molgaard, V. (2003). Exploratory study of a preventive intervention with general population African-American families. *Journal of Early Adolescence, 23,* 435–468.

Spoth, R., Guyll, M., & Day, S. X. (2002). Universal family-focused interventions in alcohol-use disorder prevention: Cost-effectiveness and cost-benefit analyses of two interventions. *Journal of Studies on Alcohol, 63,* 219–228.

Spoth, R., Redmond, C., Haggerty, K., & Ward, T. (1995). A controlled parenting skills outcome study examining individual difference and attendance effects. *Journal of Marriage and the Family, 57,* 449–464.

Spoth, R., Redmond, C., & Lepper, H. (1999). Alcohol initiation outcomes of universal family-focused preventive interventions: One- and two-year follow-ups of a controlled study. *Journal of Studies on Alcohol, 13*(Suppl.), 103–111.

Spoth, R., Redmond, C., & Shin, C. (1998). Direct and indirect latent-variable parenting outcomes of two universal family-focused preventive interventions: Extending a public health-oriented research base. *Journal of Consulting and Clinical Psychology, 66,* 385–399.

Spoth, R., Redmond, C., & Shin, C. (2000). Reducing adolescents' aggressive and hostile behaviors: Randomized trial effects of a brief family intervention four years past baseline. *Archives of Pediatrics and Adolescent Medicine, 154,* 1248–1257.

Spoth, R., Redmond, C., & Shin, C. (2001). Randomized trial of brief family interventions for general populations: Adolescent substance use outcomes four years following baseline. *Journal of Consulting and Clinical Psychology, 69,* 627–642.

Spoth, R. L., Redmond, C., Trudeau, L., & Shin, C. (2002). Longitudinal substance initiation outcomes for a universal preventive intervention combining family and school programs. *Psychology of Addictive Behaviors, 16,* 129–134.

Spoth, R., Reyes, M. L., Redmond, C., & Shin, C. (1999). Assessing a public health approach to delay onset and progression of adolescent substance use: Latent transition and loglinear analyses of longitudinal family preventive intervention outcomes. *Journal of Consulting and Clinical Psychology, 67,* 619–630.

Taylor, T. K., & Biglan, A. (1998). Behavioral family interventions for improving childrearing: A review of the literature for clinicians and policy makers. *Clinical Child and Family Psychology Review, 1,* 41–60.

Weissberg, R. P., & Greenberg, M. T. (1998). Community and school prevention. In I. Siegel & A. Renninger (Eds.), *Handbook of child psychology: Vol. 4. Child psychology in practice* (5th ed., pp. 877–954). New York: Wiley.

Williams, C. L., Perry, C. L., Dudovitz, B., Veblen-Mortenson, S., Anstine, P. S., Komro, K. A., & Toomey, T. L. (1995). A home-based prevention program for sixth-grade alcohol use: Results from Project Northland. *Journal of Primary Prevention, 16,* 125–147.

Windle, M., & Windle, R. C. (2001). Depressive symptoms and cigarette smoking among middle adolescents: Prospective associations and intrapersonal and interpersonal influences. *Journal of Consulting and Clinical Psychology, 69,* 215–226.

Appendix

Nonlinear Growth Curve Analyses

As summarized in the text, nonlinear growth curve analyses were conducted with school-level outcome variables aggregated over respondents who completed all six assessments in each school. We conducted analyses using school-based means. Limiting analyses to include only schools in which six or more students provided data across all study waves yielded a sample of 23 schools (7 ISFP schools, 8 PDFY schools, and 8 control schools). As a result, there were 15 observations at each assessment point in each ISFP–control analysis and 16 observations at each assessment point in each PDFY–control analysis. Intervention effects on growth curves were tested in pairwise comparisons of ISFP versus control and PDFY versus control. The following logistic growth curve model was used to fit the data:

$$y_{ij} = \frac{\alpha_0 + \alpha_1 D_i + U_{1,i}}{1 + \exp[(\beta_0 + \gamma_0 t_{ij} + \beta_1 D_i + \gamma_1 D_i t_{ij} + U_{2,i})]} + e_{ij}$$

for $i = 1, 2, \ldots, 15$, or 16 (schools) and $j = 1, 2, \ldots, 6$ (waves of data collection). In the model, y_{ij} is the school-level outcome variable and t_{ij} is the average time in months from pretest to data collection wave j for school i. D_i is the dichotomized variable representing the intervention or control condition (scored 1 or 0, respectively) for school i. The e_{ij} are random errors assumed to be independently and normally distributed with mean zero and variance σ^2. The $U_{1,i}$ and $U_{2,i}$ are random-effect parameters assumed to have bivariate normal distribution with mean zero and variance of σ_1^2 and σ_2^2, respectively. The covariance between $U_{1,i}$ and $U_{2,i}$ is assumed to be σ_{12}, and $U_{1,i}$ and $U_{2,i}$ are independent of the e_{ij} for school i at the data collection wave j (Lindstrom & Bates, 1990).

The upper limit or maximum value of the curve in each treatment condition, characterized by its upper tail (right upper tail in this study because $\gamma_0 > 0$), is determined by α_0 and α_1. The difference in the lower limit of the growth curve (reflecting baseline levels of substance use in this study) between treatment condition and control condition is determined by

$$\left(\frac{\alpha_0}{1 + \exp(-\beta_0)}\right) - \left(\frac{\alpha_0 + \alpha_1}{1 + \exp[-(\beta_0 + \beta_1)]}\right).$$

The significance of that difference can be tested using the ESTIMATE statement of PROC NLMIXED. Specifically, it is the difference of the estimated value of the outcome variable at pretest ($t_{ij} = 0$) between the intervention and control conditions in the model. In a similar manner, the inflection points of the two experimental conditions also can be calculated and the difference between the two points can be tested.

Received December 23, 2002
Revision received August 16, 2003
Accepted August 22, 2003 ■