Substance use outcomes 5½ years past baseline for partnership-based, family-school preventive interventions

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Abstract

This article reports adolescent substance use outcomes of universal family and school preventive interventions 5½ years past baseline. Participants were 1677 7th grade students from schools ($N = 36$) randomly assigned to the school-based Life Skills Training plus the Strengthening Families Program: For Parents and Youth 10–14 (LST + SFP 10–14), LST-alone, or a control condition. Self-reports were collected at baseline, 6 months later following the interventions, then yearly through the 12th grade. Measures included initiation—alcohol, cigarette, marijuana, and drunkenness, along with a Substance Initiation Index (SII)—and measures of more serious use—frequency of alcohol, cigarette, and marijuana use, drunkenness frequency, monthly poly-substance use, and advanced poly-substance use. Analyses ruled out differential attrition. For all substance initiation outcomes, one or both intervention groups showed significant, positive point-in-time differences at 12th grade and/or significant growth trajectory outcomes when compared with the control group. Although no main effects for the more serious substance use outcomes were observed, a higher-risk subsample demonstrated significant, positive 12th grade point-in-time and/or growth trajectory outcomes for one or both intervention groups on all measures. The observed pattern of results likely reflects a combination of predispositions of the higher-risk subsample, the timing of the interventions, and baseline differences between experimental conditions favoring the control group.

Keywords

Prevention; Family; School; Risk moderation; Adolescents

1. Introduction

This article reports long-term outcomes of universal family-and school-based interventions designed to prevent adolescent substance use in general populations. It is based on follow-up

assessments through 5½ years past baseline (12th grade) for a prevention trial called the Capable Families and Youth Study. Earlier reports from this study examined outcomes at 1½ and 2½ years past baseline.

There is a clear rationale for rigorous research on universal family-focused and school-based interventions targeting substance use among general populations. As noted in relevant literature reviews, there are very few randomized, controlled studies examining outcomes 3 years or more past baseline or intervention posttest (Foxcroft et al., 2003). Key reasons for intervention research on this topic concern the prevalence of substance use in the general population, with its social, health, and economic consequences, and the influence of factors originating in family and school environments on substance use.

Concerning prevalence of adolescent substance use, a national survey reveals continued high rates of alcohol, cigarette, and marijuana use among adolescents in the U.S. (Johnston et al., 2007). In 2006, 6.4% of 8th graders and 25.1% of 12th graders reported having used alcohol on three or more occasions in the past 30 days. Cigarette smoking also is prevalent among adolescents. Johnston et al. (2007, p. 28) state that since 1975, cigarettes have consistently remained the class of abusable substances most frequently used on a daily basis by high school students. Also, in 2006, 15.7% of 8th graders and 44.8% of 12th graders had initiated marijuana use. Further, 5.0% of 12th graders smoked marijuana daily and 48.2% of 12th graders reported lifetime use of any illicit drug.

It is well established that a number of specific factors in both family and school socializing environments contribute significantly to adolescent substance use (Getz and Bray, 2005; Hawkins et al., 1992; Mrazek and Haggerty, 1994; Resnick et al., 1997; Wood et al., 2004). This study incorporated a multicomponent intervention, addressing such factors in both socializing environments. The intervention consisted of two theory-based programs: the Strengthening Families Program: For Parents and Youth 10–14 (SFP 10–14; Molgaard et al., 2000); and Life Skills Training (LST; Botvin et al., 1995), a school-based universal intervention. Together they target a wide range of empirically-and theoretically-supported factors (e.g., family-, individual-, peer-, and school-related) associated with adolescent substance use. It is especially noteworthy that the universal design of these two programs offers a significant advantage by potentially influencing a larger number of individuals prone to adult substance use disorders than interventions designed for clinical subpopulations (Jamieson and Romer, 2003; Offord et al., 1998).

Another important reason for implementing the tested universal interventions derives from recent epidemiological research. This research shows that a developmental window of opportunity exists to intervene with general population adolescents who have not yet initiated or have recently initiated substance use; substantial public health benefits might be gained if appropriately-timed interventions are applied to delay onset or, following initiation, to delay transition to more serious use (Anthony, 2003). Moreover, with data collected through participants' senior year of high school, more serious and problematic substance use attained a sufficiently high frequency to examine intervention-control differences on these outcomes, as projected in earlier reports (Spoth et al., 2002, 2005). Accordingly, the current study not only addressed the preventive interventions' effects on delaying initiation of substance use through 5½ years past baseline, but also examined more serious and problematic substance involvement (namely, frequency of alcohol, cigarettes, and marijuana use, as well as drunkenness; monthly poly-substance use [alcohol, cigarettes, and marijuana]; and more advanced poly-substance use).

Developmentally, the greatest increase in substance initiation, frequency of use, and number of substances used occurs during the high school years—a period during which some

adolescents who use substances experiment with multiple substances in a developmental progression (Kandel and Yamaguchi, 2002). Thus, in this report, continuous measures of both individual substances and poly-substance use indices are examined. Among the more serious types of substance use, poly-substance use (i.e., the use of different substances on the same or different occasions—Toumbourou and Catalano, 2005), is particularly important to consider. Adolescent poly-substance use is associated with a number of problematic outcomes, such as adverse psychological and social consequences, particularly for girls (Lex, 1995; Overman et al., 2004), increased delinquent acts for boys (Mason and Windle, 2002), an increased likelihood of developing substance abuse and other mental health problems in adulthood (Newcomb and Felix-Ortiz, 1992; Toumbourou and Catalano, 2005), lower levels of adolescent achievement motivation and adult job-related problems (Mohler-Kuo et al., 2003; Stein et al., 1993), accidental death due to drug overdose (Coffin et al., 2003), suicide (Midanik et al., 2007), high-risk sexual behaviors (Midanik et al., 2007), and substance-related accidents in adulthood (Guy et al., 1993).

Earlier reports on study results through the 9th grade supported hypotheses that students in both intervention conditions would demonstrate significantly lower substance initiation than the control condition students at 1½ years and 2½ years past baseline (Spoth et al., 2002, 2005). In addition, when the students were in 9th grade, the latter study (Spoth et al., 2005) found significantly lower levels of monthly alcohol use and weekly drunkenness for the LST + SFP 10–14 combined intervention students relative to the control group, as well as significant intervention-control differences for the LST-only condition on weekly drunkenness. A recent supplemental report utilized data from this and another similar study to examine intervention effects on methamphetamine use measures that were incorporated into later data collection waves (Spoth et al., 2006). The present study extends earlier research by testing intervention effects (point-in-time differences and rate of change) on substance initiation through 5½ years past baseline, when the participants were in 12th grade. Also, the present study extends previous work by investigating intervention effects on a range of more problematic or advanced levels of substance involvement. Based on earlier findings from the current study, and on reports of the tested interventions from other studies (e.g., Griffin et al., 2003; Spoth et al., 2001), it was hypothesized that students in both the intervention conditions would demonstrate significantly less substance use than those in the control condition.

For variables on which no long-term intervention main effects were observed, risk-related moderation of those outcomes also was evaluated. In this context, risk-related moderation entails examination of factors that might influence the effectiveness of an intervention, but which the intervention cannot change (e.g., pre-existing individual characteristics or behaviors) or was not designed to change (e.g., mental health status—see MacKinnon et al., 1988; Spoth et al., 2006). Risk-related moderation was evaluated primarily for two reasons. First, differential trends toward higher rates of substance initiation occurring early on, evident at pretest among the intervention groups relative to the control group, could make intervention effects more difficult to detect. In effect, a higher proportion of substance-using intervention group adolescents may have had a "head start" on progression to more intense or frequent and varied use (see Spoth et al., 2005). Second, possible differential effects of the intervention across subgroups would not be evident when analyzing the entire sample, suggesting an investigation into subgroup comparisons (Brookes et al., 2004).

Although previous investigations of risk moderation by aggregate family risk (Spoth et al., 1998) and parental social–emotional maladjustment (Guyll et al., 2004) conducted with earlier studies found that both lower- and higher-risk groups received comparable benefits from the interventions, there was reason to expect that in this particular study, such would not be the case. In the current study, interventions were conducted when students were in the 7th grade, rather than in 6th grade as in the earlier studies, and many more students had initiated substance

use by that time. These higher rates of initiation allowed us to examine risk based on early adolescent use, which likely produced a more accurate assessment of risk for later, more serious use than family-related risk indices. In addition, an analysis of school-level risk moderation conducted when students in the sample were in the 10th grade showed results favoring the higher-risk subgroup (Trudeau et al., 2004). Thus, we conducted a risk-stratified analysis in order to assess possible differential effects of the interventions on adolescents who had already initiated use of at least two substances at pretest (defined as higher-risk students).

2. Methods

2.1. Participants

Participants were students and their parents enrolled in 36 rural Midwestern schools, recruited from a regional pool of 43 schools. Selection criteria were: 20% or more of school district households eligible for the free or reduced cost school lunch program; school district enrollment under 1200; and having all middle school grades (6–8th) taught at one location. At recruitment, schools did not know their experimental assignment, which was guided by a randomized block design. Based on school-level risk measures calculated from data collected through a prospective telephone survey of randomly selected parents of eligible children, the schools were split into 12 matched sets of three. Within each matched set, schools were randomly assigned across the three experimental conditions: those receiving the 15-session, classroom-based LST plus the 7-session SFP: 10–14; those receiving the LST-only; and a minimal contact control condition (leaflets on teen development mailed to parents). Schools were then contacted and informed of experimental condition assignment.

All 7th grade students were recruited; approximately 91.6% of eligible students participated in the in-school assessment at pretest (3.4% were absent, 3.6% were not consented, and 1.4% were not eligible for other reasons). On average, 46 students in each school completed the pretest. Table 1 presents participation rates through 12th grade.[1] Slightly over half of the students were male (53%) and the majority were White (96%). Families and schools were compensated for their participation. In addition, a randomly selected subset of students and their families (approximately 20 families per school) were recruited for more extensive in-home assessments.[2]

2.2. Procedure

A passive consent procedure allowed parents to decline participation for their adolescent, and adolescents were allowed to refuse on their own. Approximately 40–45 min were required to complete the questionnaires; students were assured confidentiality. In addition, through the 9th grade data collection, each student exhaled into a balloon which was then connected to a carbon monoxide (CO) meter to provide a CO reading; following 9th grade, the CO reading was discontinued. The primary purpose of this procedure was to serve as a "bogus pipeline," to

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[1]The "undetermined" category represents participants who had missing ID numbers, or subsequently moved from a school in one condition to a school in another condition.

[2]In-home family pretest interviews were conducted with 691 randomly selected families of the 7th graders in the 36 study communities (most 7th graders participating in the in-home interviews also participated in the in-school survey). These interviews included written questionnaires completed by parents and the 7th grade child as well as videotaped family interactions. Although the primary purpose of the in-home interviews was to assess family characteristics and dynamics, the child questionnaires also included items addressing substance use. Some of these items were similar—though generally not identical to—the items from the in-school survey used in the current study. An examination of nonidentical but parallel items from the in-home and in-school questionnaires through 9th grade conducted by Azevedo et al. (2003) suggested that students may tend to underreport levels of substance use during interviews conducted in their home (despite the presence of an interviewer to protect confidentiality); it was not unusual for reporting level differences at pretesting to be more than 50% lower for data collected in the home (reporting differences tended to decline over the time frame evaluated, but remained substantial at the 9th grade assessment). These findings, in conjunction with the smaller in-home sample size, led us to focus on the data collected through the in-school surveys for this and the two previously published outcome studies (Spoth et al., 2002, 2005). Work continues toward arriving at definitive conclusions about setting effects in our and similar studies.

encourage honesty in answering the smoking-related questions (see Bauman et al., 1988; Murray et al., 1989).

2.2.1. Interventions—Earlier reports from follow-up assessments of this study noted the importance of universal interventions implemented via existing delivery systems and community–researcher collaboration as a basis for scaling up such interventions. Interventions implemented in this study were delivered via partnerships within the Land Grant University-based Extension system, through university partnerships with local implementers.

After pretesting, all students in the LST-only and LST + SFP 10–14 conditions were exposed to the LST program, offered as part of the school curriculum. In addition, intervention group families in the LST + SFP 10–14 schools who participated in the in-home pretest assessments were recruited for the SFP 10–14 program; intervention group families not participating in in-home pretesting were allowed to enroll in the SFP 10–14 intervention but were not actively recruited. The two empirically-supported preventive interventions that were combined to form the multicomponent intervention were both designed to address factors frequently associated with adolescent substance use in earlier etiological studies. These programs are described below.

2.2.1.1. Life Skills Training (LST): LST is a universal preventive intervention program based on social learning theory (Bandura, 1977) and problem behavior theory (Jessor and Jessor, 1977). The primary goals of LST are to promote skill development (e.g., social resistance, self-management, general social skills) and to provide a knowledge base concerning the avoidance of substance use. Students are trained in the various LST skills through the use of interactive teaching techniques (e.g., coaching, facilitating, role modeling, feedback and reinforcement, plus homework exercises and out-of-class behavioral rehearsal).

Trained teachers conducted the 15-session program during 40–45-min classroom periods when students were in 7th grade. Classroom teachers were observed by project staff on two or three occasions to assess adherence to the instructional content with checklists delineating objectives and curriculum items covered. For example, one content adherence item was: "Review verbal skills for saying no." Ninety-eight LST teacher observations were completed; 20 classroom observations included two observers for the assessment of interrater agreement. Adherence averaged 85% and interrater agreement was 78%.

Approximately 1 year later, students also participated in five LST booster sessions. As in the first year, the overall thrust of the booster sessions was to promote skill development, primarily social resistance skills, self-management skills, and generic social skills. Sixty-one teacher observations were completed, including 8 double observations; adherence averaged 82% and interrater agreement was 71%.

Additional LST booster sessions were provided during the spring semester of 11th grade to students in a subset of 12 randomly selected intervention schools, six from the LST-only condition schools and six from the LST + SFP 10–14 condition schools ($N = 639$). Four lessons from the LST curriculum (Botvin, 2000) focused on social interaction skills: assertiveness, conflict resolution, coping with anxiety, and coping with anger. Once again, implementation quality observers were trained and observations were conducted; each teacher was observed on two occasions; adherence averaged 77% and interrater agreement was 75%.

Analyses conducted in this and an earlier intervention trial have found minimal significant relationships between fidelity and outcome variables (Spoth et al., 2002), likely due to the generally high level of implementation quality and its limited variability. In this vein, the earlier report describes factors related to how the community-university partnership-based

implementation (e.g., selection of implementers and their training) likely played a major role in the consistently high quality implementation.

2.2.1.2. The Strengthening Families Program: For Parents and Youth 10–14 (SFP-14):
SFP 10–14 targets empirically-based factors originating in the family environment that are associated with adolescent substance use (Kumpfer et al., 1996; Molgaard et al., 2000). The long-range goal of SFP 10–14 is to reduce youth substance use and other problem behaviors. Intermediate goals include the enhancement of parental skills in nurturing, limit-setting, and communication, as well as youth prosocial and peer resistance skills.

Forty-five SFP 10–14 program facilitators received 3 days of on-site training; all were White, 38 were female (84%), and all were between the ages of 30 and 65. Ongoing consultation and technical assistance for facilitators also was available. The seven SFP 10–14 program sessions were conducted in the participating schools during the evening for seven consecutive weeks when the youth were in the second semester of 7th grade. Each session included separate, concurrent 1-h parent and youth skills-building curricula, followed by a 1-h conjoint family curriculum during which parents and youth practiced skills learned in their separate sessions. Each session required three facilitators, one for the parent session and two for the youth session; all facilitators participated in the family sessions. A total of 137 families attended the SFP 10–14 in 22 groups in the 12 schools assigned to the condition. Each team of facilitators was observed two or three times by trained observers who completed ratings of program content coverage, based on the manualized group instructions. Coverage of the component tasks or activities described in the group leader's manual averaged 98% in the family sessions, 92% in the parent sessions, and 94% in the youth sessions. Reliability checks were conducted on approximately 40% of the family session observations, 21% of the parent session observations, and 14% of the youth session observations. Observers' assessments of coverage of detailed group activities varied by an average of 1.6% for the family sessions, 3.1% for the parent sessions, and 2.4% for the youth sessions.

Families were invited to participate in four booster sessions approximately 1 year following the initial SFP 10–14 sessions. As in the first set of sessions, booster sessions addressed factors associated with substance use and other problem behaviors. Ninety of the families attending at least one of the earlier SFP 10–14 sessions also attended at least one booster session (69%). Observer-based adherence assessments indicated that coverage of the component tasks or activities averaged 97% for the family sessions, 94% for the parent sessions, and 96% for the youth sessions. Reliability checks were conducted on 40% of the family sessions, 28% of the parent sessions, and 15% of the youth sessions. Observers' assessments varied by an average of 2.6% for the family sessions, 3.4% for the parent sessions, and 2.5% for the youth sessions. As noted earlier, prior study of community-university partnership-based program implementation has shown consistently high levels of implementation quality and, related to those findings, limited evidence of implementation quality-outcome relationships (Spoth et al., 2002). In addition, dose-effect relationships have been examined for an earlier version of the family intervention (Spoth et al., 1999), with the conclusion that the limited dosage effects observed in initial follow-up assessments tended to dissipate as the years past intervention increased.

The family-focused booster interventions conducted for the six randomly selected LST + SFP 10–14 intervention schools during the 11th grade included three components: (a) a videotape on effective parenting plus a self-assessment questionnaire; (b) a family–school resource fair and resource directory; and (c) a goal-setting seminar presented to students. The parenting videotape, *Parenting Older Teens with Love and Limits*, addressed older adolescent developmental issues and was designed by project staff to closely align with the SFP 10–14. The videotape, mailed to families who had previously participated in the in-home assessments

in six schools (115 families, approximately 19 per school), demonstrated both effective and ineffective parenting in scenarios illustrating common situations involving parents and older adolescents. A one-page handout addressing issues of adolescent development, *Guidelines for Parenting Older Teens*, also accompanied the videotape.

2.3. Measures

Self-reported substance use was obtained from the classroom-administered questionnaire. Measures were chosen to address the full range of substance behaviors expected at this developmental stage, from initiation through more serious substance involvement.

2.3.1. Substance initiation—As an extension of earlier analyses when the students were in the 8th and 9th grades, the current investigation analyzed the Substance Initiation Index (SII), which consists of three items: (a) "Have you ever had a drink of alcohol?"; (b) "Have you ever smoked a cigarette?"; and (c) "Have you ever smoked marijuana (grass, pot) or hashish (hash)?" All three items were answered using a yes/no format and coded as 1 for "Yes" and 0 for "No." Students were considered to have initiated lifetime use of a substance from the time they first reported such use, even if they reported no lifetime use at a later assessment point. The three lifetime use items were summed to form the SII. Reliability (K–R 20) for the SII at the follow-up assessment 5½ years past baseline was in the range expected for this type of index (0.58—Spoth et al., 2005). Prior studies have reported the use of similar substance use indices and their predictive validity (Spoth et al., 1999; Trudeau et al., 2003), consistent with the general literature on the validity of such self-report measures (e.g., Botvin et al., 1995; Elliott et al., 1983; Williams et al., 1995).

The individual initiation measures included the items specified above, namely alcohol (AI), cigarette (CI), and marijuana initiation (MI), plus an item concerning drunkenness initiation (DI) on which responses were coded as 0 for "Never" and 1 for responses indicating at least one experience of drunkenness.

2.3.2. Frequency of substance use: Alcohol Use, Cigarette Use, Drunkenness, and Marijuana Use—The alcohol frequency (AF), drunkenness frequency (DF), cigarette frequency (CF), and marijuana frequency (MF) measures were included to address increasing levels of substance involvement and heavy use, reflecting the patterns of use expected as adolescents progress through high school. Responses were obtained from questionnaire items: "About how often (if ever) do you: (a) Drink beer, wine, wine coolers, or liquor (more than just a few sips), (b) Drink until you get drunk, (c) Smoke cigarettes, and (d) Smoke marijuana (grass, pot) or hashish (hash)?" Responses were coded so that 0 = "Never," 1 = "A few times a year," 2 = "Once a month to a few times a month," 3 = "Once a week to a few times a week," and 4 = "Once a day to more than once a day." Similar measures of frequency have been used in past research (Li et al., 2001; Nash et al., 2005).

2.3.3. Measures of more problematic or serious substance use—Although no standard definition, conceptualization, or measure currently exists for poly-substance use (Ives and Ghelani, 2006; Schensul et al., 2005), two common types of assessments include concurrent poly-substance use (i.e., more than one substance in a given time period) and simultaneous poly-substance use (i.e., the co-ingestion of different substances on the same occasion; see McCabe et al., 2006). Sneed et al. (2004) examined three indices of lifetime poly-substance use: (a) an unweighted count of substances used; (b) a weighted substance use index where each substance was assigned a weight based upon severity (as determined by the researchers); and (c) a hierarchical index (i.e., ranging from alcohol or cigarettes, to use of both alcohol and cigarettes, to use of alcohol, cigarettes, and marijuana, to use of alcohol, cigarettes, marijuana plus one other illicit substance) and found basic functional equivalency among the

three. Considering the consequences of problematic alcohol, tobacco, and marijuana use (Biederman et al., 2006; Fergusson et al., 2006; Kozlowski et al., 2003) and the work by Sneed et al. (2004), the authors chose an index of monthly alcohol, cigarette and marijuana use, plus an advanced poly-substance use index combining a count of substances used with hierarchical weighting to indicate the extent of progression of substance use, as described below.

2.3.3.1. Monthly poly-substance use (MPU): MPU was constructed by dichotomizing the *Alcohol Use*, *Cigarette Use,* and *Marijuana Use* items so 1 indicated monthly or more frequent use and 0 indicated use less than once a month. These items were chosen to correspond to the SII; they are the primary substances used on a relatively more regular basis in this population. The three items were summed to form the scale; K–R 20 reliability averaged 0.62.

2.3.3.2. The advanced poly-substance use (APU) index: The APU index was similar to measures of poly-substance use in past research that has examined more serious substance involvement (Newcomb and Bentler, 1987; Smit et al., 2002; Sneed et al., 2004). APU was scored as a count of substance use behaviors meeting specified threshold levels, with specified thresholds ranging from frequent or regular use of gateway substances to lifetime use of relatively less frequently used substances. It was computed as the sum of five items, each coded as present (1) or absent (0), assessing (a) daily or more frequent use of cigarettes, (b) alcohol use a few times a month or more, (c) monthly (or more frequent) drunkenness, (d) lifetime marijuana use, and (e) lifetime use of glue, paint, gas, or other inhalants. Single questionnaire items assessing substance use frequency (described above) were dichotomized so that "1" would indicate the corresponding amount of use (i.e., daily or more, monthly or more, a few times a month or more, or lifetime) and "0" would indicate less frequent or no use. The five items were then summed to form the APU measure. Reliability (K–R 20) for the APU at the follow-up assessment 5½ years past baseline was 0.72.

2.4. Data analysis

Outcome analyses were "intent-to-treat," using data from individuals in the entire sample, whether or not particular individuals participated in the intervention(s). These are conservative analyses frequently recommended for randomized controlled trials as a first step in an unbiased evaluation of intervention effects. Such analyses address possible selection biases, or biases associated with individuals who may be relatively more motivated to participate in an intervention.

Individual scores on SII, AF, DF, CF, MF, MPU, and APU variables were examined using a multilevel analysis of covariance (hierarchical linear modeling using SAS PROC MIXED) with school included as a random factor (students were nested within schools). Analyses were conducted based on a randomized block design. Pretest scores and the pretest proportion of dual biological-parent families (aggregated to the school-level) were included as covariates, consistent with earlier outcome studies from this project (Spoth et al., 2002, 2005). To ensure that measures exhibited reasonably normal distributions, the dichotomous initiation outcome measures (AI, DI, CI, and MI) were aggregated to the school level prior to analysis.

Repeated measures analyses with linear slope contrasts were conducted to test for linear slope differences between study conditions across time and for point-in-time differences. Because participants were assessed during classroom periods, many students did not participate in every wave of data collection, due to absences or competing school activities. In order to reduce the likelihood of biased parameter estimates, only adolescents with complete information on the study variables for at least three of the seven assessments were included in the analyses. It was determined that, for the present analyses, using pretest, posttest, and at least one additional wave of data would provide an estimate of intervention effects that would be more conservative

than using data from all students—and would accurately estimate growth curves. The technique chosen for handling missing data was full-information maximum likelihood estimation (FIML). This method has been found to yield more efficient and less biased parameter estimates than traditional methods for dealing with missing data, such as pairwise or listwise deletion of cases (Acock, 2005; Wothke, 2000), and has become a preferred strategy for dealing with missing data (Allison, 2003; Schafer and Graham, 2002).[3]

To test for risk moderation of intervention effects on frequency of substance use (AF, DF, CF, MF), MPU, and APU, participants were divided into higher- and lower-risk subgroups, based on their pretest levels of SII. Those in the higher-risk subgroup had initiated two of three substances (alcohol, cigarettes, and marijuana) by the time of pretesting.[4] First, risk moderation of intervention effects and linear growth in substance use were tested using SAS PROC MIXED. LST-only versus control group and LST + SFP 10–14 versus control group analyses were conducted that incorporated two-way interactions (Condition × Risk) and contrasts to assess risk-related differences in linear growth. To test simple effects, risk-related subgroups were examined separately, first by comparing higher-risk intervention subgroups with the higher-risk control subgroup, then comparing the lower-risk intervention and control subgroups. As in the previous analyses, pretest levels of the variables were used as covariates; the pretest proportion of dual biological-parent families, however, was not included as a covariate due to model convergence issues.

It is noteworthy in this context that analyses of SFP 10–14 participants found that the proportion of higher-risk individuals that participated in the intervention was similar to the proportion of higher risk individuals in the full sample (approximately 20%), suggesting equivalent intervention participation for individuals across levels of risk.

3. Results

3.1. Pretest equivalence

Pretest equivalence of the sample on sociodemographic and outcome measures was assessed. Despite the school matching procedures and the confirmation of the homogeneity of the blocks to which schools were assigned, there was evidence of inequivalence on one of the sociodemographic factors, namely, the proportion of dual biological parents (LST-only, 70%, LST + SFP 10–14, 72%, Control, 78%; F (2, 22) = 4.25, $p < 0.05$). The control group appeared

[3]Multiple imputation (MI) also was considered as an acceptable alternative to address missing data; however, MI utilizes all possible information as covariates for more accurate imputations, and because many of our outcomes (e.g., drunkenness, marijuana) have very low frequencies at pretest, MI has a higher potential for producing biased results (Schafer, 2003). FIML is an alternative that does not have that particular disadvantage, and is well-supported as a missing data technique (Allison, 2003; Schafer and Graham, 2002; Wothke, 2000). Supplemental FIML analyses utilizing an unrestricted sample that included all individuals who provided data at the pretest produced results similar to those presented. When small differences were found between the restricted sample presented in this report and the non-restricted sample, the non-restricted sample generally showed stronger intervention effects. Thus, the restricted sample was a more conservative representation of intervention effects.

[4]The choice of dichotomizing the risk variable was made for both conceptual and empirical reasons. Conceptually, when over 50% of youth have initiated alcohol use, alcohol initiation can be considered normative. In the current sample, more than 50% had initiated alcohol use at pretest. Typically, as indicated by examination of patterns of use, individuals who initiate more than one substance progress from alcohol and/or tobacco as the first substance initiated to more "illicit" drugs, such as marijuana (Kandel and Yamaguchi, 2002). Further, research has consistently documented that a greater degree of substance involvement indicated by use of more than one substance leads to more problematic outcomes (Coffin et al., 2003; Degenhardt et al., 2007; Ives and Ghelani, 2006; McCabe et al., 2006; Schensul et al., 2005; Wish et al., 2006). For these reasons adolescents considered to be at higher risk were those who had initiated more than one substance. In addition, very few adolescents (less than 2% overall) had initiated three substances, so it was considered reasonable to combine those who had initiated 2 or 3 substances (20%) into one higher-risk group. Finally, supplemental analyses using the risk variable as a class variable with four levels (0, 1, 2, and 3 substances initiated) produced a pattern of risk moderation results that did not differ greatly from those in the dichotomized groups that are presented–only one difference was found that changed risk moderation results from significant to non-significant. The overall risk moderation result for AF in the LST + SFP 10–14 group compared to controls was non-significant when analyzing four levels of risk, whereas it was significant when analyzing two levels of risk. We concluded that reporting results using the dichotomized risk variable summarized findings well and, also, avoided issues with space constraints resulting from the presentation of findings on the multiple substance use outcome variables.

to be at a lower level of risk (that is, it showed a greater proportion of dual-parent families than the two intervention groups) at the time the study was initiated. As described above, this variable was included as a control variable where appropriate. Control group adolescents also showed lower levels of substance use than intervention group adolescents; those differences, however, were not statistically significant when aggregated across schools.

3.2. Differential attrition

Analyses were conducted to rule out differential attrition by examining condition by dropout status interactions with the outcome variables across the waves of data collection (assessed from each wave to each of the succeeding waves), along with an assessment of condition by dropout status for those who met inclusion criteria versus those who did not. No significant dropout by condition interactions were found. Across conditions, however, those who remained in the study tended to demonstrate a lower level of substance use at pretest than those who dropped out.

3.3. Substance initiation

Participation by condition for the in-school assessment is summarized in Table 1. The actual Ns for each analysis varied slightly, because the number of students who provided data at pretest, posttest, and at least one additional data collection varied slightly across outcome measures. Results of the analyses for the substance initiation variables are summarized in Table 2, including relative reduction rates for the intervention conditions for all dichotomous initiation outcome variables. For all analyses of dichotomized variables aggregated to the school level, $N = 36$ (in the text, ns in parentheses indicate the individual-level ns—the sample size prior to aggregation).

Results for the Substance Initiation Index ($n = 1621$) showed significant intervention effects on 12th grade adjusted mean levels and on linear growth for both the LST (12th grade mean level, $p < 0.01$; linear growth, $p = 0.02$) and the LST + SFP 10–14 (12th grade mean level, $p = 0.01$; linear growth, $p = 0.01$) conditions versus the control condition; intervention condition students demonstrated lower mean levels in 12th grade and a slower rate of increase across time. Adjusted means across time are illustrated in Fig. 1.

Individual initiation measures include alcohol, drunkenness, cigarettes, and marijuana; all variables were aggregated and analyzed at the school level. Alcohol initiation (AI; $n = 1622$) analyses showed that the 12th grade mean levels of AI did not differ significantly between conditions; however, the rate of change in AI differed by condition, with both intervention condition schools showing a slower rate of increase over time than the control condition schools (LST versus control, $p = 0.09$; LST + SFP 10–14 versus control, $p = 0.04$).

The rate of change across time in drunkenness initiation ($n = 1634$) also differed between conditions, with schools in both intervention conditions showing a significantly slower rate of increase over time than schools in the control condition (LST versus control, $p = 0.01$; LST + SFP 10–14 versus control, $p = 0.02$). A marginally significant difference in the 12th grade adjusted mean was found, favoring the LST condition ($p = 0.06$).

For cigarette initiation (CI; $n = 1621$), both the mean level at 12th grade and the linear increase across time differed significantly between conditions; both the LST ($p = 0.002$) and the LST + SFP 10–14 ($p = 0.04$) condition schools demonstrated a lower level of CI at 12th grade and a slower rate of increase across time than did the control condition schools (both intervention conditions versus control, $p = 0.003$).

Schools in both intervention conditions demonstrated significantly lower mean levels of marijuana initiation (MI; $n = 1,622$) in the 12th grade than control condition schools (both

intervention conditions versus control, $p = 0.02$); the LST schools also demonstrated a marginally slower rate of increase over time ($p = 0.09$).

There were no significant differences between intervention conditions on any variables, neither for point-in-time comparisons nor for growth rates.

3.4. Frequency of substance use, monthly poly-substance use, and the advanced poly-substance use index

Following examination of initiation measures, intervention effects on the variables representing more serious substance involvement were examined. First, main effects of the interventions were assessed using the same multilevel ANCOVA analysis procedure that was used for the SII. No significant effects were found for either the 12th grade mean levels or for the growth trajectories for any of the variables.

Next, moderation analyzes were undertaken to conduct a risk-stratified assessment of the intervention outcomes. As noted earlier, the higher-risk subgroup was defined as those students who reported use of at least two of three substances (alcohol, cigarettes, and marijuana) at pretest. Approximately 20% of all students were in the higher-risk subgroup, including 22% of students in both intervention conditions and 15% of students in the control condition, a significant difference, $\chi^2_{(2)} = 11.60$, $p < 0.01$. To place these findings in context it should be noted that, despite random assignment, pretest differences, statistically significant or otherwise, tended to favor the control group. Consequently, the control group schools had a lower proportion of higher-risk students, possibly rendering it more difficult to detect significant intervention effects in basic analyses. Tests of risk moderation controlled for design effects and used the pretest value of the outcome measure as a covariate. Two-way interactions (Condition × Risk) were significant for *both* intervention conditions versus the control group for all variables except DF, indicating that differences between intervention and control condition students on overall mean levels of the variables (from posttest through the 12th grade assessment) varied significantly by risk-related subgroups. That is, intervention effects on the overall mean levels of AF (LST versus control, $p = 0.004$, LST + SFP 10–14 versus control, $p = 0.03$), CF (ps < 0.01), MF (ps < 0.01), MPU (ps < 0.01), and APU (ps < 0.01) significantly differed across risk groups. The higher-risk intervention group students demonstrated lower overall levels on the more serious substance use variables compared with the higher-risk control group students, with the exception of drunkenness frequency, for which levels were comparable.

Linear slope contrasts also were significant for the LST-only group versus the control group for MF ($p < 0.001$), MPU ($p = 0.04$), and APU ($p = 0.01$) and for the LST + SFP 10–14 group versus the control group for MF ($p < 0.001$) and MPU ($p = 0.03$), indicating that the intervention condition effects on the linear growth trajectories also were significantly moderated by risk.

Finally, to clarify the relation of intervention effects with risk, the sample was analyzed separately by subgroup. Results of analyses on the lower-risk subgroup found *non*-significant intervention condition effects on 12th grade mean levels and linear growth trajectories for all the frequency and frequent or serious substance use variables. In contrast, results of analyses on the higher-risk subgroup showed a number of significant intervention condition effects, as reported in Table 3. Effects of the LST intervention on AF and DF for higher-risk students were significant (LST versus control on 12th grade mean levels of AF and DF, $p = 0.02$ and $p = 0.03$, respectively); LST effects on 12th grade mean levels for CF ($p = 0.002$), MF ($p = 0.01$), MPU ($p < 0.001$), and APU ($p < 0.001$) and LST + SFP 10–14 effects on 12th grade mean levels for CF ($p = 0.01$), MF ($p = 0.002$), MPU ($p < 0.001$) and APU ($p < 0.001$) also were significant. Further, LST effects on *growth trajectories* for CF ($p = 0.01$), MF ($p = 0.01$), MPU ($p = 0.01$) and APU ($p < 0.001$) and LST + SFP 10–14 effects on growth trajectories for

CF ($p = 0.04$), MF ($p = 0.01$), MPU ($p = 0.01$) and APU ($p = 0.01$) were significant, suggesting that the interventions were effective in preventing escalation into more problematic, later substance use for early initiators. Figs. 2 and 3 illustrate condition effects on adjusted mean levels of MPU and APU across time for the higher-risk subgroup.

4. Discussion

Findings from the prevention trial follow-up assessment 5½ years after baseline indicated positive outcomes for 12th graders on all substance initiation measures, for one or both intervention conditions. In addition, positive outcomes on more serious or problematic use were shown for higher-risk subsamples. The significant substance initiation results for both the multi-component LST + SFP 10–14 and the LST-alone are consistent with earlier longitudinal findings (Spoth et al., 2002, 2005). In particular, the Substance Initiation Index has shown positive intervention results in each of the two earlier longitudinal follow-up studies. Moreover, intervention-control differences in initiation growth trajectories were generally stronger than point-in-time differences, suggesting accumulating intervention benefits across time. Finally, the 12th grade relative reduction rates for the initiation measures convey their practical significance, particularly for drunkenness, cigarette and marijuana initiation. For example, for marijuana initiation in both intervention conditions, the 12th grade relative reduction rate is 23%, suggesting that for every 100 non-intervention general population adolescents who initiated marijuana use, only 77 intervention group adolescents would do so during the same period.

The developmental progression of substance use, entailing higher levels of more serious or problematic use in the late high school years, allowed a more in-depth examination of this type of use in the current study, as compared with the previous study, conducted 3 years earlier when students were in the 9th grade (Spoth et al., 2005). As has been observed in other school-based intervention studies (e.g., August et al., 2001; Brown and Liao, 1999; Kellam et al., 1998; Stoolmiller et al., 2000), significant intervention effects were in evidence for a higher-risk subsample, absent effects for the full sample. Twelfth grade point-in-time intervention effects for LST-only were significant for all outcomes; corresponding LST + SFP 10–14 effects were significant for all outcomes except alcohol and drunkenness frequencies. Significant risk moderation of both interventions' effects on growth trajectories were found for all outcomes except alcohol and drunkenness frequencies. Among the higher-risk subsample, the intervention-control differences attained the highest levels of significance for monthly marijuana and poly-substance use, as well as more serious, advanced poly-substance use.

The type of relatively stronger intervention effects for the higher-risk subsample on measures of more serious or problematic substance use is often characterized as a compensatory effect, indicating that an intervention provides more benefit to higher-risk subgroups. The reasons for the observed pattern of effects on initiation outcomes for the full sample and compensatory effects on more serious or problematic types of use are not entirely clear. An earlier report on the current study provides the background for exploring this pattern of results.

To begin, the earlier report suggested reasons for less consistent and lower magnitude substance initiation outcomes from this trial, as compared with findings from other trials of brief universal interventions also reported by the authors. The first reason was intervention timing. To be optimally effective, universal interventions should be implemented prior to student experimentation with gateway substances (e.g., alcohol). In this trial, a higher proportion of students than expected already had initiated alcohol use at baseline. This was especially suboptimal for the family-focused intervention component, one that typically had been implemented when students were in the 6th grade, rather than the 7th grade. (In this case, the family-focused intervention was linked to the school-based intervention, which is typically

conducted in 7th grade.) Thus, the timing of the intervention was less than optimal, missing the early stage of exposure to and experimentation with substance use. Intervention timing-related effects on intervention-control group differences could have been exacerbated by inequivalencies at baseline favoring the control group, with possible suppression of peer-related diffusion of positive intervention influences in the intervention conditions (see Spoth et al., 2005 for a more detailed explanation). Nevertheless, the interventions did have positive, *long-term* effects on substance initiation for those students who had not initiated at pretest in the current study.

In tandem with the timing of the interventions and baseline inequivalencies, another reason for the general pattern of results in this trial on more serious substance use outcomes may be that students at higher-risk were more predisposed to respond differentially to the interventions. That is, possibly, the interventions' positive effects were experienced relatively more by those who were early initiators because exposure to the intervention's prevention messages and activities had more salience for them, as well as for their parents. Multiple aspects of the higher-risk youths' environments (e.g., opportunities to use substances, offers to use, exposure to peers' pro-use conversations, consequences of substance use) are targeted by the intervention and would likely be more salient for the higher-risk group. Higher-risk students' measured use prior to the intervention suggests that they likely already had exposure to peer substance use and opportunities to use, possibly sensitizing them to the intervention's prevention messages and activities. The lower-risk adolescents, many of whom had yet to initiate substance use, in contrast, could have perceived the intervention to be less relevant and thus paid less attention (e.g., perceiving that it "doesn't apply to me") relative to the higher-risk group. The lower-risk group had less exposure to a substance-using subculture and had not experienced any negative effects of substance use. In this context it is noteworthy that, overall, lower-risk adolescents in both intervention and control groups showed limited multi-substance use across the years of assessment (7th through 12th grade).

An evaluation of the levels of significance of effects by type of substance suggests the strongest confidence in results on poly-substance use indicators, at least among higher-risk students. The relatively higher level of *advanced* poly-substance use effects for higher-risk subgroups was evidenced in both intervention conditions. This latter type of use is more likely to develop when students are older but still within the window of opportunity for preventing transition to more advanced use. This pattern of outcomes is especially of interest in consideration of the adverse consequences of such use noted in the introduction.

For both intervention conditions the *growth trajectory* outcomes for alcohol and drunkenness initiation were stronger than the 12th grade point-in-time outcomes for those substances, but the opposite was generally true for the more serious levels of alcohol and drunkenness frequency measures for the higher-risk subsample; in the latter case, *point-in-time* results were stronger. This pattern of results is consistent with alcohol initiation ceiling effects. That is, the ceiling on levels of alcohol initiation in 12th grade would diminish intervention-control differences. Though the growth of rate of initiation from 7th to 12th grade would be slowed to some extent as well, it would not be expected to be diminished to the same degree. In the case of frequency measures, however, a wider variation in levels at 12th grade would occur. Relatively, among those higher-risk students, the intervention group students consistently demonstrated lower frequencies than control group students.

Differential findings associated with the two intervention conditions also warrant discussion. In the case of one outcome, LST + SFP 10–14 produced a significant intervention-control difference when LST-only did not (the alcohol initiation growth trajectory); in two cases (alcohol and drunkenness frequency outcomes for higher-risk 12th graders) the opposite was observed. Generally, however, intervention-control differences were similar across

interventions. Notably, no difference between intervention groups was statistically significant. This pattern of generally similar results of the two intervention conditions also was observed in the earlier assessment at 2½ years past baseline. However, in the 1½ year past baseline follow-up stronger substance initiation outcomes were observed in the LST + SFP 10–14 condition, compared with the LST-only condition; differences between intervention conditions on one of the initiation outcomes attained statistical significance.

Initially, larger differences between intervention conditions were expected by the investigators, based on (1) the wider range of mediating factors (in family and school environments) addressed by the multicomponent intervention, with possible synergistic effects among the individual intervention components; (2) the possible additive effects from factors targeted for intervention in both the family-focused and school-based interventions and, most importantly, (3) the size of the effects of the family-focused component observed in an earlier study. The factors that might have suppressing effects on the intervention outcomes, namely suboptimal timing of the SFP 10–14 intervention (typically implemented during the 6th grade rather than the 7th grade, as noted earlier) and baseline differences between the control and both intervention conditions, may have reduced variability in the outcomes or otherwise limited the range of observed differences between the intervention conditions. Planned follow-ups with the participants when they are young adults (and possibly have increased variability in substance abuse frequencies) may reveal greater differences among intervention conditions. Analyses at these follow-ups will include the application of growth mixture modeling to identify participant subgroups that respond differentially to the interventions. Such subgroups could be examined to specify pretest correlates that may be different from the type of risk specified for the current evaluation of differential effects.

Limitations of this study were discussed in earlier reports and should be considered in interpreting the findings of the current long-term follow-up assessment, as well. These limitations include the extent to which findings generalize beyond predominantly White residents of small Midwestern communities and towns. As noted in earlier reports, other studies of the LST and SFP 10–14 (including adaptations for non-majority populations) suggest that the interventions can produce positive effects in other populations. Possible limitations related to self-reported substance use also have been discussed, noting that reliability and validity issues of self-reported substance use have been addressed extensively in the relevant literature.

Also noted in the earlier longitudinal outcome reports are the potential public health benefits of the tested preventive interventions. Especially important are the prevented or avoided social, health and economic consequences of adolescent substance use noted in the introduction. It is worth considering four points here. First, this study confirms that lasting and long-term preventive intervention effects can be generated. Second, relative reduction rates for the substance initiation outcomes suggest the practical significance of the findings for communities implementing the interventions. Third, effects on relatively more serious and problematic types of substance use were observed in the higher-risk subsample; the greatest social, health and economic consequences are associated with higher-risk subpopulations. Finally, it is expected that public health benefits could be realized in general populations, if sufficient proportions of populations could be engaged in brief interventions readily implemented via existing intervention delivery systems (Spoth and Greenberg, 2005; Spoth et al., 2004). As described earlier, the interventions implemented in this study were delivered via community–university partnerships, under relatively more "real world" conditions. Importantly, subsequent study of multicomponent interventions demonstrated that they can be implemented with quality and reach significant numbers of eligible students and families in communities (Spoth et al., 2007a,b), when administered through an existing intervention delivery system; this suggests potential for large scale dissemination and public health benefits.

Acknowledgments

References

Acock AC. Working with missing values. J Marriage Family 2005;67:1012–1028.

Allison PD. Missing data techniques for structural equation modeling. J Abnorm Psychol 2003;112:545–557. [PubMed: 14674868]

Anthony, J. Selected issues pertinent to epidemiology of adolescent drug use & dependence. Talking Points Prepared for the Annenberg Meeting; 1st August 2003; Philadelphia, PA. 2003.

August GJ, Realmuto GM, Hektner JM, Bloomquist ML. An integrated components preventive intervention for aggressive elementary school children: The Early Risers program. J Consult Clin Psychol 2001;69:614–626. [PubMed: 11550728]

Azevedo, K.; Redmond, C.; Lillehoj, C.; Spoth, RL. Contradictions across in-school and in-home reports of adolescent substance use initiation. 2003, June; Poster presented at the meeting of the Society for Prevention Research; Washington, DC.

Bandura, A. Social Learning Theory. Prentice Hall; Englewood Cliffs, NJ: 1977.

Bauman KE, Koch GG, Bryan ES. Validity of self-reports of adolescent cigarette smoking. Int J Addict 1988;17:1131–1136. [PubMed: 6816745]

Biederman J, Monuteaux MC, Mick E, Wilens TE, Fontanella JA, Poetzl KM, Kirk T, Masse J, Faraone SV. Is cigarette smoking a gateway to alcohol and illicit drug use disorders? A study of youths with and without attention deficit hyperactivity disorder. Biol Psychol 2006;59:258–264.

Botvin, GJ. Life Skills Training. Princeton Health Press; Princeton, NJ: 2000.

Botvin GJ, Baker E, Dusenbury L, Botvin EM, Diaz T. Long-term follow-up results of a randomized drug abuse prevention trial in a white middle-class population. JAMA 1995;273(14):1106–1112. [PubMed: 7707598]

Brookes ST, Whitely E, Egger M, Smith GD, Mulhearn PA, Peters TJ. Sub-group analysis in randomized trials: risks of subgroup-specific analyses; power and sample size for the interaction test. J Clin Epidemiol 2004;57:226–236.

Brown CH, Liao J. Principles for designing randomized preventive trials in mental health: An emerging developmental epidemiology paradigm. Am J Community Psychol 1999;27:673–710. Special issue: Prevention Science Part II. [PubMed: 10676544]

Coffin PO, Sandro Galea Ahern J, Leon AC, Viahov D, Tardiff K. Opiates, cocaine and alcohol combinations in accidental drug overdose deaths in New York City 1990–98. Addiction 2003;98(6):739–747. [PubMed: 12780362]

Degenhardt L, Coffey C, Carlin J, Moran P, Patton G. The predictors and consequences of adolescent amphetamine use: findings from the Victorian Adolescent Health Cohort Study. Addiction 2007;102:1076–1084. [PubMed: 17567396]

Elliott, DS.; Ageton, SS.; Huizinga, D.; Knowles, BA.; Canter, RJ. The Prevalence and Incidence of Delinquent Behavior. Behavioral Research Institute; Boulder, CO: 1983. p. 1976-1980.

Fergusson DM, Boden JM, Horwood LJ. Cannabis use and other illicit drug use: testing the cannabis gateway hypothesis. Addiction 2006;101:556–569. [PubMed: 16548935]

Foxcroft DR, Ireland D, Lister-Sharp DJ, Lowe G, Breen R. Longer-term primary prevention for alcohol misuse in young people: a systematic review. Addiction 2003;98:397–411. [PubMed: 12653810]

Getz JG, Bray JH. Predicting heavy alcohol use among adolescents. Am J Orthopsychiatry 2005;75:102–116. [PubMed: 15709854]

Griffin KW, Botvin GJ, Nichols TR, Doyle MM. Effectiveness of a universal drug abuse prevention approach for youth at high risk for substance use initiation. Prev Med 2003;36:1–7. [PubMed: 12473419]

Guy SM, Smith GM, Bentler PM. Adolescent socialization and use of licit and illicit substances: impact on adult health. Psychol Health 1993;8:463–487.

Guyll M, Spoth RL, Chao W, Wickrama KAS, Russell D. Family-focused preventive interventions: evaluating parental risk moderation of substance use trajectories. J Fam Psychol 2004;18:293–301. [PubMed: 15222836]

Hawkins JD, Catalano RF, Miller JY. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: implications for substance abuse prevention. Psychol Bull 1992;112:64–105. [PubMed: 1529040]

Ives R, Ghelani P. Polydrug use (the use of drugs in combination): a brief review. Drugs: Prev Policy 2006;13:225–232.

Jamieson, KH.; Romer, D. Findings and future directions. In: Romer, D., editor. Reducing Adolescent Risk: Toward an Integrated Approach. Sage; Thousand Oaks, CA: 2003.

Jessor, R.; Jessor, SL. Problem Behavior and Psychosocial Development: A Longitudinal Study of Youth. Academic Press; New York: 1977. p. 374-378.

Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future National Results on Drug Use, 1975–2006: vol. 1 Secondary school Students (NIH Publication No. 07-6205). National Institute on Drug Abuse; Bethesda, MD: 2007.

Kandel, DB.; Yamaguchi, K. Stages of drug involvement in the U.S. population. In: Kandel, DB., editor. Stages and Pathways of Drug Involvement: Examining the Gateway Hypothesis. Cambridge University Press; New York: 2002. p. 65-89.

Kellam SG, Ling X, Merisca R, Brown CH, Ialongo N. The effect of the level of aggression in the first grade classroom on the course and malleability of aggressive behavior into middle school. Dev Psychopathol 1998;10:165–185. [PubMed: 9635220]

Kozlowski LT, O'Connor RJ, Edwards BQ, Flaherty BP. Most smokeless tobacco use is not a causal gateway to cigarettes: using order of product use to evaluate causation in a national U.S. sample. Addiction 2003;98:1077–1085. [PubMed: 12873242]

Kumpfer, KL.; Molgaard, V.; Spoth, R. The Strengthening Families Program for the prevention of delinquency and drug use. In: Peters, RD.; McMahon, RJ., editors. Preventing Childhood Disorders, Substance Abuse, and Delinquency. Sage; Thousand Oaks, CA: 1996. p. 241-267.

Lex, BW. Alcohol and other psychoactive substance dependence in women and men. In: Seeman, MV., editor. Gender and Psychopathology. American Psychiatric Association; Washington, DC: 1995. p. 311-358.

Li F, Duncan T, Hops H. Examining developmental trajectories in adolescent alcohol use using piecewise growth mixture modeling analysis. J Stud Alcohol 2001;62:199–201. [PubMed: 11327186]

MacKinnon DP, Weber MD, Pentz MA. How do school-based drug prevention programs work and for whom? Drugs Soc 1988;3:125–143.

Mason WA, Windle M. Reciprocal relations between adolescent substance use and delinquency: a longitudinal latent variable analysis. J Abnorm Psychol 2002;111:63–76. [PubMed: 11866180]

McCabe SE, Cranford JA, Morales M, Young A. Simultaneous and concurrent polydrug use of alcohol and prescription drugs: prevalence, correlates and consequences. J Stud Alcohol 2006;67:528–537.

Midanik LT, Tam TW, Weisner C. Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey. Drug Alcohol Depend 2007;90:72–80. [PubMed: 17446013]

Mohler-Kuo M, Lee JE, Wechsler H. Trends in marijuana and other illicit drug use among college students: results from 4 Harvard School of Public Health College Alcohol Study surveys: 1993–2001. J Am Coll Health 2003;52:17–24. [PubMed: 14717576]

Molgaard, VM.; Spoth, R.; Redmond, C. Competency Training: The Strengthening Families Program for Parents and Youth 10–14. OJJDP Juvenile Justice Bulletin (NCJ 182208). U.S. Department of Justice, Office of Juvenile Justice and Delinquency Prevention; Washington, DC: 2000.

Mrazek, PJ.; Haggerty, RJ., editors. Reducing Risks for Mental Disorders: Frontiers for Preventive Intervention Research. National Academy Press; Washington, DC: 1994.

Murray DM, Hannan PJ, Zucker DM. Analysis issues in school-based health promotion studies. Health Educ Q 1989;16:230–315.

Nash SG, McQueen A, Bray J. Pathways to adolescent alcohol use: family environment, peer influence, and parental expectations. J Adoles Health 2005;37:19–28.

Newcomb MD, Bentler PM. The impact of late adolescent substance use on young adult health status and utilization of health services: a structural equation model over four years. Soc Sci Med 1987;24:71–82. [PubMed: 3823999]

Newcomb MD, Felix-Ortiz M. Multiple protective and risk factors for drug use and abuse: cross-sectional and prospective findings. J Pers Soc Psychol 1992;63:280–296. [PubMed: 1403617]

Offord DR, Kraemer HC, Kazdin AE, Jensen PS, Harrington R. Lowering the burden of suffering from child psychiatric disorder: trade-offs among clinical, targeted, and universal interventions. J Am Acad Child Adoles Psychiatry 1998;37:686–694.

Overman WH, Frassrand K, Ansel S, Trawalter S, Bies B, Remond A. Performance on the IOWA card task by adolescents and adults. Neuropsychologia 2004;42:1838–1851. [PubMed: 15351632]

Resnick MD, Bearman PS, Blum RW, Bauman KE, Harris KM, Jones J, Tabor J, Beuhring T, Sieving RE, Shew M, Ireland M, Bearinger LH, Udry JR. Protecting adolescents from harm: findings from the National Longitudinal Study on Adolescent Health. JAMA 1997;278:823–832. [PubMed: 9293990]

Schafer JL. Multiple imputation in multivariate problems when the imputation and analysis models differ. Statistica Neerlandica 2003;57:19–35.

Schafer JL, Graham JW. Missing data: our view of the state of the art. Psychol Methods 2002;7(2):147–177. [PubMed: 12090408]

Schensul JJ, Convery M, Burkholder G. Challenges in measuring concurrency, agency and intentionality in poly-drug research. Addict Behav 2005;30:571–574. [PubMed: 15718073]

Smit F, Monshouwer K, Verdurmen J. Polydrug use among secondary school students: combinations, prevalences, and risk profiles. Drugs: Educ Prev Policy 2002;9:355–365.

Sneed CD, Morisky DE, Rotheram-Borus MJ, Ebin VJ. Indices of lifetime polydrug use among adolescents. J Adoles 2004;27:239–249.

Spoth R, Clair S, Greenberg M, Redmond C, Shin C. Toward dissemination of evidence-based family interventions: maintenance of community-based partnership recruitment results and associated factors. J Fam Psychol 2007a;21(2):137–145. [PubMed: 17605536]

Spoth R, Clair S, Shin C, Redmond C. Long-term effects of universal preventive interventions on methamphetamine use among adolescents. Arch Pediatr Adoles Med 2006;160:876–882.

Spoth R, Greenberg M. Toward a comprehensive strategy for effective practitioner–scientist partnerships and larger-scale community benefits. Am J Comm Psychol 2005;35(34):107–126.

Spoth R, Greenberg M, Bierman K, Redmond C. PROSPER community–university partnership model for public education systems: capacity-building for evidence-based, competence-building prevention. Prev Sci 2004;5(1):31–39. [PubMed: 15058910]

Spoth R, Guyll M, Lillehoj CJ, Redmond C, Greenberg M. PROSPER study of evidence-based intervention implementation quality by community–university partnerships. J Comm Psychol 2007b;35(8):981–999.

Spoth R, Randall GK, Redmond C, Shin C. Randomized study of combined universal family and school preventive interventions: patterns of long-term effects on initiation, regular use, and weekly drunkenness. Psychol Addict Behav 2005;19:372–381. [PubMed: 16366809]

Spoth R, Redmond C, Lepper H. Alcohol initiation outcomes of universal family-focused preventive interventions: one- and two-year follow-ups of a controlled study. J Stud Alcohol 1999;(Suppl 13): 103–111. Invited article for Special issue: Alcohol and the Family: Opportunities for Prevention. [PubMed: 10096315]

Spoth R, Redmond C, Shin C. Randomized trial of brief family interventions for general populations: adolescent substance use outcomes four years following baseline. J Consult Clin Psychol 2001;69:623–627.

Spoth R, Redmond C, Shin C, Lepper H, Haggerty K, Wall M. Risk moderation of parent and child outcomes in a preventive intervention: a test and replication. Am J Orthopsychiatry 1998;68:565–579. [PubMed: 9809116]

Spoth R, Redmond C, Trudeau L, Shin C. Longitudinal substance initiation outcomes for a universal preventive intervention combining family and school programs. Psychol Addict Behav 2002;16:129–134. [PubMed: 12079251]

Stein JA, Smith GM, Guy SM, Bentler PM. Consequences of adolescent drug use on young adult job behavior and job satisfaction. J Appl Psychol 1993;78:463–474. [PubMed: 8331025]

Stoolmiller M, Eddy JM, Reid JB. Detecting and describing preventive intervention effects in a universal school-based randomized trial targeting delinquent and violent behavior. J Consult Clin Psychol 2000;68:296–306. [PubMed: 10780130]

Toumbourou, JW.; Catalano, RF. Predicting developmentally harmful substance use. In: Stockwell, T.; Gruenewald, PJ.; Toumbourou, JW.; Loxley, W., editors. Preventing Harmful Substance Use: The Evidence Base for Policy and Practice. John Wiley & Sons, Ltd; West Sussex, England: 2005. p. 53-65.

Trudeau, L.; Redmond, C.; Spoth, R. Risk moderation of adolescent universal family and school preventive interventions. Poster presented at the Society for Prevention Research 12th Annual Meeting; Quebec City, Canada. May. 2004

Trudeau L, Spoth R, Lillehoj C, Redmond C, Wickrama KAS. Effects of a preventive intervention on adolescent substance use initiation, expectancies, and refusal intentions. Prev Sci 2003;4:109–122. [PubMed: 12751880]

Williams CL, Perry CL, Dudovitz B, Veblen-Mortenson S, Anstine PS, Komro KA, Toomey T. A home-based prevention program for sixth-grade alcohol use: results from Project Northland. J Prim Prev 1995;16:125–147.

Wish ED, Fitzelle DB, O'Grady KE, Hsue MH, Arria AM. Evidence for significant polydrug use among ecstasy-using college students. J Am Coll Health 2006;55:99–104. [PubMed: 17017306]

Wood MD, Read JP, Mitchell RE, Brand NH. Do parents still matter? Parent and peer influences on alcohol involvement among recent high school graduates. Psychol Addict Behav 2004;18:19–30. [PubMed: 15008682]

Wothke, W. Longitudinal and multigroup modeling with missing data. In: Little, TD.; Schnabel, KU.; Baumert, J., editors. Modeling Longitudinal and Multilevel Data: Practical Issues, Applied Approaches, and Specific Examples. Mahwah, NJ: 2000. p. 219-240.
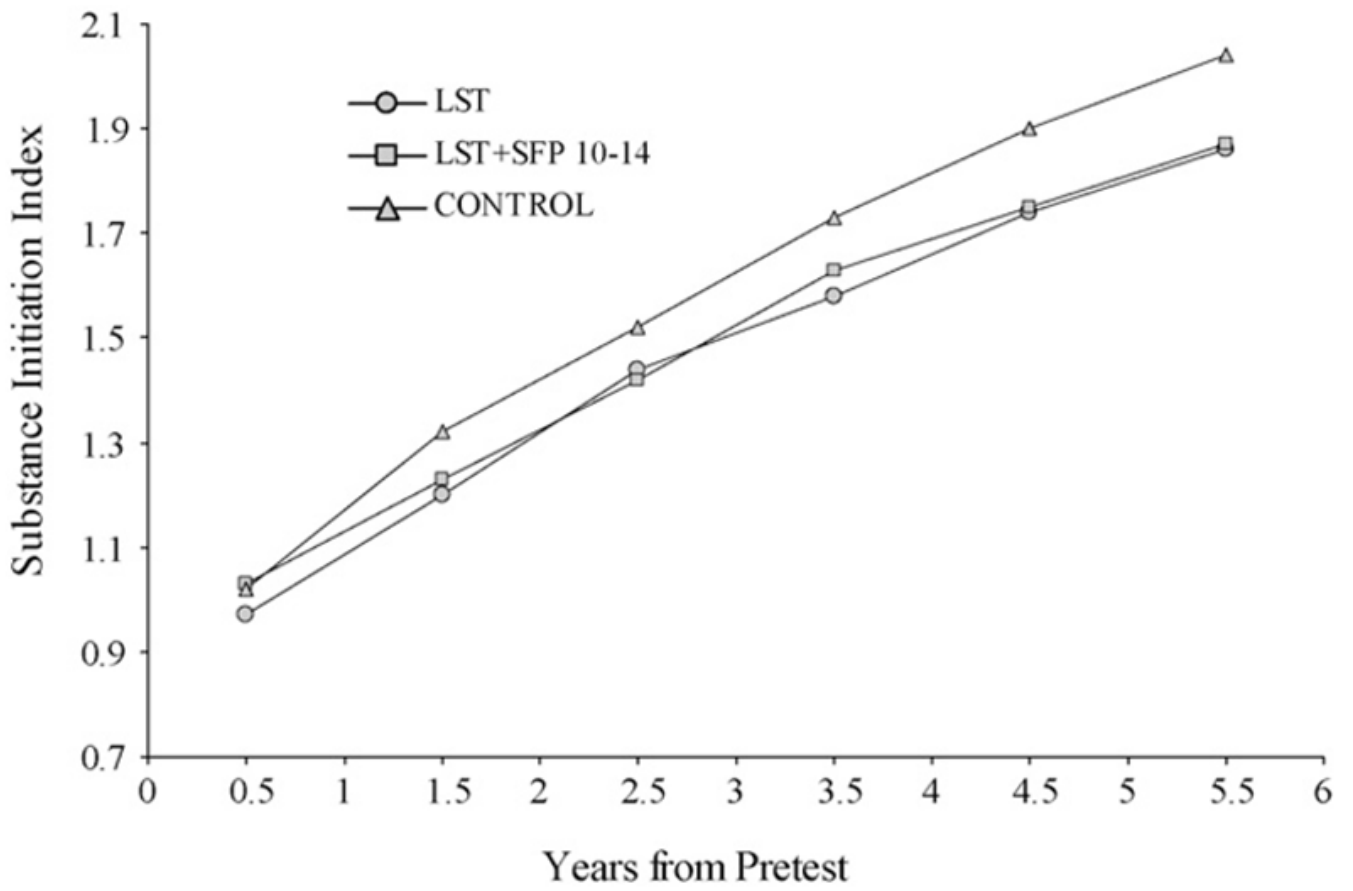
Fig. 1.
Growth in the adjusted means on Substance Initiation Index. *Note*: Substance Initiation Index combined lifetime use of alcohol, cigarettes, and marijuana and ranged from 0 (= no substances initiated) to 3 (= all three substances initiated).
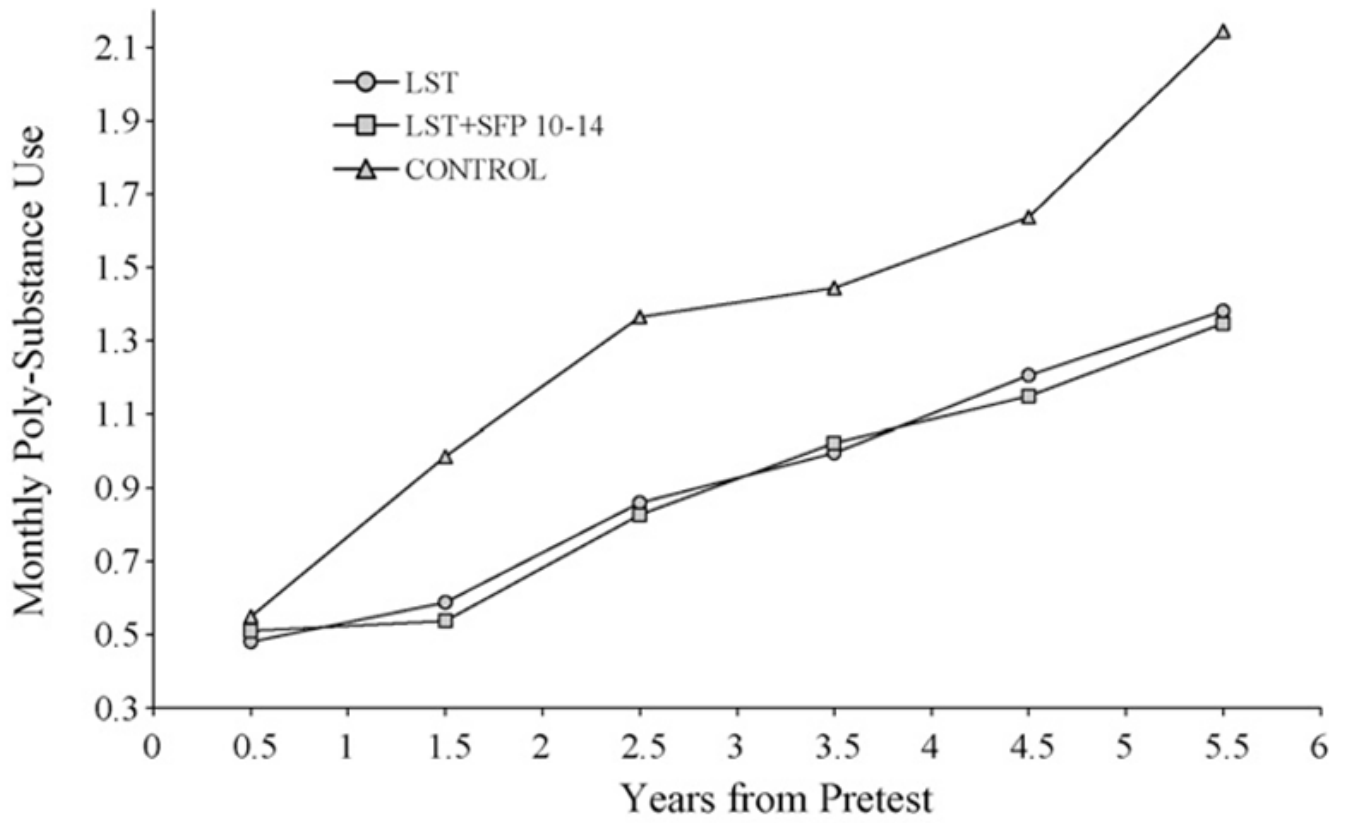
Fig. 2.
Growth in adjusted means on monthly poly-substance use index for higher-risk subsample.
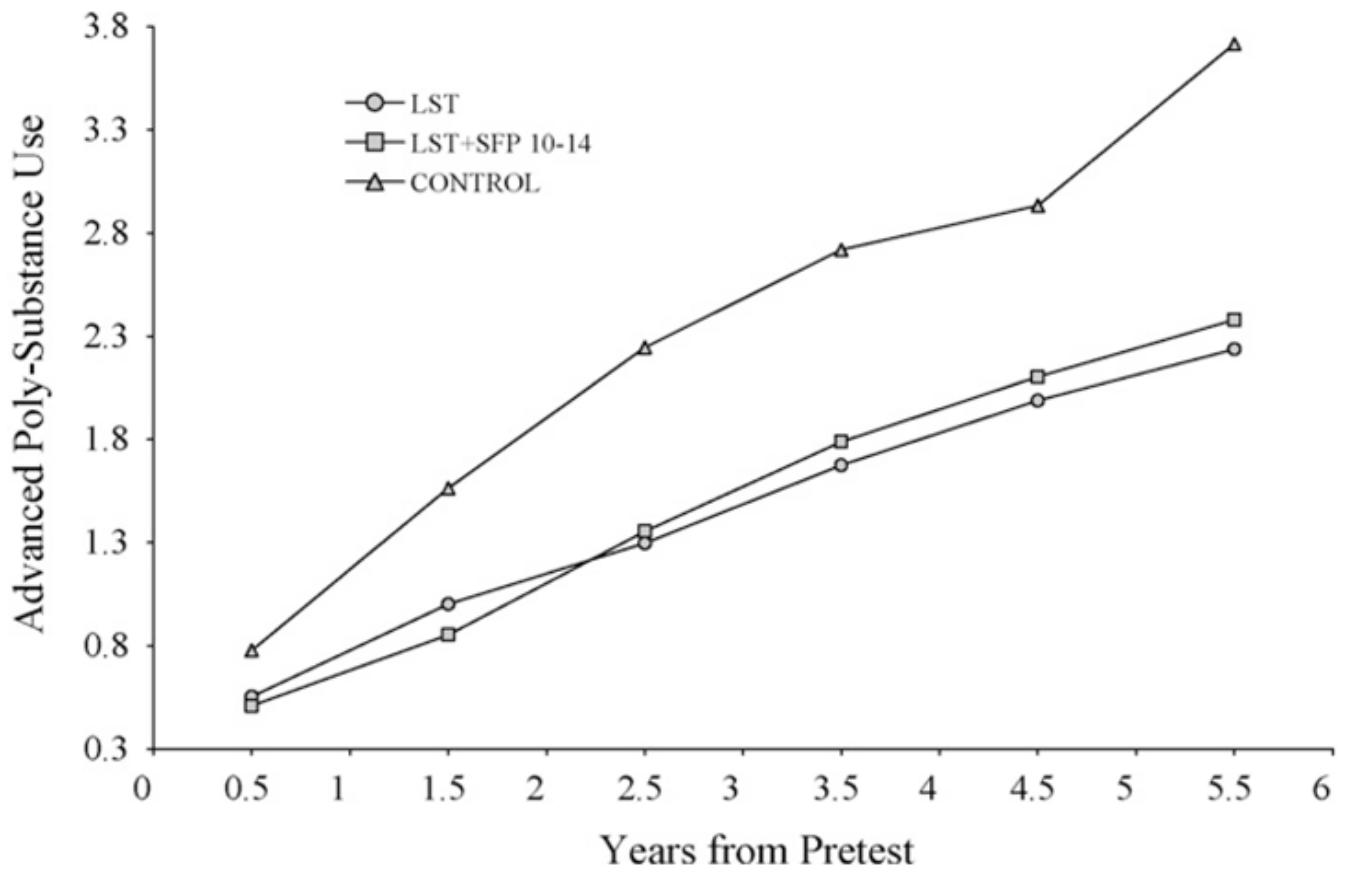
Fig. 3.
Growth in adjusted means on advanced poly-substance use index for higher-risk subsample.

Table 1

Participation in the in-school assessments by condition

	LST + SFP 10–14	LST-only	Control	Undetermined	Total *N*
Pretest	543	622	489	23	1677
Posttest	554	618	496	22	1690
8th grade	539	583	488	23	1633
9th grade	563	556	485	20	1624
10th grade	558	536	464	18	1576
11th grade	522	477	456	17	1472
12th grade	450	428	347	12	1237

Table 2

Growth curve and 12th grade results for substance initiation outcomes: Substance Initiation Index (SII), alcohol initiation (AI), drunkenness initiation (DI), cigarette initiation (CI), marijuana initiation (MI)

Outcome	Adjusted means						Tests of differences (*t*-values)		Relative reduction		Growth trajectories	
	LST (T1)		LST + SFP 10–14 (T2)		Control (C)		12th grade point-in-time					
							T1 versus C	T2 versus C	T1%	T2%	T1 versus C	T2 versus C
	M	S.E.	*M*	S.E.	*M*	S.E.						
SII	1.861	0.049	1.871	0.050	2.040	0.053	2.40**	2.28**	–	–	2.04*	2.46**
AI	0.944	0.022	0.939	0.022	0.963	0.022	§0.67	0.87	2.0	2.5	1.33+	1.73*
DI	0.607	0.031	0.645	0.030	0.679	0.032	§1.56+	0.76	10.6	5.2	2.24**	1.99*
CI	0.526	0.033	0.583	0.033	0.669	0.035	§2.86**	1.76*	21.4	12.3	2.81**	2.84**
MI	0.293	0.029	0.293	0.029	0.381	0.030	§2.10*	2.17*	23.1	23.1	1.37+	1.17

$N \sim 1625$ (*N*s for each analysis varied somewhat—only those students who participated at pretest, posttest, and in at least one additional data collection were included in analyses. For dichotomous variables—analyses were conducted at the school-level, $N = 36$).

+ $p \leq 0.10$;

* $p \leq 0.05$;

** $p \leq 0.01$; one-tailed tests. Adjusted means are from the multilevel analyses of covariance. Covariates included Time 1 measure of the outcome and the proportion of students in the school living with both biological parents.

§ indicates dichotomous variables—analyses were conducted at the school level. T1, Life Skills Training only; T2, Life Skills Training plus Strengthening Families Program: For Parents and Youth 10–14; C, minimal contact control.

Table 3

Growth curve and 12th grade results for higher-risk students on more serious or problematic use outcomes: alcohol frequency (AF), drunkenness frequency (DF), cigarette frequency (CF), marijuana frequency (MF), monthly poly-substance use (MPU–alcohol, cigarettes, and marijuana), and advanced poly-substance use (APU)

| Outcome | Adjusted means | | | | | | | Tests of differences (t-values) | | | |
| | LST(T1) | | LST + SFP 10-14 (T2) | | Control(C) | | | Point-in-time | | Growth trajectories | |
	M	S.E.	M	S.E.	M	S.E.		T1 versus C	T2 versus C	T1 versus C	T2 versus C
AF	1.917	0.121	2.126	0.126	2.395	0.188		2.14*§	1.19§	0.47	0.17
DF	1.635	0.121	1.787	0.125	2.060	0.184		1.93*	1.23	0.72	0.10
CF	2.060	0.184	2.169	0.195	3.040	0.295		2.84**§	2.47**§	2.30**	1.75*
MF	0.886	0.138	0.783	0.144	1.512	0.216		2.47**§	2.85***§	2.36***§	2.38***§
MPU	1.398	0.125	1.348	0.131	2.127	0.199		3.13***§	3.30***§	2.29***§	2.45**§
APU	2.237	0.177	2.380	0.183	3.718	0.284		4.43***§	3.96***§	3.37***§	2.56**

$N \sim 315$ (Ns for each analysis varied somewhat–only those students who participated at pretest, posttest, and at least one additional data collection were included in analyses).

*
$p \le 0.05$.

**
$p \le 0.01$; one-tailed tests. Adjusted means are from the multilevel analysis of covariance. Null effects were found for the lower-risk subgroups.

§
indicates significant test of risk moderation at $p \le 0.05$. The Time 1 measure of the outcomes was included as a covariate. T1, Life Skills Training only; T2, Life Skills Training plus Strengthening Families Program: For Parents and Youth: 10–14; C, minimal contact control.