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Universal Intervention Effects on Substance Use Among Young Adults Mediated by Delayed Adolescent Substance Initiation

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Abstract

In this article, the authors examine whether delayed substance initiation during adolescence, achieved through universal family-focused interventions conducted in middle school, can reduce problematic substance use during young adulthood. Sixth-grade students enrolled in 33 rural midwestern schools and their families were randomly assigned to 3 experimental conditions. Self-report questionnaires provided data at 7 time points for the Iowa Strengthening Families Program (ISFP), Preparing for the Drug Free Years (PDFY), and control groups through young adulthood. Five young adult substance frequency measures (drunkenness, alcohol-related problems, cigarettes, illicit drugs, and polysubstance use) were modeled as distal outcomes affected by the average level and rate of increase in substance initiation across the adolescent years in latent growth curve analyses. Results show that the models fit the data and that they were robust across outcomes and interventions, with more robust effects found for ISFP. The addition of direct intervention effects on young adult outcomes was not supported, suggesting long-term effects were primarily indirect. Relative reduction rates were calculated to quantify intervention-control differences on the estimated proportion of young adults indicating problematic substance use; they ranged from 19% to 31% for ISFP and from 9% to 16% for PDFY.

Keywords

universal family-focused prevention; adolescent substance use; mediation of long-term outcomes; young adult substance use

In this article, we examine whether universal family-focused interventions conducted during sixth grade can reduce problematic substance use during young adulthood through their impact on adolescent substance initiation. Epidemiological data highlight how problematic or serious types of substance use often are more prevalent in young adulthood than in earlier developmental stages (Johnston, O'Malley, Bachman, & Schulenberg, 2007; Substance Abuse

and Mental Health Services Administration, 2007). The consequences of problematic adult substance use include less competent functioning and lower educational and occupational attainment (Ackerman, Zuroff, & Moskowitz, 2000), risky sexual practices (Park, Mulye, Adams, Brindis, & Irwin, 2007), mental health problems (Windle & Windle, 2001), adult crime (Kosterman, Graham, Hawkins, Catalano, & Herrenkohl, 2001), and increased mortality (Park et al., 2007).

Many of the risk and protective factors for adolescent substance misuse originate in the family environment (Hawkins, Catalano, & Miller, 1992; Wood, Read, Mitchell, & Brand, 2004). These include parental monitoring, consistent discipline, clear communication about rules and expectations, and parent-child affection and warmth. For this reason, family-focused preventive interventions designed to reduce substance use among elementary and middle school age children have been developed. Reviews of the literature on family-focused intervention reveal a number of effective strategies (see Alexander, Robbins, & Sexton, 2000; Lochman & van den Steenhoven, 2002; Spoth, 2008; Spoth, Greenberg, & Turrissi, 2008; Taylor & Biglan, 1998) with a range of formats (e.g., DVD-based, group formats, reading materials with professional support provided via telephone calls), targeted populations (e.g., at-risk families, rural vs. urban), and intervention settings (e.g., home, school, community, health care). Among the promising strategies are community-based interventions offered to groups of general population families, frequently labeled universal programs.

A number of universal interventions have been shown to be effective in delaying substance initiation during the adolescent period (National Institute on Drug Abuse, 2003; Spoth et al., 2008); very few studies, however, have followed participants into young adulthood. A recent report demonstrated continued positive effects into young adulthood for a longer, more intensive, multi-component school and family-based preventive intervention on a range of outcomes (Hawkins, Kosterman, Catalano, Hill, & Abbott, 2005; see also Poduska et al., 2008). These positive effects of intensive intervention on long-range outcomes encourage investigating whether *brief, universal family-focused* interventions also might produce long-lasting positive effects.

The extant literature on universal interventions emphasizes the importance of timing program implementation to occur during the developmental window when adolescents are just beginning to initiate substance use. Epidemiological research suggests that well-timed interventions could accrue substantial public health and economic benefits, should they delay onset of substance use or delay transition to more serious use (Anthony, 2003; Chen et al., 2004; Offord & Bennett, 2002). Indeed, the interventions investigated in the current report have demonstrated favorable results in delaying adolescent substance initiation and reducing adolescent substance use (e.g., Spoth, Redmond, & Shin, 2001; Spoth, Redmond, Shin, & Azevedo, 2004). This pattern of earlier results sets the stage to address whether these comparatively proximal effects in adolescence portend continued favorable effects on problematic substance use in young adulthood.

Etiological research provides the rationale for hypothesizing that intervention effects delaying substance initiation will be related to reduced adult substance use. Research has demonstrated that substance-related risk factors that endure in adolescence predict problematic substance use in young adulthood (Guo, Hawkins, Hill, & Abbott, 2001; Hawkins et al., 1997; White et al., 2006). Therefore, the observed intervention effects among adolescents should translate into less problematic use in young adulthood.

To address the gap in the literature pertaining to long-term effects of family-based universal interventions, in the current study we examined a developmental model of long-term effects of two such interventions implemented during early adolescence on young adult substance use

outcomes 10 years after intervention implementation. From a developmental perspective, early adulthood is particularly important for evaluating intervention effects because it is the stage in which problematic use typically increases, and because it entails major changes in roles and responsibilities in home, work, and school environments that could be impacted by substance use (Schulenberg, Sameroff, & Cicchetti, 2004).

The tested developmental model was designed to address a number of issues in the examination of long-term intervention outcomes. The first issue concerns the mechanisms of intervention-related change. Over the past 2 decades, leading program evaluators have recommended, in addition to analyses of direct intervention outcomes, testing models that examine sequences of intervention effects on substance use or mechanisms of intervention-related change (Lipsey, 1990). However, the literature also clearly indicates it has been difficult to demonstrate indirect or mediating effects of interventions across developmental stages (Shrout & Bolger, 2002). In addition to very limited research to date, only weak support has been found for hypothesized intervention mechanisms (Ennett et al., 2001; Orlando, Ellickson, McCaffery, & Longshore, 2005).

The second issue concerns the challenge of modeling the complex interplay of long-term intervention effects, age-related patterns of substance use, and developmental processes (Masten, Faden, Zucker, & Spear, 2008; Masten et al., 2005). Modeling intervention effects on substance initiation trajectories is a parsimonious way to capture intervention effects across a long developmental time span (see Blozis, Feldman, & Conger, 2007). These trajectories can be viewed as the result of multiple interrelated pathways of intervention effects (e.g., proximal effects on early adolescent substance refusal skills, parental monitoring, and other vectors of influence) that may convey intervention effects into young adulthood. The developmental model examined herein posits that (a) the range of previously demonstrated proximal effects of the tested universal interventions (intervention-related effects on parenting, such as parental monitoring, along with effects on adolescents' intention to use, attitudes, or skills; e.g., Spoth, Redmond, & Shin, 1998) likely delays substance initiation or slows its rate of increase across the adolescent years and decreases the average level of initiation (e.g., Spoth et al., 2001, 2004), and (b) those effects on substance initiation are the primary means by which long-term effects into young adulthood are produced.

A third set of issues is methodological in nature. In the current study, we address several limitations of previous studies with regard to intervention effects across developmental stages. These limitations include (a) failure to account for time-related changes in initiation across adolescence, (b) reliance on retrospective reports of behaviors that occurred many years prior to data collection, and (c) focusing on urban samples, as compared with the rural sample in the present study (Hawkins et al., 2005). The analytic method of the current study entails latent growth modeling that specifies proximal intervention effects on adolescents' average level and rate of increase of substance initiation, with effects on young adult substance outcomes modeled as more distal indirect effects, similar to analytic strategies used in relevant etiological research (e.g., Blozis et al., 2007).

A final issue to address is the practical significance of small intervention effects observed at points well beyond intervention implementation. As detailed in the Method section, this is accomplished by performing an additional set of analyses in which the young adult outcome variables are dichotomized, on the basis of specified threshold values defining *caseness* for each outcome. Caseness is defined as a level of use that likely is problematic from a public health perspective. Comparison of the case rates in the intervention and control conditions yields *relative reduction rates* (RRRs), which correspond to the proportion of control condition cases that would have been prevented had those individuals been in the intervention condition.

Earlier work with this young adult data set evaluated the social development model-based mediators of Preparing for the Drug Free Years (PDFY), one of the currently tested interventions. The authors of that article applied regression and structural equation modeling to examine mechanisms of intervention effects on a single diagnostic outcome: alcohol abuse at 21 years of age (Mason et al., in press). Consistent with literature indicating the difficulty of disentangling the complex interplay of causal pathways, that analysis found significant effects for only one of six selected proximal risk and protective factor mediators assessed at posttest (sixth grade). These earlier findings suggested the application of a more parsimonious approach that focused solely on mediation of intervention effects on young adult outcomes through substance initiation growth factors.

As part of a broad spectrum evaluation, three major kinds of problematic substance use were examined in the current study, namely, those related to alcohol, cigarettes, and illicit drugs. A fourth measure that was examined pertained to polysubstance use, an index combining use of the three types of substances. In addition, a measure of problematic health and social outcomes associated with alcohol use was examined. The primary analysis entailed an indirect effects model to predict problematic young adult substance use. As part of an additional set of analyses used to evaluate the practical significance of intervention effects, dichotomous caseness outcomes also were evaluated, as further described below. Consistent with the posited developmental model, it was hypothesized that intervention effects on problematic young adult substance use would occur primarily indirectly, via intervention effects on adolescent substance initiation. Earlier research reports that used these data sets have found only positive or null intervention effects on substance outcomes across multiple waves of data spanning from early to late adolescence, suggesting directional study hypotheses with one-tailed tests of significance. Nonetheless, exact *t* values are presented so that two-tailed results are transparent.

Method

Sample

At the beginning of the study, participants were sixth graders enrolled in 33 rural schools in 19 contiguous counties in a midwestern state. Schools considered for inclusion in the study were in districts in which 15% or more of families were eligible for free or reduced-cost school lunches and in communities with populations of 8,500 or fewer. A randomized block design guided the assignment of the 33 schools prior to pretesting. Schools were blocked on the basis of school size and proportion of students who resided in lower income households. Schools within blocks were then randomly assigned to three experimental conditions: those receiving the seven-session Iowa Strengthening Families Program (ISFP), the five-session PDFY, or a minimal-contact control condition.

All families of sixth graders in participating schools were eligible and were recruited for participation. Of the 1,309 eligible families recruited for this study from the 33 schools, 667 (51%) agreed to participate in the project and completed pretesting (238 ISFP group families, 221 PDFY group families, and 208 control group families). This compared favorably with, or exceeded, recruitment rates commonly reported for prevention trials addressing child problem behaviors with similar evaluation components (see Spoth & Redmond, 1994). At the time of pretesting, participating parents did not know the experimental condition to which their child's school had been assigned, although they had been informed that the project included an intervention component in some schools. Refusal rates for family participation in the study were similar across conditions. All intervention condition families who participated in pretest assessments were recruited for the intervention programs after pretesting. In addition, all families in the intervention condition schools were permitted to enroll in the interventions; families not participating in the pretest assessments were not actively recruited and provided no data for analyses. Figure 1 provides sample participation information.

The large majority of families were dual-parent (85%), including 64% dual-biological parents, and virtually all were Caucasian (98.6%), which is representative of the study region. The mean age of the target child was 11.3 years at the beginning of the study, and 51% were female. Almost all mothers and fathers completed high school (97% and 96%, respectively), with over half reporting additional education. Median household income was \$33,400 (circa 1993).

Sample Quality

Earlier reports describe tests of sample representativeness, pretest equivalence, and attrition (Spoth, Goldberg, & Redmond, 1999; Spoth et al., 1998, 2001). These reports found (a) the study sample was representative of families in the targeted population, (b) no evidence of differential attrition between intervention and control conditions through a 4-year follow-up assessment, (c) pretest equivalence of the intervention and control conditions with respect to family sociodemographic characteristics, and (d) pretest equivalence of intervention and control conditions for all outcome measures. Analyses updated for the current report confirmed there were no significant differential attrition effects through the young adult assessment.

Interventions: Description, Implementation, Fidelity, and Participation

PDFY—PDFY (now called Guiding Good Choices) is a family competency training program, offered in five weekly 2-hr sessions. The primary objectives of PDFY are to enhance protective parent–child interactions and to reduce children's risk for early substance initiation. PDFY is based on the social development model (Catalano & Hawkins, 1996; Hawkins & Weis, 1985), building on social control theory (Hirschi, 1969), social learning theory (Akers, 1977), and differential association theory (Matsueda, 1988).

After training, 15 two-person teams implemented PDFY with 19 groups of families in the 11 PDFY schools, with an average of 10 families per group. On average, 16 individuals attended the parent sessions, and an average of 25 individuals attended the one session that included both parents and children. Videotapes were used to guide presentation and to cue group leaders to cover essential program content. Results from fidelity observations (two observations per group) provided by observers trained to monitor the group leaders' adherence to key program content showed that although there was some variability in group leaders' delivery, all leader teams covered all of the key program concepts. In addition, the 15 teams were found to have covered an average of 69% of the component tasks in the group leader's manual. Approximately 56% of pretested families attended at least one intervention session. Session attendance among families enrolled in the intervention generally was high, with 93% of families attending four or five sessions. For additional details regarding the theoretical foundations, content, and implementation of the PDFY intervention, see Spoth et al. (1998).

ISFP—The ISFP (now called the Strengthening Families Program for Parents and Youth: 10–14) is based on empirically supported risk and protective factor theoretical models (Kumpfer, Molgaard, & Spoth, 1996). The first six sessions began with separate, concurrently running 1-hr skills-building sessions for parents and for children, followed by a second 1-hr joint session in which parents and children together practiced skills introduced in their separate sessions. The seventh session consisted of a single 1-hr family session for both parents and children. The trained implementers included 21 three-person teams conducting 21 groups in the 11 ISFP schools. Group sizes ranged from 3 to 15 families, with an average of 8 families or 20 individuals attending the weekly sessions. Approximately 49% of pretested families attended at least one intervention session, with approximately 94% of attending families participating in five or more sessions. Essential program content for the parent and child skills training sessions was presented on videotapes that included family interactions to illustrate key program concepts. Trained observers monitored the implementation fidelity of each team two or three times and reported average coverage of 87%, 83%, and 89% of the component tasks in the

group leader's manual for the family, parent, and youth sessions, respectively. Further details on the ISFP, implementation procedures, and quality of implementation can be found in Kumpfer et al. (1996) and Spoth et al. (1998, 2001).

Minimal Contact Control Condition—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). Control group families received this information concurrent with the implementation of the PDFY and ISFP programs in the intervention groups.

Data Collection Procedure

Data were collected from sixth graders as part of the family assessments conducted by project staff in the families' homes. All pretested families—including intervention group families who had not enrolled in the interventions—were recruited to complete the 6-month posttest (also in the 6th grade) and the four follow-up assessments, conducted approximately 18, 30, 48, and 72 months following the pretest, when students were in the 7th, 8th, 10th, and 12th grades. An additional follow-up assessment was completed by telephone when the participants were approximately 21 years of age; this assessment did not include parents. Participants were reimbursed for the time required to complete all assessments.

Measures

Adult Outcomes (Wave 7)

Drunkenness frequency: Drunkenness frequency was assessed with one question—“How often do you usually get drunk?”—on a 6-point scale ranging from 0 (*never*) to 5 (*about every day*).

Alcohol-related problems: Alcohol-related problem behaviors during the past year were measured with a short, modified form of the Rutgers Alcohol Problems Index (White & Labouvie, 1989). Eight questions were scaled from 0 (*never*) to 4 (*four or more times*) and assessed alcohol abuse-related problems with the stem, “How often have the following things happened during the past 12 months?” Example items include “You had trouble remembering what you had done when you were drinking” and “You got picked up by the police because of your drinking.” Scores were computed as the average response to the eight items ($\alpha = .70$).

Cigarette frequency: Past year cigarette frequency (i.e., “During the past 12 months how often did you smoke cigarettes?”) was assessed on a 7-point scale ranging from 1 (*not at all*) to 7 (*about 2 packs/day*).

Illicit drug frequency: Past year illicit drug frequency was measured with nine open-ended items (e.g., “How many times in the past 12 months did you use [specific substance]?”). To address item skew and to obtain an appropriate weighting of items in the illicit use measure, we natural-log transformed each item and then summed the items. Items assessed past year use of marijuana, narcotics (Vicodin, Oxycontin, Percocet—not under a doctor's order), cocaine, ecstasy (MDMA), methamphetamine, amphetamines (other than methamphetamine, and not under a doctor's order), barbiturates (sedatives—not under a doctor's order), tranquilizers (not under a doctor's order), and LSD.

Polysubstance use index: This measure combined the above drunkenness frequency, cigarette frequency, and illicit drug frequency items by first dichotomizing each variable to indicate use (1) or no use (0) of any substances, then summing the three dichotomous items to form an

index with values ranging from 0 (indicating no use of any substance) to 3 (indicating at least some occurrence of all three substance use behaviors).

Adolescent outcomes (Waves 1–6): This measure is the sum of five individual measures of substance initiation that map onto the types of use measured at the young adult stage. Each was scored so that “Yes” = 1 and “No” = 0. Scores ranged from 0 (indicating no initiation) to 5 (indicating the initiation of alcohol use [without parental permission], drunkenness, tobacco, marijuana, and other illicit drugs). Measures were corrected for consistency, so that if an individual indicated initiation of a substance, all later waves also indicated initiation. Internal consistency of the composite measure, as assessed by Cronbach's alpha, averaged .60 across waves. This level of internal consistency is not unexpected in light of the fact that the individual items of the composite measure refer to disparate substances and behaviors among which only midrange correlations would be expected. Also noteworthy, Sneed, Morisky, Rotheram-Borus, Lee, and Ebin (2004) compared three methods of constructing lifetime substance use indices—a count variable, an index weighted by severity, and a hierarchical index—and concluded that the relationships between the various indices and predictor variables were roughly equivalent for a general population sample with little ethnic diversity.

Analysis

Hierarchical latent growth curve models were used to assess intervention effects on Adolescent Alcohol, Tobacco, and Other Drug Initiation Index (AII) growth factors and, in turn, AII growth factor effects on the subsequent young adult substance use outcomes. As depicted in Figure 2, the model specifies direct effects on the young adult outcomes from the latent intercept and slope factors describing growth in AII across Waves 2–6 of the study. The specified latent growth factor loadings on the observed measures of AII set the growth model intercept to the midpoint of the postintervention period, from the 6th grade posttest through the 12th grade follow-up. In this manner the intercept value corresponds to the average level of initiation across that time period, as estimated by the model. The slope value is the estimated growth or rate of increase in initiation across the same postintervention time period. Growth was modeled as linear (polynomial contrasts fixed at -2.4 , -1.4 , -0.4 , 1.1 , 3.1).¹ The growth factor indicators were modeled with an autoregressive error structure, and the latent intercept and slope factors were allowed to correlate. The model also controlled for the potential relationship between preintervention AII assessed at Wave 1 and the subsequent adolescent growth factors by including direct effects of Wave 1 AII on the intercept and slope factors, as well as on the adult outcomes. Other specified control variables measured at Wave 1 were gender, parent marital status, parent education level (averaged across mother and father), and family income. Finally, the influence of assignment to the intervention condition (1) versus the control condition (0) was incorporated via direct effects on both the intercept and slope factors of AII, with resulting indirect effects on young adult outcomes through those growth factors. In this manner the model tested for indirect intervention effects on young adult substance use that were accounted for by intervention effects on both the average level (intercept) and rate of change across time of AII.

¹A number of alternatives for optimal growth modeling were considered. Because an earlier examination of these data—from *pretest* through 12th grade—modeled adolescent substance initiation as a logistic growth curve to reflect nonlinear growth over time, this type of growth curve modeling also was considered for the present application, but it was not selected for two reasons. First, the earlier analyses included the pretest measure as the starting point in the growth curves, whereas in the current analyses we modeled growth curves across time *postintervention*, using the pretest measure as a covariate; this resulted in trajectories that closely approximated linear growth. Consequently, the structural equation model specifying a linear growth factor for the variables demonstrated good model fit, suggesting that it appropriately represented postintervention growth in adolescent substance initiation. Second, the purpose of the current analysis was not a close examination of the pattern of initiation but rather to test the possible role of proximal outcomes in mediating the effects of preventive interventions on distal young adult outcomes. In addition, we explored analyses that used a nonlinear growth function for substance initiation in a multilevel context, but the model was not identified.

Although the substantive and methodological literature reviewed in the introduction supported the hypothesized developmental model focusing on indirect effects, further structural equation model testing was conducted to examine direct intervention effects in two ways. First, simple direct effects were calculated with the same analytical modeling technique described above but eliminating the adolescent growth factors as mediators of intervention effects (eliminating paths a, b, c, and d in Figure 2; see L. K. Muthén & Muthén, 1998–2007); this allowed for a straightforward examination of intervention effects on the outcome variables while controlling for the same covariates as the indirect effects model. As suggested by the literature reviewed earlier, such effects were not necessarily expected to be significant or large, because of the length of time between intervention implementation and the young adult outcomes (e.g., Shrout & Bolger, 2002). Second, to conduct a more rigorous test of indirect effects and to confirm that intervention effects on young adult outcomes operated primarily through effects on adolescent developmental growth factors, supplemental model testing was conducted that added a direct path from intervention group participation to the young adult outcome while also maintaining the indirect effect pathways through the growth factors. Results from the models were then examined with regard to the significance of the direct and indirect effects, as well as overall model fit. We compared model fit by using a chi-square difference test with the Yuan–Bentler T2* chi-square test statistic, an empirically supported test developed to adjust for clustered sampling and conditions of multivariate nonnormality (Fouladi, 2000; L. K. Muthén & Muthén, 1998–2007).

Traditional data analytic procedures are inappropriate for hierarchically structured data because they assume independence of individual observations and, as a result, tend to underestimate standard errors and bias significance tests toward rejection of the null hypothesis (Kreft & deLeeuw, 1998). In the current study, adolescents were clustered within schools. Accordingly, school was included as a higher level cluster variable in the analyses, which used robust maximum likelihood estimation to address effects of nonnormality and nonindependence of observations. Analyses were performed with Mplus 5.1 (L. K. Muthén & Muthén, 1998–2007), a data analytic program that computes full-information maximum likelihood estimates with incomplete data. Utilization of maximum likelihood estimation to account for incomplete data has been found to yield more efficient and less biased parameter estimates than traditional methods for dealing with missing data, and allows for estimations based on all the available data (B. Muthén, Kaplan, & Hollis, 1987; Wothke, 2000). In addition to the chi-square value, model fit was evaluated with the root-mean-square error of approximation (RMSEA; Steiger & Lind, 1980) and the comparative fit index (CFI; Bentler, 1988), with CFI $\geq .95$ and RMSEA $\leq .06$ indicating good model fit (Hu & Bentler, 1999).

Finally, secondary analyses were conducted to evaluate the practical significance of the intervention effects, as specified in the introduction. For these analyses, cut points were selected for each outcome variable, allowing them to be recoded into dichotomous variables representing positive versus negative caseness for that outcome. We evaluated the dichotomized outcome variables for indirect intervention effects using estimates from the same model that was applied to the continuous outcomes analyses. The potential impact of each intervention was determined from these estimated percentages by computing RRRs.²

Cut points for dichotomizing the variables were determined by considering potential public health impact. For drunkenness, recent national prevalence estimates found that nearly 50% of young adults had been drunk during the past month (Johnston, Bachman, O'Malley, &

²The numbers of individuals estimated to be above the cut points were calculated from the model results by multiplying the proportions estimated to be above the cut points for each condition by the corresponding sample size; the estimated proportion and sample size of those below the cut points were then calculated by subtraction. The predicted percentages above the cut points for intervention and control groups were used to calculate the RRR of each intervention for each outcome.

Schulenberg, 2006). In our sample, 74% reported they usually get drunk no more than once per month, and 26% had been drunk more frequently. On the basis of national norms and our sample characteristics, we determined that being drunk two or more times per month could be considered a frequency of drunkenness likely to lead to appreciable public health consequences. Relevant to the alcohol-related problems outcome, the American Psychiatric Association (2000) stated that 60% of men and 30% of women in the United States had experienced one or more alcohol-related adverse events, such as driving after consuming too much alcohol or missing school or work because of a hangover. In the current sample, 17% reported more than one adverse event, representing serious alcohol-related problems, and in the current analysis, were categorized as being above the criterion for this outcome. With regard to cigarette use, any cigarette use was considered to be above threshold, both because any cigarette use is considered to be harmful to an individual's health and because nicotine is addictive, and even infrequent use puts an individual at risk of long-term nicotine use. Of the current sample, 45% were above the threshold for cigarette use. Similarly, any illicit substance use was categorized as being above threshold because any such use, by definition, entails illegal behavior and, thereby, greater risk for negative outcomes. In this study, 18% of individuals reported past year illicit substance use in young adulthood. For the Polysubstance Use Index, 43% of individuals reported no drunkenness, no cigarette use, and no illicit substance use, suggesting these individuals would have less serious health consequences and would be less likely to utilize societal resources, whereas the other 57% were classed as above threshold.

Results

Table 1 presents the means and standard deviations of the study variables by intervention group, and Table 2 reports the correlations of the study variables, with the PDFY versus control group correlations above the diagonal and the ISFP versus control group correlations below the diagonal. Table 3 presents the corresponding model fit indices, standardized parameters, indirect effects of the interventions, and R^2 s for the separate analyses that we conducted for each intervention and each outcome using the model depicted in Figure 2. An examination of the fit indices suggests that the model fit the observed data across the outcomes considered. Although the chi-square value was significant for most analyses, fit indices were within acceptable limits. Further, results were consistent with the hypothesized developmental model, in that the indirect intervention effects on young adult outcomes through the adolescent substance initiation growth factors were significant.

An examination of the hypothesized pathways of effects demonstrates a somewhat different pattern of results for the two interventions. The ISFP intervention significantly predicted both the intercept (average level), via Path a, and slope (rate of increase), via Path b, for the adolescent AAI, and evidenced significant indirect effects on the outcomes via these effects on initiation. PDFY intervention effects on initiation, although significant, were less robust. Results presented in Table 3 indicate some variation across outcomes as to which growth factor (level or rate of increase) related most strongly to its corresponding outcome variable.

As noted in the description of the analytic strategy, we examined simple direct effects using a model in which only direct effects from the control variables and intervention condition on the young adult outcomes were considered, without inclusion of the paths associated with the indirect effect. Findings indicated significant ($p < .05$) ISFP direct effects on drunkenness frequency and the Polysubstance Use Index, and a marginally significant ($p < .10$) ISFP direct effect on cigarette frequency. Significant direct PDFY effects on cigarette frequency and alcohol-related problems also were found ($p < .05$). However, an examination of the R^2 results for these models showed that more variance was explained by the indirect effects models for every outcome (e.g., for drunkenness frequency, the ISFP direct effects model R^2 was .105,

compared with an R^2 of .223 for the indirect effect model, and the PDFY direct effects model R^2 was .114, compared with an R^2 of .236 for the indirect effects model).

Additional analyses considered a modification of the model shown in Figure 2, adding a direct effect path from the intervention to the young adult outcomes. This model modification was not supported; none of the 10 analyses showed a significant improvement in model fit and/or a significant direct intervention effect. Further, in none of the 10 analyses did inclusion of the direct effect alter the direction or significance of the indirect effect that was obtained from the hypothesized model that included only indirect effects from the interventions to the young adult outcomes. In this context, it is important to note that the direct path that was added would capture direct intervention effects on the outcomes, as well as any other indirect effects that were not accounted for by the interventions' indirect effect conveyed via the level or rate of increase of substance initiation. Thus, the overall pattern of results detailed above provides consistent support for the model hypothesizing that the interventions' effects on the distal outcomes are predominantly conveyed indirectly, through effects on adolescent substance initiation.

Finally, the supplemental analyses noted in the *Analysis* section were conducted to provide insight regarding the practical significance of intervention effects on young adult substance use by utilizing the dichotomous young adult outcome variables to estimate intervention effects on the estimated probability of an individual achieving caseness. The estimated caseness percentages generated by the analytic model for intervention and control groups were used to calculate the RRR for each intervention and outcome.

An examination of Table 4 indicates that significant indirect effects were found for both interventions on all dichotomously scored outcomes. The RRR was calculated for each analysis to estimate the percentage of cases that were likely prevented as a result of the intervention, and it ranged from 9% to 31%. Higher RRRs and higher level significance of effects were observed for the ISFP intervention as compared with the PDFY, consistent with results for the continuous variable outcomes.³

Discussion

Literature cited in the introduction and earlier reports on follow-up evaluations of three longitudinal prevention trials have summarized the social, health, and economic consequences of adolescent and adult substance use (e.g., Park et al., 2007; Spoth, Shin, Guyll, Redmond, & Azevedo, 2006; Windle & Windle, 2001). As noted, substance use, particularly problematic or serious types of use, peaks during the young adult developmental stage. There is, however, a gap in the research regarding the long-term effects on young adult outcomes of preventive

³Earlier reports from this study, cited in the introduction, distinguish between the practical, public health significance of statistically significant effects on substance-related outcomes and the clinical significance of those outcomes. Most often, RRRs, such as those reported in the current article, are used to estimate the proportion of cases prevented. In the current report, young adult scores on the alcohol-related problems measure were used to capture public health impact of alcohol use because alcohol-related problems scores reflect functional difficulties caused by alcohol use. The intervention trial on which this article is based also entailed administration of the Diagnostic Interview Schedule (Robins, Cottler, Bucholz, & Compton, 1995) for the young adult assessment, thereby enabling assessment of significance pertaining to clinical outcomes, in addition to those relating to public health that are the focus of this report. In particular, two diagnoses specific to the past year young adult period were available: past year alcohol abuse and past year alcohol dependence as defined by *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000) criteria (although the telephone survey assessment of alcohol dependence was of slight variance from *DSM-IV-TR*). However, consistent with previously published reports for PDFY (Mason et al., in press), neither intervention demonstrated statistically significant effects on either diagnostic category. Interestingly, the rate of past year alcohol abuse (19.5%) and the rate of caseness for the alcohol-related problems (17.0%) were similar, suggesting that the different results across these two measures did not stem from less variability of the diagnostic outcome. In addition, the two measures correlated modestly ($r = .29$), indicating that although they are related, they by no means tap identical constructs. It is likely that the alcohol-related problems measure more accurately captures behaviors influenced by the interventions, possibly because they are more sensitive indicators of prodromal symptomatology.

interventions implemented during early adolescence. The gap is particularly large for the kinds of brief, universal, and family-focused interventions that are presented in this report. In the case of the present prevention trial, having established preventive intervention effects on delayed substance initiation among adolescents, the next step was to evaluate subsequent effects on young adults, examining how intervention effects on adolescent substance initiation might affect use in the subsequent developmental period.

The evaluation of developmental pathways to long-term intervention effects must address a number of challenging issues, particularly given the complex interplay of developmental and long-range intervention effects over time (Masten et al., 2008). To address these issues, in this study we evaluated two universal intervention programs administered during early adolescence across a 10-year time span, using a developmental model for testing their effects on several types of problematic substance use in young adulthood. Results show that the models fit the data and were robust across types of outcomes and interventions. Most importantly, results support the posited indirect effects of the interventions via adolescent substance initiation, with those indirect effects found to be significant for both interventions. The effects of adolescents' delayed initiation and reduced levels of use on young adult outcomes reached high significance levels, albeit with some variation across particular outcomes.

Consistent with the pattern of findings provided in earlier reports, observed long-term outcomes were relatively more robust for ISFP as compared with PDFY. Because this study joined two separate grant-funded proposals (one entailing a two-condition ISFP study and one with a two-condition PDFY study), ISFP–PDFY differences were neither hypothesized nor tested. To the extent that those differences may be meaningful, less robust findings for PDFY may be due to that intervention's apparently weaker effects on the initiation growth factors, which are more strongly predictive of the young adult outcomes. In addition, ISFP's impact may benefit from differences between the interventions discussed earlier. For example, ISFP is relatively more intensive than PDFY in that it includes two additional sessions, and all intervention sessions are attended by the targeted adolescents, whereas PDFY focuses primarily on parents, with adolescents attending only one of the PDFY sessions. Nonetheless, an interpretation of the ISFP–PDFY differences should consider the advantage of PDFY's relatively fewer sessions and lower cost. To date, both interventions have demonstrated favorable benefit–cost ratios; which one of the two is more strongly favored depends on the specific economic analysis conducted (Spoth, Guyll, & Day, 2002).

Results of the analytic model provide clear support for the hypothesis that long-term preventive intervention effects on young adult substance use outcomes are conveyed by reducing, delaying, or slowing the growth of substance initiation in adolescence, regardless of which developmentally specific factors are operative. Considering implications of the findings for developmental models of substance use behaviors, it is important to note that support for mediation of long-term effects via substance initiation remained significant even when a direct path was included between the intervention and the adult outcomes, the latter of which would have captured any other direct or indirect effects of the intervention on that outcome. Moreover, these direct effects were not significant, further supporting the hypothesis that intervention effects on the distal outcomes were conveyed primarily via effects on adolescent initiation. This pattern of effects is consistent with conclusions in Shrout and Bolger (2002), who commented that interventions generally have stronger effects on proximal than distal outcomes.

In addition to confirming the expectation that universal intervention effects over a 10-year time span would be primarily indirect, the results suggest that it can be useful to consider long-term intervention effects as alterations of the natural sequelae of substance initiation behaviors over time (see Masten et al., 2008). The current model focused on the role of delayed initiation in the mediation of long-term intervention effects on distal outcomes and, as such, is distinct from

an alternative approach that would seek to track sequences of effects across time and among variables that are qualitatively different from each other. Specifically, a typical causal analysis might test whether an intervention favorably impacts one or more risk and protective behaviors—such as school functioning or parenting practices—and whether these, in turn, ultimately reduce substance use (e.g., Mason et al., in press). However, the complex interplay among a multitude of potential measured and unmeasured risk behaviors and protective factors presents challenges to this approach. For example, it is conceivable that although an intervention might target a particular risk factor, and that risk factor might typically predict distal outcomes, the intervention might actually operate through multiple pathways and a variety of mechanisms. Moreover, the particular pathways and mechanisms that are beneficially impacted by an intervention may differ across individuals. Thus, whereas one adolescent might benefit from improved parental monitoring, another might benefit from enhanced peer refusal skills or increased school bonding. Results from the current analyses suggest that the effects of substance use preventive interventions that may be conveyed by varied pathways to distal outcomes are well-captured via their mediating effects on adolescent initiation.

Challenges and issues associated with the complex interplay of risk and protective factors notwithstanding, an incremental mediation model building strategy warrants consideration. A reasonable strategy would be to begin with the basic developmental model—starting with an examination of “simple” indirect effects via substance initiation, such as was the case with the model tested in this article—continuing with incorporation of a promising, primary mediator suggested by the relevant theoretical and empirical literature. One example would be mediation of intervention effects on initiation via intervention-related reduction of exposure to opportunities for substance initiation (Spoth, Gyll, & Shin, in press). Although encountering such exposures does not necessarily lead to initiation, being shielded from such opportunities avoids the risk associated with early substance initiation, thus greatly reducing the chances of later problematic use—described as a protective shield effect. Along these lines, intervention effects on substance use exposures could be incorporated into the tested model as mediating initiation.

The developmental epidemiology of substance use, revealing that young adulthood is the developmental stage during which the highest levels of substance use are observed, indicates the significance of the findings. Analyses focusing on the practical significance of the findings further indicate that the risk of surpassing cutoff values and attaining caseness was reduced among individuals assigned to the preventive intervention conditions. In concrete terms, the RRR estimates suggest that among adolescents who would have otherwise progressed to problematic substance use in young adulthood, ISFP could be effective in preventing from 19% (drunkenness) to 31% (illicit drug use) from doing so, depending on the particular outcome considered. Similarly, PDFY also was associated with beneficial RRR values, ranging from 9% for drunkenness to 20% for illicit drug use. These findings suggest a public health benefit accrued to individuals and communities by implementing the tested interventions, especially when considering related indications of their cost effectiveness and positive benefit–cost ratios (Spoth et al., 2002).

The primary limitations of the study include questions about the generalizability of results on the basis of our predominantly White, rural sample. Although it seems likely that relationships among variables found in the current study would be found in other populations as well, that remains to be verified through future research. Other cautions include issues typical of longitudinal effectiveness trials conducted in communities, including sample attrition and reliance on self-reported substance use behaviors. Preliminary analyses concerning differential attrition, the use of full information analytic techniques, and prior research supporting the validity of substance use self-reports (Elliott, Ageton, Huizinga, Knowles, & Canter, 1983;

Kraus & Augustin, 2001; Smith, McCarthy, & Goldman, 1995) provide confidence in the results, though readers should remain cognizant of these issues.

The current findings suggest several directions for future research. First, it remains an open question as to whether the tested developmental growth model generalizes to other young adult outcomes, such as mental health or conduct problems. Second, the utility of the model should be evaluated by replicating analyses across even longer time frames with future data from the participants in this trial as they progress further into adulthood. Similarly, these effects should be replicated with other empirically supported interventions, as well as in samples of participants whose demographics differ from those of the current report. In addition, future research will adopt an incremental mediation model-building strategy. It will evaluate the degree to which the interventions' effects on delaying substance use initiation may be mediated by the interventions' tendency to induce protective shield effects that delay initiation by preventing exposure to substance initiation opportunities during a critical period of adolescent development.

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Figure 1.

Participation summary for the Iowa Strengthening Families Program (ISFP), Preparing for the Drug Free Years (PDFY), and control conditions. Note: Threats to internal validity/differential sample attrition through the age 21 assessment were assessed, and no evidence was found. Retention rates are similar to comparable longitudinal trials.

Figure 2.

Model of universal intervention effects via adolescent growth in substance initiation. Note: AAI = Adolescent Alcohol, Tobacco, and Other Drug Initiation Index. Model control variables include pretest AAI, gender, parent marital status, parent education, and family income. Intercept is specified at the midpoint of the adolescent time frame. Correlations between intercept and slope, along with autoregressive correlations between indicator variables of the adolescent growth curve factors, are not illustrated.

Table 1

Means and Standard Deviations of the Variables by Intervention Condition

Condition	Pretest		Posttest		7th grade		8th grade		10th grade		12th grade		Young adult			
	AAII		AAII		AAII		AAII		AAII		AAII		Drunkennes		Alcohol problem	
	AAII	AAII	AAII	AAII	AAII	AAII	AAII	AAII	AAII	AAII	AAII	AAII	frequency	frequency	frequency	frequency
ISFP																
M	0.22	0.31	0.49	0.56	1.15	1.66	1.45	0.27	2.02	0.41	0.79					
SD	0.55	0.74	0.90	1.02	1.25	1.38	1.34	0.36	1.41	1.26	0.93					
PDFY																
M	0.28	0.35	0.61	0.97	1.44	1.95	1.66	0.23	1.94	0.65	0.90					
SD	0.62	0.77	0.97	1.20	1.44	1.55	1.50	0.36	1.45	2.15	1.00					
Control																
M	0.19	0.28	0.53	0.95	1.60	2.27	1.68	0.31	2.24	0.56	0.97					
SD	0.47	0.60	0.87	1.14	1.41	1.53	1.43	0.48	1.52	1.88	0.91					

Note. AAI = Adolescent Alcohol, Tobacco, and Other Drug Initiation Index; ISFP = Iowa Strengthening Families Program; PDFY = Preparing for the Drug Free Years.

Table 2

Correlations of the Variables: ISFP and PDFY Versus Control Conditions

Variable	Pretest	Posttest	7th grade	8th grade	10th grade	12th grade	Young adult					Condition
	AAII	AAII	AAII	AAII	AAII	AAII	Drunkness frequency	Alcohol problem frequency	Cigarette frequency	Illicit drug frequency	Polysubstance use index	
Pretest AAI	—	.90**	.67**	.58**	.40**	.31**	.09	.02	.13*	.16**	.19**	.08
Posttest AAI	.83**	—	.77**	.63**	.45**	.36**	.14*	.02	.21**	.23**	.25**	.05
7th-grade AAI	.68**	.81**	—	.80**	.57**	.47**	.15*	.03	.24**	.21**	.23**	.04
8th-grade AAI	.59**	.65**	.84**	—	.79**	.66**	.13*	.13*	.36**	.20**	.28**	.01
10th-grade AAI	.36**	.44**	.56**	.76**	—	.82**	.17**	.20**	.39**	.22**	.33**	−.06
12th-grade AAI	.29**	.34**	.40**	.58**	.84**	—	.34**	.21**	.50**	.33**	.52**	−.10 [†]
Drunkness frequency	.10 [†]	.13*	.17**	.15*	.22**	.34**	—	.47**	.18**	.26**	.71**	−.01
Alcohol problem frequency	.08	.10 [†]	.15*	.21**	.30**	.31**	.55**	—	.16**	.11 [†]	.42**	−.09
Cigarette frequency	.11*	.13*	.23**	.31**	.38**	.49**	.23**	.27**	—	.33**	.59**	−.10 [†]
Illicit drug frequency	.12*	.19**	.23**	.26**	.32**	.30**	.23**	.22**	.24**	—	.48**	.02
Polysubstance												
Use Index	.16**	.18**	.21**	.26**	.39**	.51**	.72**	.56**	.59**	.47**	—	−.04
Condition	.03	.02	−.02	−.18**	−.17**	−.21**	−.08	−.04	−.08	−.05	−.10 [†]	—

Note. PDFY—control above the diagonal; ISFP-control below the diagonal. AAI = Adolescent Alcohol, Tobacco, and Other Drug Initiation Index; PDFY = Preparing for the Drug Free Years; ISFP = Iowa Strengthening Families Program.

[†]
p < .10.

*
p < .05.

**
p < .01.

Table 3
Intervention Effects on Young Adult Outcomes in the Developmental Model

Variable	N	χ^2	df	p	CFI	RMSEA	Path a		Path b		Path c		Path d		Indirect effects	
							β	t	β	t	β	t	β	t	β	t
ISFP versus control																
Drunkness frequency	446	67.85	33	<.000	.971	.049	-.15	-3.68**	-.25	-3.99**	.16	1.14	.25	2.32*	-.09	-3.16**
Alcohol problem frequency	446	62.57	33	.001	.975	.045	-.15	-3.54**	-.25	-3.98**	.18	1.80	.21	2.68**	-.08	-3.34**
Cigarette frequency	446	55.24	33	.009	.981	.039	-.14	-3.41**	-.24	-3.95**	.15	1.08	.41	3.32**	-.12	-3.41**
Illicit drug frequency	446	55.11	33	.009	.981	.039	-.16	-3.68**	-.26	-4.16**	.35	3.34**	.05	0.53	-.07	-3.57**
Polysubstance Use Index (drunkness, cigarettes, illicit drugs)	446	61.32	33	.002	.976	.044	-.15	-3.42**	-.24	-3.99**	.17	2.03*	.40	5.14**	-.12	-3.77**
PDFY versus control																
Drunkness frequency	428	53.81	33	.013	.986	.038	-.09	-1.94 [†]	-.11	-1.94 [†]	.24	1.31	.19	1.41	-.04	-1.97*
Alcohol problem frequency	428	54.61	33	.010	.986	.039	-.09	-1.94 [†]	-.11	-1.96*	.02	0.28	.26	3.57**	-.03	-1.64 [†]
Cigarette frequency	428	47.88	33	.045	.990	.032	-.09	-1.96*	-.11	-2.02*	.61	6.92**	.01	0.13	-.06	-1.89 [†]
Illicit drug frequency	428	46.63	33	.058	.990	.031	-.19	-1.98*	-.11	-2.00*	.66	2.07*	-.20	-0.94	-.04	-1.98*
Polysubstance Use Index (drunkness, cigarettes, illicit drugs)	428	50.04	33	.029	.989	.035	-.09	-1.91 [†]	-.11	-1.92 [†]	.50	2.86**	.13	1.01	-.06	-2.05*

Note. CFI = comparative fit index; RMSEA = root-mean-square error of approximation; ISFP = Iowa Strengthening Families Program; PDFY = Preparing for the Drug Free Years.

[†] $p < .10$.

* $p < .05$.

** $p < .01$.

Table 4
Model-Based Estimates of Relative Reduction Rates for Intervention Indirect Effects on Dichotomous Substance Use Young Adult Outcomes

Variable	Above cutoff		Indirect effects <i>t</i>	Below cutoff		Total <i>N</i>	RRR ^a %
	Estimated <i>N</i>	%		Estimated <i>N</i>	%		
ISFP versus control							
Drunkenness							
ISFP	53	22.2**	-2.61	185	77.8	238	19
Control	57	27.4		151	72.6	208	
Alcohol-related problems							
ISFP	39	16.5**	-3.57	199	83.5	238	23
Control	45	21.6		163	78.4	208	
Cigarettes							
ISFP	100	42.2**	-3.54	138	57.8	238	23
Control	115	55.1		93	44.9	208	
Illicit drugs							
ISFP	33	13.7**	-3.76	205	86.3	238	31
Control	41	19.9		167	80.1	208	
Polysubstance Use Index							
ISFP	123	51.7**	-3.55	115	48.3	238	21
Control	136	65.6		72	34.4	208	
PDFY versus control							
Drunkenness							
PDFY	59	26.9*	-1.74	162	73.1	221	9
Control	61	29.4		147	70.6	208	
Alcohol-related problems							
PDFY	35	15.9*	-1.65	186	84.1	221	11
Control	37	17.8		171	82.2	208	
Cigarettes							
PDFY	97	44.1*	-1.98	111	55.9	221	11

Variable	Above cutoff		Indirect effects		Below cutoff		RRR ^a	
	Estimated N	%	t		Estimated N	%	Total N	%
Control	103	49.6			105	50.4	208	
Illicit drugs								
PDFY	39	17.5*	-2.01		182	82.5	221	16
Control	43	20.9			165	79.1	208	
Polysubstance Use Index								
PDFY	128	58.1*	-2.19		93	41.9	221	10
Control	134	64.2			74	35.8	208	

Note. Drunkenness at greater than once per month; alcohol-related problems at greater than 1 out of 8 problems during the past year; cigarettes at greater than no use during the past year; illicit drugs at greater than no use during the past year; Polysubstance Use Index at greater than none. Because separate analyses compare (a) Iowa Strengthening Families Program (ISFP) versus control and (b) Preparing for the Drug Free Years (PDFY) versus control, model-based estimates of the percentages above the cutoff differ between the two analyses. Those estimates are the basis for the estimated *N*s.

^aRRR = relative reduction rate; the estimated proportion of control condition cases that would have been prevented had those individuals been in the intervention condition.

* $p < .05$ (one-tailed indirect intervention effects).

** $p < .01$ (one-tailed indirect intervention effects).