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Replication RCT of Early Universal Prevention Effects on Young Adult Substance Misuse

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Abstract

Objective—For many substances, more frequent and problematic use occurs in young adulthood; these types of use are predicted by the timing of initiation during adolescence. We replicated and extended an earlier study examining whether delayed substance initiation during adolescence, resulting from universal preventive interventions implemented in middle school, reduces problematic use in young adulthood.

Method—Participants were middle school students from 36 Iowa schools randomly assigned to the Strengthening Families Program plus Life Skills Training (SFP 10–14 + LST), LST-only, or a control condition. Self-report questionnaires were collected at 11 time points, including four during young adulthood. The intercept (average level) and rate of change (slope) in young adult frequency measures (drunkenness, alcohol-related problems, cigarettes, and illicit drugs) across ages 19–22 were modeled as outcomes influenced by growth factors describing substance initiation during adolescence. Analyses entailed testing a two-step hierarchical latent growth curve model; models included the effects of baseline risk, intervention condition assignment, and their interaction.

Results—Analyses showed significant indirect intervention effects on the average levels of all young adult outcomes, through effects on adolescent substance initiation growth factors, along with intervention by risk interaction effects favoring the higher-risk subsample. Additional direct effects on young adult use were observed in some cases. Relative reduction rates were larger for the higher-risk subsample at age 22, ranging from 5.8% to 36.4% on outcomes showing significant intervention effects.

Conclusions—Universal preventive interventions implemented during early adolescence have the potential to decrease the rates of substance use and associated problems, into young adulthood.

Keywords

Universal prevention; family; school; substance misuse; risk-related moderation

This article reports long-term young adult outcomes of combined universal family- and school-based interventions designed to prevent adolescent substance misuse in general

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populations. It is based on follow-up assessments through 9.5 years past baseline (age 22) for a prevention trial called the Capable Families and Youth Study (CaFaY). Previous reports from this study examined outcomes through 12th grade (Spoth, Randall, Trudeau, Shin, & Redmond, 2008). The tested developmental outcome model replicates one examined in an earlier study of a different sample (Spoth, Trudeau, Gyll, Shin, & Redmond, 2009) with an extended model that also evaluates risk-related moderation of outcomes.

Epidemiological data highlight how substance misuse often is: (1) more prevalent in young adulthood than in earlier developmental stages (Johnston, O'Malley, Bachman, & Schulenberg, 2012; Substance Abuse and Mental Health Services Administration, 2012), and (2) how young adult substance misuse is predicted by misuse during the adolescent developmental stage (Guo, Hawkins, Hill, & Abbott, 2001; Spoth et al., 2009). For purposes of the present report all substance use during *adolescence* will be characterized as misuse, because all use is illegal at that age. During *young adulthood*, however, the use of the term will be reserved for higher frequency, potentially problematic use. The problems associated with adult substance misuse include less competent functioning and lower educational and occupational attainment (Fergusson & Boden, 2008; Kosterman, Graham, Hawkins, Catalano, & Herrenkohl, 2001), risky sexual practices (Parks, Collins, & Derrick, 2012), mental health problems (O'Neil, Conner, & Kendall, 2011; Windle & Windle, 2001), adult crime (Boden, Fergusson, & Horwood, 2013; Kosterman et al., 2001), and increased mortality (Hayes et al., 2011; Kertesz et al., 2012). In consideration of this range of substance misuse-related problems, greater attention to long-term effects of universal preventive interventions is warranted, as illustrated by the present study.

Concerning the etiology of adolescent substance misuse, it is well established that risk and protective factors originating in both family and school socializing environments contribute greatly to adolescent substance misuse (Cleveland, Feinberg, & Greenberg, 2010; Ennett et al., 2008; National Research Council & Institute of Medicine [NRC & IOM], 2009a; 2009b; Szapocznik, Tolan, Sambrana, & Schwartz, 2007). This study tests long-term effects of a multicomponent intervention that addresses such factors in both family and school socializing environments. The intervention consisted of two theory-based programs: (1) the Strengthening Families Program: For Parents and Youth 10–14 (SFP 10–14; Molgaard, Spoth, & Redmond, 2000); and (2) Life Skills Training (LST; Botvin., 1995; 2000), a school-based universal program. Together they target a wide range of empirically- and theoretically-supported risk and protective factors (e.g., family-, school-, peer-, and individual-related) for adolescent substance misuse. It is especially noteworthy that the universal design of these two programs creates a significant advantage by potentially influencing a larger number of individuals prone to adult substance-related disorders than interventions designed for clinical subpopulations (Offord, Kraemer, Kazdin, Jensen, & Harrington, 1998).

The extant literature on universal interventions emphasizes the importance of purposefully 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 misuse or delay transition to more serious misuse (Anthony, 2003; Chen et al., 2004; Offord & Bennett, 2002). Although a number of universal interventions have been shown to be effective in delaying substance initiation through the adolescent period (National Institute on Drug Abuse, 2003), very few studies have followed participants into young adulthood. Some studies have 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 a more intensive intervention on long-range outcomes encouraged investigation of whether *brief, universal* preventive interventions also might produce long-lasting positive effects. A prevention trial conducted previously by our research group involved such an investigation, examining the effects of a family-focused intervention on young adults; the present study replicates and extends that earlier research with the evaluation of a multicomponent intervention administered to a different sample at a later point in time.

Earlier findings concerning the multicomponent intervention examined in the present study, conducted through 5.5 years past baseline, supported a primary hypothesis that participants would demonstrate significantly lower substance initiation than the control condition students (Spoth, Redmond, Trudeau, & Shin, 2002; Spoth, Randall, Shin, & Redmond, 2005; Spoth et al., 2008). This pattern of earlier results sets the stage for examining whether the comparatively more proximal effects in adolescence portend continued favorable effects on substance misuse in young adulthood. As noted, research has demonstrated that substance-related risk factors that endure in adolescence predict substance misuse in young adulthood (e.g., Guo et al., 2001; Hawkins et al., 2005). Thus, it was expected that the observed intervention effects among adolescents would translate into less misuse in adulthood, as observed in our earlier study of family-focused interventions.

The current study examined a replication of a developmental model of long-term effects of universal interventions implemented during early adolescence on young adult substance misuse outcomes approximately ten years after intervention implementation. In addition to a study rationale grounded in positive adolescent stage effects on substance misuse, this study is motivated by a developmental perspective postulating that early adulthood is particularly important for evaluating universal intervention effects. It is the stage in which misuse typically increases and entails major changes in roles and responsibilities in home, work, and school environments potentially impacted by substance misuse (Schulenberg, Sameroff, & Cicchetti, 2004), as indicated by the epidemiological data cited above.

The tested developmental model addresses a key gap in the literature associated with the challenge of modeling the complex interplay of long-term intervention effects, age-related patterns of substance misuse, and developmental processes (Masten et al., 2005; Masten, Faden, Zucker, & Spear, 2008). Modeling intervention effects on growth in substance initiation is a parsimonious way to capture intervention effects across a long developmental time span (see Blozis, Feldman, & Conger, 2007). Growth in substance initiation results from multiple interrelated pathways of intervention effects (e.g., proximal effects on early adolescent substance refusal skills, parental monitoring, and other vectors of influence) and is expected to convey intervention effects into young adulthood. Our developmental model

posits that (a) earlier established proximal effects of the tested universal interventions (e.g., effects on parent and adolescent attitudes and skills—Spoth, Redmond, & Shin, 1998) will delay substance initiation or slow its rate of increase across adolescence and decrease the overall level of initiation (e.g., Spoth, Redmond, & Shin, 2001; Spoth, Redmond, Shin, & Azevedo, 2004), and (b) the effects on substance initiation during adolescence constitute the primary mechanism for the transmission of intervention effects into young adulthood.

In addition to replicating and extending the previously tested developmental model into young adulthood, the model was expanded to include examination of risk-related moderation of effects. In this context, risk-related moderation may result from factors that influence the effectiveness of an intervention, but which the intervention cannot change (e.g., pre-existing individual characteristics or behaviors; see MacKinnon, Weber, & Pentz, 1988; Spoth, Shin, Guyll, Redmond, & Azevedo, 2006). Risk-related moderation was evaluated for several interrelated reasons. Differential trends toward higher rates of early substance initiation, evident in the intervention group relative to the control group, could render positive intervention outcomes more difficult to detect. In effect, a higher proportion of substance-using intervention group adolescents had a “head start” on progression to more intense or frequent and varied use, as observed in an earlier report (see Spoth et al., 2005). In other words, possible differential effects of the intervention across subgroups might mask effects when analyzing the entire sample (Brookes et al., 2004). Further, a pattern of risk-related moderation has been observed in earlier CaFaY trial outcomes through 12th grade (Spoth et al., 2008). For these reasons, we conducted a risk-moderation analysis in order to assess possible differential effects of the interventions on adolescents who had already initiated use of at least two substances (alcohol, cigarettes, marijuana) at baseline, versus those who had not.

The cross-developmental stage model for examining universal intervention effects into young adulthood is illustrated in Figure 1. Growth factors were estimated to describe adolescent substance initiation from the post-intervention 7th grade assessment through 11th grade—the adolescent time period when initiation was increasing at the most rapid rate. Twelfth grade was not included because the initiation rate had slowed by that time, showing evidence of a ceiling effect, and because the percentage of assessed participants decreased in 12th grade (likely due to several factors, including early graduation, dropout, and competing activities that interfered with assessment participation). Variables included as predictors of the adolescent substance initiation growth factors included assignment to condition, baseline risk, and the intervention $\times$ risk interaction, along with control variables (gender and baseline initiation). In turn, the adolescent growth factors were specified as predictors of the outcome growth factors during young adulthood, to address the hypothesized indirect effects of the intervention, risk, and the intervention condition $\times$ risk interaction.

Methods

Sample, Design, Procedures

The university Institutional Review Board approved the project before sample selection began. All APA ethical standards were followed and safety was monitored throughout the study. Participants included 7th graders and their families enrolled in 36 rural northeast Iowa

schools in 1997. School selection criteria were: lunch program eligibility (20% of district families eligible); district enrollment (1200); and middle school grades taught in one location. Schools were matched to form 12 blocks of three schools each. The schools in each block were then randomly assigned to each of three conditions: the combined intervention, including the family-focused Strengthening Family Program: For Parents and Youth 10–14 and the school-based Life Skills Training program (SFP 10–14+LST), the LST alone (LST-only), or a control condition (teen development informational materials sent to parents). Students were recruited to complete in-school assessments (approximately 20 randomly selected students and their parents in each school also participated in in-home assessments, but because those assessments were conducted with only a subset of the total sample, they were not utilized for the current study). Study participation is presented in Figure 2 (participation rates at baseline were approximately 90% of the eligible sample of all 7th grade students in the districts). Baseline equivalence of the sample was established; more detailed information is provided in earlier reports and documents, including a power analysis conducted prior to study implementation (e.g. Spoth et al., 2005, 2008). At baseline (1997), families averaged 3.2 children, had household incomes averaging \$43,105 and 99% of participants were White. Analyses were conducted to assess pretest equivalence and possible differential attrition across study conditions with respect to a range of sociodemographic factors and the examined outcomes. Results indicated a higher prevalence of dual biological parent families in the control group than in the intervention groups (LST-only, 70%, LST +SFP 10–14, 72%, Control, 78%; $F(2, 22) = 4.25, p < .05$) at baseline, and a lower rate of attrition among control group participants from dual biological parent families at the 19 year-old assessment point. No other significant pretest or differential attrition effects 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.

Data collectors and interviewers were trained by university staff. School assessments occurred in the fall (baseline) and spring (posttest) of 7th grade, and in the spring of grades 8–12; following 12th grade, telephone interviews and mailed questionnaires were utilized for yearly data collection at ages 19–22. Assessments of intervention group students were not contingent on participation in the interventions. Schools received monetary compensation for their cooperation in classroom-based assessments; following high school, the participants themselves were compensated for their time in completing study assessments.

Intervention Implementation

After the baseline assessment, all students in the LST-only and SFP 10–14 + LST conditions were offered the LST program, provided as part of the school curriculum. In addition, intervention group families in the SFP 10–14 + LST schools who participated in the in-home baseline assessments were recruited for the SFP 10–14 program; intervention group families not participating in in-home baseline assessment were allowed to enroll in the SFP 10–14 intervention but were not actively recruited. Interventions implemented in this study were delivered via university partnerships with local implementers, as detailed in earlier reports (Spoth, 2007). The programs are described below.

Life Skills Training (LST) is a universal preventive intervention program based on social learning theory (Bandura, 1977) and problem behavior theory (Jessor & 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 misuse. 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.

Classroom teachers, trained in the LST program by university-based trainers, conducted the 15-session program during 40 to 45-minute classroom periods when students were in 7th grade. Teachers were observed by project staff on two or three occasions to assess adherence to the instructional content. Adherence averaged 85%. Approximately one year later (in the 8th grade), students also participated in five LST booster sessions to promote skill development— primarily social resistance skills, self-management skills, and generic social skills. Adherence averaged 82%. Four 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 and six from the SFP 10–14 + LST condition. Adherence averaged 77%.

The *Strengthening Families Program: For Parents and Youth 10–14* (SFP 10–14) targets empirically-based factors originating in the family environment that are associated with adolescent substance misuse (Kumpfer, Molgaard, & Spoth, 1996; Molgaard et al., 2000). The long-range goal of SFP 10–14 is to reduce youth substance misuse 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.

The seven SFP 10–14 program sessions were conducted in schools in the evening for seven consecutive weeks when the youth were in the second semester of 7th grade. Each session included separate, concurrent one-hour parent and youth skills-building segments, followed by a one-hour conjoint family curriculum during which parents and youth together practiced skills learned in their separate segments. Each session required three university-trained facilitators, one for the parent segment and two for the youth segment; all three facilitators participated in the family segments. A total of 137 families attended the SFP 10–14 in 22 groups in the 12 schools assigned to the condition. Coverage of the tasks or activities described in the group leader's manual averaged 98% in the family segments, 92% in the parent segments, and 94% in the youth segments.

Families were invited to participate in four booster sessions approximately one year following the initial SFP 10–14 sessions. Ninety of the families attending at least one of the earlier SFP 10–14 sessions also attended at least one booster session (69%). Coverage of the program tasks or activities averaged 97% for the family sessions, 94% for the parent sessions, and 96% for the youth sessions.

Family-focused booster interventions also were conducted in six randomly-selected SFP 10–14 + LST intervention schools during the 11th grade and included three components: (a) a videotape and handout on effective parenting with 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.

Measures

Drunkenness frequency—This and other substance misuse frequency measures were adapted from item sets in the Monitoring the Future study (see Johnston et al., 2012). Drunkenness frequency was assessed with one question, “How often do you usually get drunk?” scaled from 0 = “Never” to 7 = “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). Ten questions were scaled from 0 = “Never” to 4 = “Four or more times” and assessed alcohol misuse-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 ten items ($\alpha = .70$).

Cigarette frequency—Past year cigarette frequency was measured with the item: “During the past 12 months how often did you smoke cigarettes?” and was assessed on a scale from 1 = “Not at all” to 7 = “About 2 packs/day.”

Illicit substance use frequency—Frequency of past year illicit substance use was measured with nine open-ended items (e.g., “How many times in the past 12 months did you use [specific substance]?”). In order to address item skew and to obtain an appropriate weighting of items in the illicit substance use measure, each item was natural-log transformed and summed. 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.

Adolescent Substance Initiation Index (ASI—Waves 1 to 6)—This measure is the sum of four individual dichotomous measures of substance initiation constructed from a scale with the stem “About how often (if ever) do you:” and included one item each measuring drunkenness, smoking marijuana, and sniffing inhalants (e.g., glue, paint, gas, or other inhalants), along with one item addressing use of tobacco in any form (derived from three separate items assessing use of cigarettes, cigars, and chewing tobacco). Each substance category was scored as 0 = “Never” indicating no lifetime use and 1 = any lifetime use. Scores ranged from 0, indicating no initiation of drunkenness, tobacco, marijuana, or inhalants, to 4, indicating initiation of all four. Measures were corrected for consistency, so that once an individual indicated initiation of a given substance, that initiation was also reflected in all subsequent waves (i.e., once initiated, a substance could

not be “uninitiated” at a later wave). Internal consistency of the composite measure, as assessed by Cronbach’s alpha, averaged .64 across waves. This modest level of internal consistency was not unexpected, given that the individual items of the index refer to disparate substances and behaviors among which only mid-range correlations would be expected. Also noteworthy, Sneed and colleagues (2004) compared three methods of constructing lifetime substance misuse 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 in a general population sample with little ethnic diversity.

Control variables were baseline ASI and gender, coded 0 = “female” and 1 = “male.”

Analyses

Model overview—A two-step hierarchical latent growth curve modeling strategy was used to examine intervention effects on young adult substance misuse growth factors. In the first step, intervention and early risk effects on young adult substance misuse growth were modeled as exclusively indirect, via effects on adolescent substance initiation (ASI) growth factors (see Figure 1). In the second step, direct effects of the intervention and baseline risk level (plus their interaction) on young adult substance misuse growth parameters were added to the model; the expanded model was compared to the initial model with respect to overall fit, direct effect path significance, and change in indirect effect path significance. As depicted in Figure 1, the initial model specified direct effects on the young adult growth factor outcomes from the latent intercept and slope factors describing growth in ASI from the 7th grade posttest to 11th grade. The specified latent growth factor loadings on the observed measures of ASI set the growth model intercept to the midpoint of the post-intervention period so that the intercept value corresponded to the average level of initiation across that time period, as estimated by the model. Growth was modeled as linear (polynomial contrasts fixed at −2, −1, 0, 1 and 2). The growth factor indicators were modeled with an autoregressive error structure and the latent intercept and slope factors were allowed to correlate. The model controlled for the potential relationship between pre-intervention ASI assessed at baseline (fall of 7th grade) and the subsequent adolescent growth factors, by including direct effects of baseline ASI on the intercept and slope factors. As noted, gender also was controlled. SFP 10–14 + LST versus Control and LST-only versus Control models were analyzed separately.

To test for risk-related moderation of intervention effects, participants were classified as either higher- or lower-risk, based on their baseline levels of gateway substance initiation; those classified as higher-risk had initiated at least two out of three gateway substances—alcohol, cigarettes, and marijuana. Approximately 20% were classified as higher-risk, primarily those who had initiated both alcohol and cigarettes; only 2% had initiated marijuana at baseline. Analyses examined risk moderation of intervention effects with two-way interactions (intervention × risk). Effects of the intervention, risk, and the intervention × risk interaction on the growth factors of young adult substance misuse were modeled as indirect, through effects on the growth factors of adolescent ASI. Contrast coding (1 and −1) for the risk and the intervention variables was used to create orthogonal terms to facilitate

interpretation of main and interaction effects. With contrast coding, the effect of the intervention can be interpreted as the overall effect of assignment to the intervention condition, controlling for risk status, and the effect of risk can be interpreted as the overall effect of risk, controlling for intervention status. The interaction can be interpreted as the difference in intervention effect by level of risk—a significant negative intervention $\times$ risk effect would suggest that the intervention was more effective in lowering levels of substance misuse for the higher-risk group.

Young adult growth factors through ages 19, 20, 21, and 22 were estimated in the same manner as were the adolescent growth factors. Polynomial contrasts were fixed at -1.5 , -0.5 , 0.5 , and 1.5 for the slope factor. Latent intercept and slope factors were allowed to correlate and an autoregressive error structure was modeled for ages 19–22. This model allowed for testing the indirect effects (via effects on ASI growth parameter) of intervention condition, risk, and their interaction on adult substance misuse growth patterns.

Estimation details—Analyses were performed with Mplus 6.1 (Muthén & Muthén, 1998–2010). In the current study, adolescents were clustered within schools. Accordingly, school was included as a higher-level cluster variable in the analyses by specifying MODEL = COMPLEX in the Mplus language, which adjusts standard errors to account for the intra-unit dependency. Robust maximum likelihood estimation addressed effects of non-normality and non-independence of observations. Mplus also computes full-information maximum likelihood (FIML) 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 available data (Muthén, Kaplan, & Hollis, 1987; Wothke, 2000). Analyses were restricted to those who provided information on the exogenous predictor variables in the model (i.e., intervention condition and risk, as well as cluster [school]); for SFP 10–14 + LST versus Control, $N = 984$ and for LST-only versus control, $N = 1061$. Within these restrictions, missing data averaged around 15%. Model fit was evaluated using the root mean square error of approximation (RMSEA: Steiger & Lind, 1980), the comparative fit index (CFI: Bentler, 1988), and the chi-square, with a RMSEA $.05$ and a CFI $.96$ and indicating good model fit (Hu & Bentler, 1999). Differences between nested models were evaluated with the Yuan-Bentler T^2 * Chi-Square test statistic, an empirically-supported test developed to adjust for cluster sampling and conditions of multivariate non-normality (Fouladi, 2000; Muthén & Muthén, 1998–2010).

Following estimation of the models focusing on the indirect effects of the interventions and risk, subsequent model testing was conducted to examine direct effects of these factors. For this analysis, direct effect paths from intervention, risk, and their interaction to the young adult substance misuse growth parameters were added to the initial, indirect effects-focused model. Results from the models were then examined with regard to the significance of the direct and indirect effects, and overall model fits were compared to the corresponding initial models. Model fit was compared. (The Mplus codes for specific analyses are available from the first author.)

Supplemental Analyses—Finally, analyses were conducted to estimate the practical significance of the intervention effects on the full sample and on those classified as higher-risk. Dichotomous variables were constructed by establishing cut-points for each outcome variable at the age 22 time point to represent caseness—indicating the degree to which use of the substance could have public health consequences. Cut-points were based on health-related consequences of use (see Spoth et al., 2009) and were: drunkenness at greater than once per month; one or more (of ten) alcohol-related problems; smoking cigarettes during the past year; and illicit substance use during the past year. Intervention effects on the dichotomous outcomes were estimated by applying a similar model as the one illustrated in Figure 1 (with or without additional direct effects, based on overall model fit results), substituting a point-in-time (age 22) dichotomous outcome for the growth factors of the continuous outcomes. Relative reduction rates (RRR), were computed from the estimated percentages of those above the cut-off in the intervention and control condition groups.

Results

Tables of means and standard deviations of the study variables during adolescence and in young adulthood by intervention condition and risk are available as a supplement at _____. Covariance matrices for the analyses are available upon request from the first author.

Results of the analyses testing the model in Figure 2 are provided in: (1) Table 1, which presents the fit statistics of the outcome models; (2) Table 2, which presents the parameter estimates, including the indirect intervention and intervention $\times$ risk effects; (3) Figure 3, which illustrates the effects of intervention condition and risk on the adolescent growth factors; and (4) Figure 4, which illustrates the indirect effects on the young adult outcomes.

An examination of the fit indices in Table 1 suggests that the models adequately fit the observed data across the young adult outcomes evaluated. Although the chi-square values were significant, the CFI and RMSEA values indicated a generally good fit with the data. Replicating and extending earlier results concerning intervention effects on substance initiation across adolescence (Spoth et al., 2009), an examination of the model parameters presented in Table 2 shows that both intervention and intervention $\times$ risk effects on the adolescent ASI growth factors (intercept and slope) were either significant or marginally significant in each model, suggesting both overall intervention effects and risk moderation of intervention effects across adolescence. Intervention condition participants demonstrated a lower average level of ASI overall and a slower rate of growth than did control condition participants, and risk moderation results indicated lower levels of ASI and a slower rate of growth for the higher-risk intervention participants compared with the higher-risk control participants (see Figure 3). This was the case for both the SFP 10–14 + LST intervention and the LST-only intervention.

Indirect Intervention Effects on Young Adult Substance Misuse

Drunkenness—For both the SFP 10–14 + LST and LST-only conditions, the indirect effects of intervention (SFP 10–14 + LST $\beta = -.061, p < .001$; LST-only $\beta = -.061, p = .001$) and intervention $\times$ risk (SFP 10–14 + LST $\beta = -.057, p < .002$; LST-only $\beta = -.045, p$

= .008) on the young adult drunkenness *intercept* were significant, indicating that the average young adult levels of drunkenness were lower in the intervention groups than in the control group, and that the intervention-control difference among higher-risk participants was larger than the intervention-control difference among lower-risk participants. Conversely, indirect intervention effects on the *slopes* of young adult drunkenness were positive and marginally significant for both intervention conditions, suggesting that the intervention-control difference in level of drunkenness was decreasing across the young adult period assessed. The indirect effect of the intervention $\times$ risk interaction on the slope also was positive and marginally significant for the SFP 10–14 + LST model. Nonetheless, model estimation indicated that control condition participants demonstrated higher levels of drunkenness at each young adult time point, with stronger results for the higher-risk subsample (see Figure 4a).

Alcohol-related problems—As was the case with drunkenness, the indirect effects of intervention (SFP 10–14 + LST $\beta = -.038$, $p = .007$; LST-only $\beta = -.039$, $p = .008$) and the intervention $\times$ risk interaction (SFP 10–14 + LST $\beta = -.039$, $p < .001$; LST-only $\beta = -.029$, $p = .003$) on the young adult alcohol-related problems *intercept* were significant and negative in both the SFP 10–14 + LST and LST-only analyses, indicating that the intervention group participants had lower overall levels of alcohol-related problems during the young adult period and that those intervention effects were stronger among higher-risk participants. The SFP 10–14 + LST intervention effect on the young adult *slope* factor was positive but non-significant, while the intervention $\times$ risk interaction was positive and significant ($\beta = .030$, $p = .043$). For the LST-only intervention, the indirect effect of the intervention on the young adult *slope* was positive and significant ($\beta = .034$, $p = .015$), as was the intervention $\times$ risk indirect effect ($\beta = .024$, $p = .036$). The overall pattern of results across time indicated that the control condition participants, especially the higher-risk group, demonstrated higher levels of alcohol-related problems across the young adult measurement period for both intervention conditions versus control (consistent with the significant intervention effects on the young adult alcohol-related problems intercept), but those differences decreased at all young adult time points (as did the overall average level of alcohol-related problems; see Figure 4b).

Cigarette use—The pattern of indirect effects on cigarette use indicated significant indirect negative effects of the interventions (SFP 10–14 + LST $\beta = -.070$, $p = .011$; LST-only $\beta = -.098$, $p < .001$) and the intervention $\times$ risk interactions (SFP 10–14 + LST $\beta = -.079$, $p < .001$; LST-only $\beta = -.080$, $p = .005$) on the *intercept* of young adult cigarette use, indicating lower levels of use for the intervention participants, overall, and stronger intervention effects among higher-risk participants compared with higher-risk control participants. There were no significant effects of the intervention or intervention $\times$ risk interaction on the cigarette use *slope* (see Figure 4c).

Illicit substance use—As was the case for other young adult substance outcomes, the indirect intervention (SFP 10–14 + LST $\beta = -.049$, $p = .075$; LST-only $\beta = -.047$, $p = .033$) and intervention $\times$ risk interaction (SFP 10–14 + LST $\beta = -.059$, $p = .002$; LST-only $\beta = -.040$, $p = .049$) effects were negative and significant or marginally significant for the young

adult illicit substance use *intercept*, indicating a lower level of illicit substance use for intervention condition participants overall, with stronger intervention effects among higher- versus lower-risk participants. Effects of the intervention and intervention $\times$ risk interaction on the illicit substance use *slope* were non-significant (see Figure 4d).

Direct Intervention Effects

Drunkenness—The addition of *direct* effects of intervention, risk, and their interaction on young adult drunkenness growth factors into the initial model did not produce a significant improvement in model fit for either the SFP 10–14 + LST or LST-only models of drunkenness.

Alcohol-related problems—As was the case for drunkenness, adding direct effects to the models for this alcohol-related outcome did not produce a significant improvement in fit for either the SFP 10–14 + LST or LST-only models.

Cigarette use—The inclusion of direct effects in the models of cigarette use produced a significant improvement in overall model fit for both intervention conditions (SFP 10–14 + LST $\chi^2_{(6)} = 15.337, p = .018$; LST-only $\chi^2_{(6)} = 30.778, p < .001$). For SFP 10–14 + LST, direct effects on the young adult *intercept* from both intervention ($\beta = -.138, p = .015$) and intervention $\times$ risk ($\beta = -.123, p = .012$) were negative and significant. Likewise, for the LST-only interventions the direct negative intervention ($\beta = -.194, p < .001$) and intervention $\times$ risk effect ($\beta = -.196, p < .001$) on the young adult *intercept* were statistically significant. For both models, direct effects on the young adult *slopes* were non-significant. For both the SFP 10–14 + LST and LST-only models, indirect effects on the young adult *intercept* remained significant when the direct effects were added to the models and the total effects of both intervention and intervention $\times$ risk increased.

Illicit substance use—In the case of illicit substance use, adding direct effects to the indirect effects models resulted in an improvement in model fit for both intervention conditions (SFP 10–14 + LST $\chi^2_{(6)} = 17.590, p < .007$; LST-only $\chi^2_{(6)} = 32.438, p < .001$). For SFP 10–14 + LST, the direct negative intervention effect on the *intercept* was non-significant; however, the direct negative effect of intervention $\times$ risk was significant ($\beta = -.177, p = .027$). The total negative effect on the intercept increased for both intervention and intervention $\times$ risk, the indirect intervention effect on the intercept decreased to marginally significant, while the intervention $\times$ risk indirect effect remained significant. For the LST-only intervention, the direct intervention effect on the *intercept* was marginally significant ($\beta = -.162, p = .074$) and the direct intervention $\times$ risk effect was significant ($\beta = -.190, p = .022$). Adding direct effects increased the total negative effects of both intervention and intervention $\times$ risk on the intercept, but lowered the significance levels of the indirect effects to non-significance. For both models, direct effects of intervention and intervention $\times$ risk on the young adult *slopes* were nonsignificant.

Relative Reduction Rates

To assist in the interpretation of the potential public health impact of the tested interventions, the models were re-estimated using age 22 point-in-time dichotomized

variables as outcomes. For each measure, the model employed was either the indirect-effects-only model or the model that also included direct intervention and intervention $\times$ risk effects, based on whether or not the inclusion of the direct effects improved overall model fit. Based on these models, relative reduction rates (RRRs) for the total sample and for the higher risk participants were calculated by subtracting the estimated percentage above the cut-off in the intervention condition from the estimated percentage above the cut-off in the control condition, then dividing by the control condition percentage. RRRs can be used to approximate the percentage of those in an intervention school district who could avoid a substance misuse problem that they otherwise likely would develop if they were enrolled in a school district not offering the intervention, assuming intervention-related conditions similar to those in the study. Table 3 displays the RRRs calculated from the model-based estimates and indicates generally comparable preventive benefits for both intervention groups. The comparatively low RRRs for the alcohol-related outcomes are reflective of the generally weaker intervention effects found for those outcomes.

Discussion

As summarized in the introduction, more frequent and problematic substance use occurs in young adulthood and can result in substantial social, health, and economic consequences. Despite the magnitude of these consequences, there is a gap in the intervention knowledge base concerning the possible benefits of interventions implemented during young adolescence on the reduction of substance-related problems during young adulthood, particularly the benefits of universal interventions. The purpose of this study was to address that gap by replicating and extending the findings from an earlier prevention trial that had examined the effects of universal preventive interventions for young adolescents into young adulthood, nearly 10 years past baseline.

To place the purpose of this study and its findings in context, the last NRC & IOM report on the prevention of a range of disorders, including substance-related ones (NRC & IOM, 2009a), concluded that preventive interventions hold promise for enhancing healthy development and achieving public health impact. Universal preventive interventions were represented as having significant potential in this regard (see pages 160–178). The conclusions are based on a critical review of the empirical evidence in the literature published from the time an earlier report was issued in 1994. Based on the empirical evidence, the 2009 report encourages broader dissemination of evidence-based intervention. More recent supportive findings for universal intervention are reviewed by Spoth, Rohrbach, Greenberg and colleagues (2013).

To further examine the potential of a universal preventive intervention, as suggested by the 2009 NRC & IOM prevention report, we tested a longitudinal developmental model. Basically, epidemiological data concerning age-related patterns of substance misuse through young adulthood guided the articulation of a model testing indirect intervention effects mechanisms, focusing on adolescent substance initiation as a key mechanism through which interventions exert effects across developmental stages (illustrated in Figure 1; see also Spoth et al., 2009). An important question raised by the present and earlier report on the hypothesized developmental model concerns the implications of the complex interplay of

developmental pathways for intervention effects model testing. Earlier we argued that consideration of salient factors in developmental model testing warranted the type of parsimonious model we articulated. That is, there are challenging factors to consider in developmental modeling of long-term intervention effects, including: (1) the complex interplay of physical, affective, cognitive, and social developmental processes across the early adolescence, later adolescence, and young adulthood stages; (2) the related wide range of possible mechanisms of young adolescent intervention effects that either naturally attenuate over time or, in contrast, become stronger via a developmental cascade (Masten et al., 2005); and (3) the previously-discussed methodological and measurement issues in the evaluation of long-term universal intervention effects (e.g., complexity of modeling chains of effects, compounding of error across measures, differing assessment instruments).

Considering these issues in developmental model testing, along with the earlier empirical demonstration that most indirect effects are captured by incorporating adolescent substance initiation into the developmental model, it is instructive that the parsimonious model testing approach adopted here was generally supported. Nonetheless, results from adding direct effects to the models suggested that additional intervention factors might well be operative during young adulthood (e.g., in the case of both cigarette and illicit substance use) and indicate the need for subsequent investigation. More specifically, results of analyses supported the initially tested indirect effects model, particularly on the average level of adult use. Model testing provided evidence of the hypothesized indirect effects of universal family- and school-based interventions designed to prevent adolescent substance misuse, through 9.5 years past baseline (age 22). Indirect effects on the young adult outcome variables were shown, through growth factors of adolescent substance initiation; specifically, significant indirect effects of both the intervention and the intervention $\times$ risk interactions were demonstrated on the average level (across ages 19–22) of each outcome (Table 2).

The pattern of intervention-related effects on the rate of change in substance use during the young adult period assessed was weaker and more varied (see Figure 4 for illustrations). Overall, findings suggested only modest positive or negative changes in overall substance misuse across time for the age 19 to 22 year period, with a gradual closing of the intervention-control gap for some outcomes; most notably, analyses of alcohol-related problems showed that the positive intervention and intervention $\times$ risk effects on the young adult substance misuse slope were significant (see Figure 4d). For that outcome, the pattern of findings suggested a trend toward decreasing problems among higher-risk participants overall, with a concomitant decrease in the magnitude of the intervention-control difference among those participants. Those findings likely are reflective of previously found trends toward a decrease in misuse of some substances as people progress through young adulthood (Johnston et al., 2012). Though the relevant effects were not significant, a similar pattern was observed for illicit substance use (see Figure 4d).

Consistent with the hypothesized, primarily indirect intervention effect mechanisms, examination of adding *direct* intervention and intervention $\times$ risk effects yielded a mixed pattern of results. For drunkenness and alcohol-related problems, including direct effects in the modeling process did not produce a significant difference in model fit, indicating that the

intervention and intervention $\times$ risk effects were primarily indirect, through effects on adolescent substance initiation. Conversely, results for cigarette and illicit substance use indicated significant direct negative effects for one or both intervention conditions on the average levels across time, as well as significant direct negative intervention $\times$ risk effects on the outcomes. Including direct effects in the models improved overall model fit as well, suggesting that—in addition to intervention effects transmitted into young adulthood via adolescent substance initiation—there were intervention factors that remained directly relevant to cigarette and illicit substance use in young adulthood. For example, the interventions targeted a number of specific beliefs, attitudes, and skills that could influence choices regarding illicit substance use, such as assertiveness, decisionmaking, communication, normative beliefs, substance refusal skills, and general social skills (see Redmond et al., 2009; Trudeau, Lillehoj, Spoth, & Redmond, 2003) that may be salient during young adulthood when new exposures to substance-using peers and opportunities to use occur.

Although the present replication and extension of the developmental model generally supported the hypothesized indirect effects as the primary mechanisms of effects, results differed from the earlier test (Spoth et al., 2009) of the model in that the proximal direct intervention effects found in the current study were primarily on the adolescents' initiation slope, with comparatively weaker effects on initiation level (intercept) during adolescence. This is likely due to the inclusion of the intervention $\times$ risk term (not included in the earlier study's analysis), which appeared to account for most of the intervention effects on the adolescent substance initiation slope. The current model also differs from the earlier model in its inclusion of young adult growth parameters, rather than just point-in-time young adult outcomes. The general lack of substantial intervention effects on young adult substance use slopes is likely largely due to the generally flatter levels of use reported during the young adult period addressed. Nonetheless, significant intervention-control differences in the mean levels of use across the period, either through indirect or indirect plus direct pathways, persisted for most outcomes, confirming and extending the earlier results.

Generally, the pattern of effects on the two intervention conditions were similar, consistent with follow up assessments subsequent to those conducted 1.5 years past baseline (which showed more significant effects of the combined SFP 10–14 + LST intervention; Spoth et al., 2008). Comparable findings for the LST-only intervention in the current analysis suggest that the differences observed early on diminished over time and have remained comparable through the young adult period. In this regard, it should also be noted that the SFP 10–14 participation rate among families in the SFP 10–14 + LST intervention condition was approximately 25%. Although that rate is high relative to typical community-based program recruitment rates, the fact that the majority of eligible families did not participate in the family-focused program likely contributes to the similarity in findings for the two intervention groups.

Also of note was the generally consistent pattern of results concerning the intervention $\times$ risk interaction effects. Those results suggest comparatively greater intervention benefits for those at higher risk for substance misuse which endured across adolescence and into young adulthood. This pattern of findings is consistent with earlier findings based on the current

and other samples showing stronger effects of universal interventions for higher-risk study participants (Spoth et al., 2008). It is not clear whether this is due to increased salience of intervention content for early substance initiating youth or their parents, or due to a “floor” effect among lower-risk youth who were less likely to misuse substances with or without preventive intervention.

The more robust intervention effects for higher-risk participants are underscored by the RRRs presented in Table 3, which are considerably larger than those observed for the full sample. These RRRs suggest the practical significance of universal interventions for helping to prevent substance misuse among those at elevated risk for such problems. And more generally, even the relatively smaller RRRs found for the full sample suggest potential public health benefits from the widespread implementation of modest-intensity universal interventions like those evaluated in the current study. Such interventions are relatively inexpensive to implement, can reach broad audiences (particularly in the case of school-based interventions), require no participant risk-based screening, and can reduce problems that are both very expensive from an economic standpoint, and result in considerable quality of life costs for those experiencing the problems, as well as for those close to them.

Readers should remain cognizant of the limitations in the study. A primary limitation of the current study concerns the generalizability of results based on the predominantly White, rural sample. Although it seems likely that the global pattern of relationships among variables found in the current study would generalize to other populations as well, that remains to be verified through future research. In addition, there might be differences in the substance-specific pattern of findings, depending on what substances are normative for a particular population at a particular point in time. Other cautions include issues typical of community-based longitudinal effectiveness trials, including sample attrition and reliance on self-reported substance use behaviors. Nonetheless, prior analyses addressing differential attrition, the use of full information analytic techniques, and research supporting the validity of substance use self-reports (Elliott, Ageton, Huizinga, Knowles, & Canter, 1983; Kraus & Augustin, 2001; Smith, McCarthy, & Goldman, 1995) help bolster confidence in the current results.

In conclusion, there was general support for the replication and extension of the proposed developmental model of positive effects on reduced substance misuse in young adulthood through delayed initiation in adolescence. The observed variations in the pattern of findings (mixed direct and indirect effects) across outcomes is likely the result of many factors reflecting complex developmental processes and the inclusion of developmental risk-related factors in the model. In this context, it is worthy of note that some of the variation in the pattern of findings also may relate to implementing preventive interventions in the present study that differed from the intervention used in the earlier study. In addition, the tested model differed from the earlier model by examining growth (intercept and slope) in two consecutive developmental phases and incorporating risk-related moderation effects. Among the notable findings within the variable pattern of results are the direct intervention effects that lasted into young adulthood, across the study period of 9.5 years. Importantly, the findings comport with the conclusions of the recent literature reviews on the potential public health benefits of broader implementation of preventive interventions cited in the

introduction, underscored by the relative reduction rates observed in this study, especially for the high-risk participants. Overall and most importantly, this study further supports consideration of the large-scale implementation of universal preventive interventions during early adolescence to prevent substance misuse into young adulthood.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Young adult indirect intervention effects outcome model, mediated through adolescent substance initiation

Age 19 Follow-up 12 school districts (clusters) Mean cluster size: 31 Cluster size range: 13-41	Age 19 Follow-up 12 school districts (clusters) Mean cluster size: 30 Cluster size range: 15-56	Age 19 Follow-up 12 school districts (clusters) Mean cluster size: 34 Cluster size range: 17-61
Age 20 Follow-up 12 school districts (clusters) Mean cluster size: 31 Cluster size range: 15-41	Age 20 Follow-up 12 school districts (clusters) Mean cluster size: 31 Cluster size range: 15-60	Age 20 Follow-up 12 school districts (clusters) Mean cluster size: 35 Cluster size range: 17-62
Age 21 Follow-up 12 school districts (clusters) Mean cluster size: 31 Cluster size range: 14-44	Age 21 Follow-up 12 school districts (clusters) Mean cluster size: 31 Cluster size range: 16-57	Age 21 Follow-up 12 school districts (clusters) Mean cluster size: 35 Cluster size range: 19-64
Age 22 Follow-up 12 school districts (clusters) Mean cluster size: 32 Cluster size range: 14-44	Age 22 Follow-up 12 school districts (clusters) Mean cluster size: 31 Cluster size range: 15-58	Age 22 Follow-up 12 school districts (clusters) Mean cluster size: 36 Cluster size range: 17-64

Figure 2.

Study participation by wave

Notes: LST = Life Skills Training. SFP 10–14 + LST = Strengthening Families Program: For Parents and Youth 10–14 + Life Skills Training. Participation in the SFP 10–14 or SFP 10–14 + LST condition was 25%. Participation in a given wave of data collection was not contingent on participation in a prior wave (all enrolled students in the targeted grade were recruited for participation at each wave). The enrolled samples showed considerable stability from year to year; however, we eliminated from the sample those students who changed conditions (i.e., moved from a school district in one condition into one in a different condition) to preserve randomization ($n = 18$). Following high school, a selected sample was assessed, based on their participation in previous waves (i.e., those present at the pretest and the 11th and/or 12th grade data collection, plus any others who participated in in-home family assessments during adolescence; total eligible $n = 1410$).

Figure 3.
Adolescent substance initiation by condition and risk

Young Adult Drunkenness Frequency: SFP: 10-14 + LST Condition and Risk

Young Adult Drunkenness Frequency: LST Condition and Risk

a

Young Adult Alcohol-Related Problems: SPF: 10-14 + LST Condition and Risk

Young Adult Alcohol-Related Problems: LST Condition and Risk

b

Figure 4.

Young adult substance misuse outcomes by condition and risk: (a) Drunkenness, (b) Alcohol-Related Problems, (c) Cigarette Use, (d) Illicit Drug Use

Table 1

Fit statistics for Indirect Effects Model of young adult substance misuse outcomes

Outcome	Fit Statistics			
	N	X ² (df)	CFI	RMSEA [90% CI]
Drunkenness				
SFP 10–14+LST vs Control	984	157.08(60)**	.977	.041 [.033, .048]
LST vs Control	1061	184.15(60)**	.978	.044 [.037, .052]
Alcohol-Related Problems				
SFP 10–14+LST vs Control	984	129.52(60)**	.982	.034 [.026, .042]
LST vs Control	1061	153.38(60)**	.982	.038 [.031, .046]
Cigarettes				
SFP 10–14+LST vs Control	984	126.57(60)**	.984	.034 [.025, .042]
LST vs Control	1061	139.05(60)**	.984	.035 [.028, .043]
Illicit Substance Use				
SFP 10–14+LST vs Control	984	116.43(60)**	.969	.031 [.022, .039]
LST vs Control	1061	160.82(60)**	.962	.040 [.032, .047]

**
p<.01

Table 2

Indirect Effects Model: Effect paths and indirect effects of Intervention and Intervention×Risk on young adult outcome growth parameters

Outcome	Model Effect Paths						Indirect Effects on Young Adult Substance Growth Parameters					
	a (CI)	b (CI)	a' (CI)	b (CI)	c (CI)	d (CI)	e (CI)	f (CI)	Intervention Effects on:		Int×Risk Effects on:	
									Intercept	Slope	Intercept	Slope
Drunkenness												
SFP+LST vs Control	-.070 ⁺ (-.135,-.006)	-.178 ^{***} (-.253,-.102)	-.092 ^{**} (-.141,-.043)	-.151 ^{**} (-.241,-.061)	.156 ⁺ (.016,.297)	.282 ^{***} (.181,.383)	-.189 (-.499,.120)	-.187 (-.481,.107)	-.061 ^{***} (-.087,-.035)	.046 ⁺ (.002,.091)	-.057 ^{**} (-.087,-.027)	.046 ⁺ (.005,.086)
LST vs Control	-.086 [*] (-.141,-.031)	-.184 ^{**} (-.272,-.097)	-.068 [*] (-.119,-.017)	-.131 [*] (-.226,-.036)	.222 [*] (.081,.364)	.225 ^{**} (.109,.342)	-.079 (-.254,.096)	-.161 (-.356,.034)	-.061 ^{**} (-.090,-.032)	.036 ⁺ (.005,.067)	-.045 ^{**} (-.072,-.017)	.026 (-.001,.054)
Alcohol-Related Problems												
SFP+LST vs Control	-.072 ⁺ (-.138,-.006)	-.182 ^{***} (-.259,-.104)	-.093 ^{**} (-.142,-.044)	-.154 ^{**} (-.243,-.065)	.211 ^{**} (.079,.343)	.125 ⁺ (-.019,.231)	-.115 (-.278,.048)	-.128 (-.334,.078)	-.038 ^{**} (-.061,-.015)	.032 (-.003,.066)	-.039 ^{***} (-.058,-.020)	.030 [*] (.006,.055)
LST vs Control	-.089 ^{**} (-.142,-.035)	-.192 ^{***} (-.275,-.108)	-.070 [*] (-.121,-.019)	-.134 [*] (-.227,-.041)	.227 ^{***} (.129,.326)	.098 (-.011,.208)	-.032 (-.155,.091)	-.164 ⁺ (-.311,-.017)	-.039 ^{**} (-.063,-.015)	.034 [*] (.011,.057)	-.029 ^{**} (-.045,-.013)	.024 [*] (.005,.043)
Cigarettes												
SFP+LST vs Control	-.091 [*] (-.158,-.024)	-.195 ^{***} (-.275,-.115)	-.109 ^{***} (-.155,-.062)	-.167 ^{**} (-.254,-.080)	.594 ^{***} (.462,.727)	.083 (-.040,.205)	-.077 (-.273,.119)	.112 (-.177,.402)	-.070 [*] (-.116,-.025)	-.015 (-.055,.025)	-.079 ^{***} (-.113,-.044)	-.010 (-.038,.018)
LST vs Control	-.109 ^{**} (-.170,-.048)	-.211 ^{***} (-.297,-.126)	-.094 ^{**} (-.149,-.038)	-.161 ^{**} (-.251,-.070)	.507 ^{***} (.357,.656)	.204 [*] (.064,.344)	-.165 (-.347,.016)	.185 (-.095,.465)	-.098 ^{***} (-.142,-.054)	-.021 (-.066,.023)	-.080 ^{**} (-.127,-.033)	-.014 (-.044,.015)
Illicit Substance Use												
SFP+LST vs Control	-.088 [*] (-.162,-.015)	-.197 ^{***} (-.279,-.115)	-.112 ^{***} (-.159,-.064)	-.172 ^{**} (-.259,-.085)	.471 ^{***} (.256,.685)	.037 (-.178,.252)	-.057 (-.205,.091)	-.106 (-.325,.113)	-.049 ⁺ (-.094,-.004)	.026 (-.010,.062)	-.059 ^{**} (-.091,-.027)	.025 (-.005,.054)
LST vs Control	-.110 ^{**} (-.170,-.049)	-.216 ^{***} (-.303,-.129)	-.091 ^{**} (-.144,-.039)	-.159 ^{**} (-.249,-.069)	.543 ^{***} (.364,.723)	-.060 (-.246,.126)	.006 (-.227,.238)	-.121 (-.390,.148)	-.047 [*] (-.082,-.011)	.026 (-.017,.068)	-.040 [*] (-.074,-.007)	.019 (-.014,.051)

⁺ p<.10;
^{*} p<.05;

p<.01;

p<.001

CI: 90% Confidence Interval

Note: Refer to Figure 1 for identification of model parameters a-f.

Table 3

Relative reduction rates for age 22 variables by intervention condition: Full sample and higher risk subsample

Variable	SFP:10-14 + LST RRR	LST RRR
Drunkenness		
Full Sample	2.3%	4.2%
Higher Risk	13.4%	13.5%
Alcohol-Related Problems		
Full Sample	0.9%	1.6%
Higher Risk	5.8%	6.0%
Cigarette Use		
Full Sample	3.8% [§]	12.1% [§]
Higher Risk	23.0% [§]	36.4% [§]
Illicit Substance Use		
Full Sample	0.2%	3.5%
Higher Risk	16.9%	13.4%

Note Drunkenness at greater than once per month; alcohol-related problems at one or more out of ten, cigarettes at greater than no use during the past year; illicit substance use at greater than no use during the past year.

RRR = relative reduction rate calculated from the model-based estimates.

[§]The best-fitting model included direct effects from the intervention condition, risk, and the intervention condition × risk interaction.