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Examining Intervention Component Dosage Effects on Substance Use Initiation in the Strengthening Families Program: For Parents and Youth Ages 10–14

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Abstract

Family-based prevention programs increasingly are being disseminated and can be effective for an array of adolescent problem behaviors, including substance use initiation. Yet, we continue to have little understanding of how and why these programs work. Increased specificity in our understanding of what components drive program effects can facilitate refinement of programs, with potential for greater impact at a lower cost. Using attendance data, previously coded intervention components, and a previously developed propensity model to adjust for potential bias, this study evaluated content component-specific dosage effects of the Strengthening Families Program: For Parents and Youth Ages 10–14 on three substance use initiation outcomes by Grade 12. Results indicated that greater dosages of program content related to (a) parental monitoring and behavior management strategies and (b) promoting positive family relationships had potent and robust effects on reduction of risk for initiating drunkenness and marijuana use and (c) self-regulation and stress management had potent and robust effects on reduction of risk for initiating cigarette and marijuana use. Results indicate potential critical components within SFP 10–14, and offer a path forward for continuing work in efforts to optimize this widely-disseminated program.

Keywords

Family-Based Intervention; Substance Use Prevention; Propensity Scores; Component Analysis

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Disclosure of Potential Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent/assent were obtained from all adolescents/parents included in the study.

Introduction

Substance use during adolescence has long-term implications for development. Early substance use initiation is an established risk factor for a host of poor outcomes, including substance use disorder during adulthood, risky sexual behaviors, and delinquency (Chassin, 2008; Odgers et al., 2008). In addition to interfering with optimal individual development, adolescent substance use places significant economic burdens on society (Degenhardt, Stockings, Patton, Hall, & Lynskey, 2016). Alternatively, postponing substance use initiation until late adolescence/early adulthood is associated with decreased probability of lifetime dependence and substance use problems (DeWit, Adlaf, Offord, & Ogborne, 2000).

The individual and societal implications of adolescent substance use have motivated the development of many family-based preventive interventions that are effective in reducing risk for substance use initiation and escalation (Van Ryzin & Fosco, 2016). Yet, after decades of implementing these programs, we still do not know exactly how or why they have their effects (Sandler, Schoenfelder, Wolchik, & Mackinnon, 2011; Van Ryzin & Fosco, 2016). A deeper understanding of the drivers of program effects can guide refinements to the next generation of family-based interventions aimed at maximizing effects at reduced costs.

Drivers of Family-Based Interventions: The State of the Science

The evidence-based intervention movement (e.g. Chambless & Hollon, 1998) prompted preventive intervention researchers to write manuals to standardize interventions and to facilitate uptake, rigorous evaluation, and replication across settings and research groups. In fact, the manualization of interventions is now a key requirement to establish a program as evidence-based (Gottfredson et al., 2015). Intervention manuals provide a structure for practitioners to administer programs with fidelity, an implementation factor that has been shown to predict intervention effects (Forgatch, Patterson, & DeGarmo, 2005; Hukkelberg & Ogden, 2013). With manualization now standard practice in intervention development and evaluation, we have gained valuable information about the effectiveness of interventions as a whole; however, this approach does not allow for evaluations of the efficacy of individual program components within a given intervention, unless other methods are applied (De Martini-Scully, Bray, & Kehle, 2000).

One approach to evaluating *how* family-based interventions impact adolescent behavioral outcomes focuses on mediating processes (Kazdin, 2007). When thoughtfully applied, tests of mediation can assess both the theoretical blueprint of a program (e.g., a logic model) and the application of these theoretical blueprints through empirical processes (Fairchild & Mackinnon, 2014). Logic models articulate the translation of developmental models of risk and protective factors into “proximal targets” for a given intervention. If the logic model is correctly specified, intervention effects on proximal targets (e.g., parenting skills) will have down-stream effects on distal outcomes (e.g., substance use initiation). Thus, understanding intervention effects on theorized mediators allows us to confirm the guiding developmental theory of risk as represented in a logic model (Dishion & Patterson, 1999).

Evidence on mediators of preventive interventions for substance use in early adolescence has improved understanding of how programs have their effects on later substance use. For example, improvements in parental monitoring have been shown to mediate the effects of Multidimensional Family Therapy on adolescent abstinence from substance use (Henderson, Rowe, Dakof, Hawes, & Liddle, 2009). Other mechanisms of change may exist, such as increasing adolescents' self-regulation (Fosco, Frank, Stormshak, & Dishion, 2013) or delaying substance use initiation (Spoth, Trudeau, Guyll, Shin, & Redmond, 2009), both of which have been found to explain intervention effects on later levels of substance use. Mediational studies offer important insights into whether the program – in its entirety – elicits change in proximal outcomes. However, mediational studies do not differentiate between programs as a whole and individual components that are offered within the program (Hanisch, Hautmann, Plück, Eichelberger, & Döpfner, 2014). Component analysis approaches offer additional insight into how interventions evoke changes and can guide intervention refinement. A key benefit of component analysis approaches is that they focus on identifying the "critical ingredients" in an intervention that account for changes in outcomes. Knowledge of the specific program components that drive changes in outcomes would allow for more focused programs that target desired effects (Kazdin, 2007).

By optimizing existing evidence-based programs, it is possible to save time, reduce costs, and reduce agency and participant burden. Moreover, reducing intervention time may help address a key barrier to families' commitment and adherence to programs (Fosco et al., 2014). Reducing program length also may improve feasibility of implementation fidelity, thereby yielding stronger results (i.e. less adolescent substance use) in real-world settings (Franks & Schroeder, 2013). Component analyses of established programs represent an important approach to optimizing interventions to be more effective and less costly, while preserving fidelity.

Optimization approaches are emerging, such as the Multiphase Optimization Strategy (MOST; Collins, Murphy, Nair, & Strecher, 2005), to evaluate the most promising intervention components through iterative experimental procedures to build programs suitable for evaluation as a package. Tools such as MOST are uniquely positioned to guide program developers in creating interventions that balance efficiency and effect sizes. Thus, the MOST design is well-suited for the development of programs from conception, or re-visiting existing programs at a component level. In the current study, we leveraged quasi-experimental methods with existing data to evaluate whether there is potential promise in streamlining an existing and widely implemented preventive intervention program.

Family-Based Intervention Program Content

Family-based preventive interventions vary in composition and intensity, but they often have similar core components. These similarities provide an opportunity to study across programs and identify specific components and their effects on adolescent and family outcomes. In their component-centered meta-analysis, Van Ryzin and his colleagues (2016) developed and implemented a reliable coding system to capture 10 distinct program components that may be delivered, to varying degrees, across family-based interventions for adolescent substance use. The coding system was developed after reviewing intervention content across

programs and identifying theory-based core components of the identified 116 family-based, adolescent substance use prevention programs (Van Ryzin et al., 2016). This system reliably coded the quantity of content delivered in the following categories: (1) parental monitoring and behavior management, (2) fostering school success, (3) positive family relationships, (4) substance use, knowledge, attitudes, and values, (5) self-regulation and stress management, (6) problem solving, (7) resisting peer risk, (8) psycho-education on adolescent development, (9) ethnic identity, and (10) future orientation. Each of these categories of program content reflect core dimensions of evidence-based family-focused preventive interventions. For example, parental monitoring *(1)*, the tracking and knowledge of where youth are and what they are doing, often declines during adolescence. Inadequate parental monitoring during this time predicts adolescent problem behavior, including substance use (Eiden et al., 2016; Fosco, Stormshak, Dishion, & Winter, 2012). Adolescents who have poor self-regulation skills *(5)* are at elevated risk for a host of problem behaviors, including substance use (Fosco et al., 2013; Gardner, Dishion, & Connell, 2008; Trentacosta & Shaw, 2009). Problem solving content *(6)* targets skills in handling family conflict, an established risk factor for adolescent marijuana use, alcohol use, and binge drinking (Cordova et al., 2014). Although theory and empirical findings support including these intervention targets in programs, there is a dearth of evidence evaluating each component content individually for effects on adolescent substance use.

The Present Study

The goal of this study was to strengthen our ability to estimate the causal effects of exposure to specific content within the Strengthening Families Program: For Parents and Youth Ages 10–14 (SFP 10–14; Kumpfer, Molgaard, & Spoth, 1996). Using attendance records from the PROSPER (PROmoting School-community-university Partnerships to Enhance Resilience) trial of SFP 10–14 and previously coded SFP 10–14 component content, we calculated exposure time to each program component content for each family enrolled in the intervention. This component analysis aims to assess whether the receipt of higher levels of specific program content exposure decreases the likelihood of initiating three different substances by the end of high school.

Component analyses of intervention programs have historically been plagued by concerns about the large number of confounders that might undermine the validity of their results (Crowley, Coffman, Feinberg, Greenberg, & Spoth, 2014; Liddle, 2004). Leveraging naturally occurring exposures of an intervention as a predictor of outcomes can pose a threat to validity, because these exposures are intrinsically tied to program attendance which may reflect individual differences in risk factors (e.g., poorer attendance may be due to family disorganization). Considerable work has been devoted to identifying the confounders and sociodemographic barriers associated with program attendance; Family SES, race and ethnicity (Dumas, Moreland, Gitter, Pearl, & Nordstrom, 2008), family functioning (Fleming et al., 2015), and marital status (Gross, Julion, & Fogg, 2001) have each been found to explain variability in attendance (Spoth & Redmond, 1995). Further, there are additional potential confounding factors, such as existing youth problem behavior, that may interfere with both a family's ability to attend the program and the potential impact program exposure could have on outcomes (Crowley et al., 2014). To address potential confounders,

we employed propensity scoring methods prior to conducting outcome analysis to balance covariates across the specific component exposures for each of the seven program sessions. Propensity scores allow for estimates of probability of receiving a given dosage of program component content, accounting for the identified potential confounding factors (Rosenbaum & Rubin, 1983). Assuming that all potential confounders are included in the model, these estimates are then used within predictive models to complete outcome assessments.

In the current study, we assess the dosage effects of each central program component content from SFP 10–14 on adolescent drunkenness, cigarette use, and marijuana use initiation by Grade 12. SFP 10–14 is a seven-session, universal family-based prevention program. The program is designed for at least one parent and his or her child to attend together, as program content is addressed during concurrent, independent (parent-only/youth-only) groups followed by whole-family groups, contained within each program session (Kumpfer et al., 1996). We expected that family and individual skills components would be related to risk reduction for the three outcomes. We considered three components in each domain (see Table 1 for a summary):

Family skills domain.—The family skills components include parental monitoring and behavior management, positive family relationships, and problem solving. We predicted that parental monitoring and behavior management content would be the most potent family skills program component, as there is an abundance of research evidencing the critical value of parental monitoring during adolescence in the prevention of substance use.

Individual skills domain.—The individual skills components include self-regulation and stress management, future orientation, and peer resistance skills. We predicted that self-regulation and stress management content would be the most potent predictor of the three outcomes among the individual skills components, as prior work has found these skills to be integral in substance use behaviors (Pokhrel et al., 2013).

Method

Participants

We leveraged existing data from the PROSPER study, a community-randomized trial of a substance misuse prevention program delivery system. Twenty-eight communities were randomized, 14 implemented the PROSPER delivery system and 14 participated as the control, completing pre-test and post-test assessments. Intervention communities (n=14) were offered three choices of school-based and family-based interventions. All communities chose SFP 10–14 for the latter, in which 17% of families enrolled (Spoth, Clair, Greenberg, Redmond, & Shin, 2007). The final sample used for analysis was N=1,003 families that enrolled in SFP 10–14. The adolescent analysis sample was 50.1% female (49.9% male) and 86.8% White (4.9% Latino/Hispanic, 2.1% Black/African American, 1.8% Native American/American Indian, 0.2% Asian, and 4.1% “Other”), with an average youth age of 11.8 at the first assessment (fall of Grade 6). About 20% of the youth lived in a single-parent household, and 65.2% lived with both biological parents. About 28% of the youth were eligible for free/reduced price lunch, a proxy for socioeconomic status. The sample was drawn from rural and semi-rural communities in two states. SFP 10–14 was offered during

the evenings in the fall of the adolescents' sixth grade year. Program participants included both adolescents and their parent(s) who came to the intervention. Program facilitators recorded attendance from the SFP 10–14 implementations at each session.

Procedure

Families were recruited for SFP 10–14 in a variety of ways, through both community and school outlets (e.g. mail invitations, school newsletters, local newspaper; see Spoth et al., 2007 for full description). Program sessions were held in community facilities across seven consecutive weekly meetings in the evenings in the spring of Grade 6 (Redmond et al., 2009). Childcare and dinner were provided (Spoth et al., 2007). Program content was led by two trained program facilitators and was delivered through DVD instruction, discussion, games, projects, and role play (Spoth et al., 2015). SFP 10–14 has been subjected to multiple long-term randomized clinical trials, either as a free-standing program or as part of a multicomponent intervention. This research has established it as an effective and cost-beneficial intervention for decreasing and delaying substance use initiation, decreasing youth problem behavior, and improving family management skills and family climate (Redmond et al., 2009; Spoth et al., 2013; Spoth, Guyll, & Day, 2002).

Measures

Program component content dosage.—We used previously calculated values for program-component dosages in the present study. Program components were coded across 41 family-based prevention programs for adolescent substance use for a recent meta-analysis (Van Ryzin & Fosco, 2016; Van Ryzin et al., 2016). SFP 10–14 was included in this original analysis. This coding system evidenced good inter-rater reliability (ICC's ≥ .90). The coding system captures the amount of time (in minutes) programs devote to particular intervention component content within each program session. Using the calculations from this prior work, we converted attendance data from the PROSPER trial to reflect the quantity of time each family member (parent or youth) was exposed to specific intervention component content. The program components in SFP 10–14 are (1) parental monitoring and behavior management, (2) fostering school success, (3) positive family relationships, (4) substance use knowledge, attitudes, and values, (5) self-regulation and stress management skills, (6) problem solving, (7) resisting peer risk, (8) psycho-education on adolescent development, and (9) future orientation. Families who enrolled in SFP 10–14 could attend 0–7 sessions, and adolescents could attend a different number of sessions than the parents. During the two-hour weekly sessions, SFP 10–14 first delivers 1 hour of content to youth and parents separately, and then delivers a 1-hour joint session to both the youth and parents together. Program content was coded for parents, youth, and joint portions of the full sessions. Parents and youth received different program content in the first half of each session, and then received the same content as each other in the second half of each session. Therefore, family program component content dosages were calculated as a sum of minutes received by parents and by youth. Attendance data specifying which parents were present were not available, thus, "parent dosage" was calculated at a family level, and did not adjust for the number of parents present. As a result, all families (single or multiple-caregiver) had the same potential range of parent dosage minutes. Each program session consists of a different make-up of program component content, and each type of component content has a different

dosage in minutes during each session (see Table 1). Three components were excluded (fostering school success, substance use knowledge, attitudes, and values, and psycho-education on adolescent development) from analyses because of inadequate quantities (e.g., 7.5 – 35 min), or indistinguishability (e.g., fostering school success and substance use knowledge, attitudes, and values were both delivered in the same single session).

Potential confounders.—This study utilized propensity scoring methods to account for biases associated with attendance to specific program sessions as well as program effects. The present study used an existing model that was previously used to evaluate attendance effects for SFP 10–14 in the PROSPER trial (Crowley et al., 2014) and included the same confounders spanning demographic information, youth functioning, youth cognitions about substance use, and family environment and which school-based program the participant received. See Appendix (available online) for information on all potential confounders.

Outcomes: Drunkenness, cigarette use, and marijuana use initiation.—Outcomes were measured with three lifetime substance use items in the spring of Grade 12: (1) “Have you ever been drunk from drinking alcohol?”; (2) “Have you ever smoked a cigarette?”; and (3) “Have you ever smoked marijuana or hashish?” The response scale was 0 (No)-1 (Yes).

Results

The analytic approach included four steps: (1) calculate continuous propensity scores for each of the six types of program component content, (2) weight families based on propensity scores in order to create equivalent groups (for each type of component content) on the range of confounders included in the propensity model, (3) assess whether the weighting resulted in group balance, and (4) conduct outcome analysis to predict the effects of program component content dosage on drunkenness, cigarette use, and marijuana use initiation. We employed a multiple imputation approach using the ‘mice’ package in R 3.3.2 to account for any missing data (20 imputations; van Buuren & Groothuis-Oudshoorn, 2011; D’Agostino & Rubin, 2000).

Step 1—*Propensity score calculations.*

Continuous propensity scores are based on a set of chosen confounding variables that may impact the probability of the degree of exposure to some intervention (Rosenbaum & Rubin, 1983; Varvil-Weld, Crowley, Turrisi, Greenberg, & Mallett, 2014). Propensity scores were used to estimate the propensity for a family enrolled in SFP 10–14 to receive any dosage of each of the six specific types of program component content. Propensity scores ($\boldsymbol{\pi}_i$) were calculated according to the following equation, where the probability that a family (i) enrolled in SFP 10–14 received a specific program component content dosage (A_i) given the measured confounds (X_i) (Rosenbaum & Rubin 1983):

$$\pi_i = P\left(A_i = 1 \middle| X_i\right)$$

Continuous propensity scores were calculated via multiple regression for the six types of component content.

Step 2—*Inverse probability weighting.*

Inverse Probability Weights (IPWs) are the inverse probability of being exposed to some intervention (Coffman & Zhong, 2012). IPWs for each component were calculated from the propensity scores in order to balance the levels of exposure (e.g. dosage) to each of the program component across the confounders that were included in the propensity model. This step models randomization procedures in RCTs, so that causal inferences can eventually be made about the intervention (Rosenbaum & Rubin, 1983).

Step 3—*Balance diagnostics.*

Weighted and unweighted Pearson correlations were calculated for each confounder with component content dosages and then compared. Balance was considered achieved if the weighted correlations were less than 0.2 between the dosages and each confounder (Cohen, 1992; Varvil-Weld et al., 2014). To ensure balance was achieved, double robustness procedure was employed for up to seven covariates in the outcome models of five predictors (Kang & Schafer, 2007; Lunceford & Davidian, 2004).

Step 4—*Outcome analyses.*

Weighted logistic regression analysis was used to assess predictions of substance use initiation by each specific program component content dosage. We regressed each dosage on initiation of drunkenness, cigarette use, and marijuana use at Grade 12, and incorporated the accompanying IPW as a regression weight to mitigate bias associated with differential attendance. Models were estimated using the STATS package in R 3.3.2 (R Core Team, 2016). Analyses were grouped by family and individual skills domains.

Family skills domain.

Three models (one for each family skills component content type) were computed for each of the three outcomes, resulting in 9 logistic regression models (see Table 2). Greater dosage related to parental monitoring and behavior management was associated with significantly reduced risk for drunkenness and marijuana use initiation, with odds ratios ranging from 0.80–0.87. An odds ratio of 0.80 can be interpreted as a 20% reduction in the odds of marijuana use initiation for every 1-hour increase in dosage of parental monitoring and behavior management content which had 3.8 hours of dosage possible. A similar pattern of findings emerged for positive family relationships, in which greater dosage was associated with reduced risk for drunkenness and marijuana use initiation; however effect sizes were smaller, with odds ratios ranging from 0.90–0.96 (6.6 hours possible). Problem solving content dosage predicated decreased risk for marijuana use initiation (OR = 0.87; 3.6 hours possible).

To further understand the unique contributions of the different components, post-hoc analyses implementing a marginal structural model (Robins, Hernán, & Brumback, 2000) were conducted. These analyses revealed that when all three family skills domain dosage values were included in the same model with a weight built from the three family dosage

weights, dosage related to parental monitoring and behavior management was the sole significant predictor. A one-hour increase in the dosage of parental monitoring and behavior management content was associated with a 45% reduction in odds of initiating cigarette use (OR= 0.55 [95% CI = 0.34–0.89]) and a 47% reduction in odds of initiating marijuana use (OR= 0.53 [95% CI = 0.36–0.80]).

Individual skills domain.

Three models (one for each individual skills component content type) were computed for each of the three outcomes, resulting in 9 logistic regression models (see Table 2). Greater dosage related to self-regulation and stress management content was associated with significantly reduced risk for cigarette use and marijuana use initiation by Grade 12, with odds ratios ranging from 0.66–0.79. An odds ratio of 0.66 can be interpreted as a 34% reduction in odds for substance use initiation for every 1-hour increase in dosage of self-regulation and stress management content, which had 1.62 hours of dosage possible. Greater dosage related to peer resistance skills content dosage was also associated with reduced risk for marijuana use initiation, though the odds ratios indicated a smaller effect (OR = 0.85; 2.7 hours possible). Future orientation dosage was not associated with lower risk of the outcomes.

Post-hoc analyses implementing a marginal structural model (Robins et al., 2000) revealed that when all three individual skills domain dosage values were included in the same model with a weight built from the three individual dosage weights, dosage related to self-regulation and stress management was the sole significant predictor. A one-hour increase in the dosage of self-regulation and stress management content was associated with a 36% reduction in odds of initiating cigarette use (OR = 0.64 [95% CI =0.43–0.97]) and a 37% reduction in odds of initiating marijuana use (OR = 0.63 [95% CI = 0.46–0.86]).

Discussion

This paper has evaluated the effects of specific types of program component content within a universal family-based preventive intervention program. Using previously established codes for SFP 10–14 content, we calculated rates of exposure to six coded component content types using attendance data from the PROSPER trial of 1,003 families that enrolled in SFP 10–14. After applying IPW's to mitigate potential bias associated with non-random assignment, we used component content dosages, received during Grade 6, to predict three substance use initiation outcomes at Grade 12. Parental monitoring and behavior management content dosage significantly predicted less drunkenness and marijuana use initiation at Grade 12. Positive family relationship content was also a significant, though weaker, predictor of drunkenness and marijuana use initiation. Self-regulation and stress management program content dosage significantly predicted less cigarette use and marijuana use initiation at Grade 12. Family problem solving and adolescent peer resistance skills program content dosages both significantly predicted less marijuana use initiation. Future orientation program content dosage was not a significant predictor of any outcomes. To further increase our capacity to directly compare components, marginal structural models were implemented. These post-hoc analyses revealed parental monitoring and behavior

management in the family domain, and self-regulation and stress management in the individual domain, to be the driving component contents in SFP 10–14, delivered during Grade 6. In this context, our primary analyses provide us with an understanding of the general importance of the different components within a Potential Outcomes Framework (in the same manner as a bivariate analysis might), while these post hoc analyses offer a multivariate perspective of the unique variance explained by the components.

Findings underscore the importance of family skills training for reducing substance use risk, particularly those components that focused on promoting effective parenting skills and family relationships. The specific pattern of results suggests that family conflict resolution (problem solving content) may not offer as robust effects for family-based programs that seek to prevent initiation of drunkenness or cigarette use. Prior evidence indicates that close and positive family relationships are more predictive of long-term youth outcomes than family conflict (Fosco, Caruthers, & Dishion, 2012), suggesting that perhaps content focused on positive aspects of family relationships has the potential for broadest impact. It is important to note that these analyses focused only on three substance use initiation outcomes; prior work has found that problem-solving behaviors within the family predict successful adolescent mastery (Conger, Williams, Little, Masyn, & Shebloski, 2009). Therefore, family problem-solving content may be a predictor of other outcomes excluded from this study.

Turning to the individual skills domain, self-regulation and stress management was the strongest and most robust predictor, peer resistance skills predicted marijuana use initiation only, while future orientation skills was not predictive of any outcomes under study. Self-regulation and stress management skills are a strong and consistent predictor of adolescent substance use initiation as well as subsequent substance use disorders (see Pokhrel et al., 2013). Self-regulation and stress management content also may promote peer resistance skills more strongly than peer resistance skills content, which had more modest effects; prior work has found self-regulation to protect against antisocial behavior in deviant peer contexts (Gardner, Dishion, & Connell, 2008), and may therefore also protect against other types of peer pressure (e.g. substance use).

Future orientation content was not predictive of substance use initiation for this study, despite prior work supporting the importance of this factor (e.g., Van Ryzin et al., 2016). It is possible that our outcomes, extending six years after the intervention, exceeded the timeframe in which future orientation exerts influence in other studies. However, it is also possible is that the content in SFP 10–14 targeting adolescents' future orientation may not function as believed. Prior work evaluating change processes in the Strong African American Families Program has found that changes in youth protective factors, including future orientation, may be driven by intervention effects on parental discipline and communication practices (Brody et al., 2004). This is consistent with our findings that content on parenting practices, but not future orientation, was associated with substance use initiation. Thus, it may be that adolescents' future orientation changes as a result of other content in the intervention attempting to foster this protective factor. This finding raises an important question for the field: do interventions elicit changes as we expect? Future work is needed that can evaluate specific components of interventions, such as those employing

factorial designs (e.g, MOST; Collins et al., 2005). We also note that the current findings should be interpreted with caution until replicated, especially when generalizing to whether these content areas can reduce risk for substance use initiation. Other programs may deliver thematically similar content through different lessons or strategies that are more or less effective. Content analysis of other programs will help in the generalization of these findings beyond the SFP 10–14 program.

By evaluating individual components of SFP 10–14, our findings prompt new questions that call for future investigation. First, future work is needed to identify sufficient dosages of key program component content to be included in interventions. Results from this study indicate that 168 minutes of future orientation content may not be sufficient to produce effects on substance use initiation outcomes (for this rural, white population). Identification of minimum effective doses and threshold doses of necessary program content will help conserve resources and improve program effects (Durlak & DuPre, 2008). Future component analyses on different programs and with different samples will provide comparisons for effectiveness of components that were found to be inefficient in their prevention of substance use initiation in this study. Second, our findings indicate that some content delivered by SFP 10–14 may not be necessary to reduce initiation of drunkenness, cigarette use, and marijuana use. Content reduction, changes to dosage, or removal of components altogether, may be fruitful next steps. However, these findings do not yet provide adequate evidence or specific guidance from which to make changes to SFP 10–14, as this would pose a serious threat to implementation fidelity. Rather, our findings call for further research through empirical processes in order to determine with certainty how types of program component content work within the structure of SFP 10–14. Future assessments may find that reducing program content reduces effects for reasons that we were not able to test. For example, there may be additive or multiplicative effects between program component content, such that removal of problem solving content weakens the effects of self-regulation and stress management content, and so on. Alternatively, factorial designs, such as MOST (Collins et al., 2005), may be applied to varied content dosages to guide decisions regarding component elimination. Such designs are a key next step to optimize SFP 10–14.

This study is not without its limitations. First, the effect sizes were small-moderate, and should therefore be interpreted with caution. Although our propensity score approach mitigates bias associated with nonrandom assignment to attendance, analyses only include families who enrolled in SFP 10–14. Thus, factors related to self-selection into the program may bias results. Additionally, as is possible with all quasi-experimental work, we may not have captured every potential confounder in our model. In addition, community-level nesting was not accounted for in this study. Because of the added complexity nesting would require and the negligible variances estimated at the community level (ICC's < .05), we chose to favor parsimony by using single-level models; however, nesting effects may be a meaningful consideration in future studies. Future component analyses should consider multiple caregivers' attendance, something we were not able to explore because our attendance records did not specify caregiver beyond mother/father, and some adolescents had more than two caregivers (e.g., grandparents, stepparents). Future research should evaluate the impact of different caregiver and family structures on how families experience universal program content. Lastly, the sample consisted of mostly white, rural adolescents, and findings may

therefore not be generalizable to some populations. Replication is important to extend this work.

Conclusion

This study explored dosage effects of SFP 10–14 component content on three substance use initiation outcomes by Grade 12. Results indicate potential critical components within SFP 10–14, and offer a path forward for improving this widely-disseminated program. Analyses were conducted using attendance data and components coded in a recent meta-analysis on family-based prevention programs; others should consider expanding on our work and using these existing resources to conduct similar analyses on other programs. Accumulating evidence on critical components is necessary and useful for efforts toward optimizing family-based programs.

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Appendix. Potential Confounders Included in Propensity Model

Variables	Items	α	Sample item
Demographic information			
Age	1	N/A	
Gender	1	N/A	
Ethnicity	1	N/A	
Free/reduced price lunch (SES)	1	N/A	
School-based intervention status	1	N/A	
Youth functioning			
Stress management	4	.80	When you feel nervous, how often do you: Focus on your breathing.
Assertiveness	5	.68	How likely would you be to…say “no” when someone asks you to do something that you don’t want to do?
Problem solving	5	.91	When you have a problem, how often do you…think about the consequences of each choice?
Self-oriented activities	3	.64	How often do you…do what feels good, regardless of the consequences?
Risky activities	3	.77	If you had the money and the chance, how likely would you be to do the following: Parachute jumping
School adjustment and bonding	10	.72	I don’t feel like I really belong at school.
Negative attitude toward school	2	.71	How much do you agree or disagree with the following statement about your closest friends? These friends don’t like school very much.
School absences	1	N/A	
Youth cognitions about S.U.			
Positive attitude toward S.U.	3	.89	How wrong do you think it is for someone your age to smoke cigarettes?

Variables	Items	α	Sample item
S.U. norms	3	.88	In general, how many people your age do you think smoke cigarettes?
Positive expectations for S.U.	11	.93	Kids who drink alcohol have more friends.
Positive expectations for C.U.	3	.75	Kids who smoke have more friends.
Positive expectations for A.U.	5	.86	Drinking helps you get along with other people.
Positive expectations for M.U.	3	.85	Smoking marijuana (pot) makes you look cool.
Substance refusal intentions	5	.92	How likely are you to say “no” when someone tries to get you to. Smoke a cigarette
Substance refusal efficacy	3	.97	How confident are you that you could do well…Refusing marijuana/pot offered by a friend
Family environment variables			
Parents’ marital status	1	N/A	
Lives with biological parents	1	N/A	
Family climate	7	.68	Family members really help and support each other.
General child management	13	.74	My parents know when I do not do things they have asked me to do.

Note.S.U. is substance use; C.U. is cigarette use; A.U. is alcohol use; M.U. is marijuana use.

References

Brody GH, Murry VM, Gerrard M, Gibbons FX, Molgaard V, McNair L, … Neubaum-Carlan E (2004). The Strong African American Families Program: Translating research into prevention programming. Child Development, 73(3), 900–917.

Chambless DL, & Hollon SD (1998). Defining empirically supported therapies. Journal of Consulting and Clinical Psychology, 66(1), 7–18. 10.1037/0022-006X.66.1.7 [PubMed: 9489259]

Chassin L (2008). Juvenile justice and substance use. Future of Children, 18(2), 165–183. [PubMed: 21338002]

Coffman DL, & Zhong W (2012). Assessing mediation using marginal structural models in the presence of confounding and moderation. Psychological Methods2, 17(4), 642–664.

Cohen J (1992). Statistical power analysis. Current Directions in Psychological Science, 1(3), 98–101. 10.1023/B:PREV.0000037641.26017.00

Collins LM, Murphy SA, Nair VN, & Strecher VJ (2005). A strategy for optimizing and evaluating behavioral interventions. Annals of Behavioral Medicine, 30(1), 65–73. [PubMed: 16097907]

Conger KJ, Williams ST, Little WM, Masyn KE, & Shebloski B (2009). Development of mastery during adolescence: the role of family problem-solving. Journal of Health and Social Behavior, 50(1), 99–114. 10.1177/002214650905000107 [PubMed: 19413137]

Cordova D, Heinze J, Mistry R, Hsieh H, Stoddard S, Salas-Wright C, & Zimmerman M (2014). Family functioning and parent support trajectories and substance use and misuse among minority urban adolescents: A latent class growth analysis. Substance Use & Misuse, 49(14), 1908–1919. 10.1016/j.pestbp.2011.02.012.Investigations [PubMed: 25033377]

Crowley DM, Coffman DL, Feinberg ME, Greenberg MT, & Spoth RL (2014). Evaluating the impact of implementation factors on family-based prevention programming: Methods for strengthening causal inference. Prevention Science, 15(2), 246–255. 10.1007/s11121-012-0352-8 [PubMed: 23430578]

D’Agostino R, & Rubin DB (2000). Estimating and using propensity scores with partially missing data. Journal of the American Statistical Associationcal Association, 95(451), 749–759.

De Martini-Scully D, Bray MA, & Kehle TJ (2000). A packaged intervention to reduce disruptive behaviors in general education students. Psychology in the Schools, 37(2), 149–156. 10.1002/(SICI)1520-6807(200003)37:2<149::AID-PITS6>3.0.CO;2-K

Degenhardt L, Stockings E, Patton G, Hall WD, & Lynskey M (2016). The increasing global health priority of substance use in young people. The Lancet Psychiatry, 3(3), 251–264. 10.1016/S2215-0366(15)00508-8 [PubMed: 26905480]

DeWit DJ, Adlaf EM, Offord DR, & Ogborne AC (2000). Age at first alcohol use: A risk factor for the development of alcohol disorders. The American Journal of Psychiatry, 157(5), 745–750. 10.1176/appi.ajp.157.5.745 [PubMed: 10784467]

Dishion TJ, & Patterson GR (1999). Model Building in Developmental Psychopathology: A Pragmatic Approach to Understanding and Intervention. Journal of Clinical Child & Adolescent Psychology, 28(4), 502–512. 10.1207/S15374424JCCP2804_10

Dumas JE, Moreland AD, Gitter AH, Pearl AM, & Nordstrom AH (2008). Engaging Parents in Preventive Parenting Groups: Do Ethnic, Socioeconomic, and Belief Match Between Parents and Group Leaders Matter? Health Education & Behavior, 35(5), 619–633. 10.1177/1090198106291374 [PubMed: 17200093]

Durlak JA, & DuPre EP (2008). Implementation matters: A review of research on the influence of implementation on program outcomes and the factors affecting implementation. American Journal of Community Psychology.

Eiden RD, Lessard J, Colder CR, Livingston J, Casey M, & Leonard KE (2016). Developmental cascade model for adolescent substance use from infancy to late adolescence. Developmental Psychology, 52(10), 1619–1633. [PubMed: 27584669]

Fairchild AJ, & Mackinnon DP (2014). Factors Affecting Implementation: Cultural Adaptation and Training In Sloboda Z & Petras H (Eds.), Defining Prevention Science (pp. 315–334). New York: Springer Science + Business Media.

Fleming CB, Mason WA, Haggerty KP, Thompson RW, Fernandez K, Casey-Goldstein M, & Oats RG (2015). Predictors of Participation in Parenting Workshops for Improving Adolescent Behavioral and Mental Health: Results From the Common Sense Parenting Trial. Journal of Primary Prevention, 36(2), 105–118. [PubMed: 25656381]

Forgatch MS, Patterson GR, & DeGarmo DS (2005). Evaluating fidelity: Predictive validity for a measure of competent adherence to the Oregon model of Parent Management Training. Behavior Therapy, 36(1), 3–13. 10.1016/S0005-7894(05)80049-8 [PubMed: 16718302]

Fosco GM, Caruthers AS, & Dishion TJ (2012). A six-year predictive test of adolescent family relationship quality and effortful control pathways to emerging adult social and emotional health. Journal of Family Psychology, 26, 565–575. [PubMed: 22709261]

Fosco GM, Frank JL, Stormshak EA, & Dishion TJ (2013). Opening the “Black Box”: Family Check-Up intervention effects on self-regulation that prevents growth in problem behavior and substance use. Journal of School Psychology, 51(4), 455–468. [PubMed: 23870441]

Fosco GM, Seeley JR, Dishion TJ, Smolkowski K, Stormshak EA, Downey-McCarthy R, … Strycker LA (2014). Lessons Learned from Scaling Up the Ecological Apprach to Family Interventions and Treatment Programs in Middle Schools In Weist M, Lever N, Bradshaw C, & Owens J (Eds.), Handbook of School Mental Health (pp. 237–251). Boston, MA: Springer.

Fosco GM, Stormshak EA, Dishion TJ, & Winter CE (2012). Family relationships and parental monitoring during middle school as predictors of early adolescent problem behavior. J Clin Child Adolesc Psychol, 41(2), 202–213. [PubMed: 22417193]

Franks R, & Schroeder J (2013). Applying Implementation Science in Early Childhood Programs and Systems edited by In Halle T, Metz A, & Martinez-Beck I (Eds.), Applying implementation science to early care and education programs and systems: Exploring a new frontier (pp. 5–19). Baltimore: Paul H. Brookes.

Gardner TW, Dishion TJ, & Connell AM (2008a). Adolescent self-regulation as resilience: Resistance to antisocial behavior within the deviant peer context. Journal of Abnormal Child Psychology. 10.1007/s10802-007-9176-6

Gardner TW, Dishion TJ, & Connell AM (2008b). Adolescent Self-Regulation as Resilience: Resistance to Antisocial Behavior within the Deviant Peer Context. Journal of Abnormal Child Psychology, 36(2), 273–284. 10.1007/s10802-007-9176-6 [PubMed: 17899361]

Gottfredson DC, Cook TD, Gardner FEM, Gorman-Smith D, Howe GW, Sandler IN, & Zafft KM (2015). Standards of evidence for efficacy, effectiveness, and scale-up research in prevention science: Next generation. Prevention Science, 16(7), 893–926. [PubMed: 25846268]

Griffin KW, Botvin GJ, Scheier LM, Diaz T, & Miller NL (2000). Parenting practices as predictors of substance use, delinquency, and aggression among urban minority youth: Moderating effects of family structure and gender. Psychology of Addictive Behaviors, 14(2), 174–184. 10.1037//0893-164X.14.2.174 [PubMed: 10860116]

Gross D, Julion W, & Fogg L (2001). What motivates participation and dropout among low-income urban families of color in a prevention intervention? Family Relations, 50(3), 246–254. 10.1111/j.1741-3729.2001.00246.x

Hanisch C, Hautmann C, Pluck J, Eichelberger I, & Dopfner M (2014). The prevention program for externalizing problem behavior (PEP) improves child behavior by reducing negative parenting: analysis of mediating processes in a randomized controlled trial. Journal of Child Psychology and Psychiatry, 55(5). 10.1111/jcpp.12177

Henderson CE, Rowe CL, Dakof GA, Hawes SW, & Liddle HA (2009). Parenting practices as mediators of treatment effects in an early-intervention trial of multidimensional family therapy. The American Journal of Drug and Alcohol Abuse, 35(4), 220–226. [PubMed: 20180674]

Hukkelberg SS, & Ogden T (2013). Working alliance and treatment fidelity as predictors of externalizing problem behaviors in parent management training. Journal of Consulting and Clinical Psychology, 81(6), 1010–1020. 10.1037/a0033825 [PubMed: 23895086]

Kang JDY, & Schafer JL (2007). Demystifying Double Robustness: A Comparison of Alternative Strategies for Estimating a Population Mean from Incomplete Data. Statistical Science, 22(4), 523–539. 10.1214/07-STS227

Kazdin AE (2007). Mediators and mechanisms of change in psychotherapy research. Annu. Rev. Clin. Psychol, 3, 1–27. 10.1146/annurev.clinpsy.3.022806.091432 [PubMed: 17716046]

Kumpfer KL, Molgaard V, & Spoth RL (1996). The Strengthening Families Program for the prevention of delinquency and drug use In Peters RD & McMahon RJ (Eds.), Preventing childhood disorders, substance abuse, and delinquency. (pp. 241–267). Thousand Oaks, C.A.: Sage.

Liddle HA (2004). Family-based therapies for adolescent alcohol and drug use: research contributions and future research needs. Addiction, (99), 76–92. [PubMed: 15488107]

Lunceford JK, & Davidian M (2004). Stratification and weighting via the propensity score in estimation of causal treatment effects: A comparative study. Statistics in Medicine, 23(19), 2937–2960. 10.1002/sim.1903 [PubMed: 15351954]

McGue M, & Iacono WG (2005). The association of early adolescent problem behavior with adult psychopathology. The American Journal of Psychiatry, 162(6), 1118–1124. [PubMed: 15930060]

Odgers CL, Caspi A, Nagin DS, Piquero AR, Slutske WS, Milne BJ, … Moffitt TE (2008). Is it important to prevent early exposure to drugs and alcohol among adolescents? Psychological Science, 19(10), 1037–1044. [PubMed: 19000215]

Patel CC, Fairchild AJ, & Prinz RJ (2017). Potential mediators in parenting and family intervention: Quality of mediation analyses. Clinical Child and Family Psychology Review, 20(2), 127–145. 10.1007/s10567-016-0221-2 [PubMed: 28028654]

Pokhrel P, Herzog TA, Black DS, Zaman A, Riggs NR, & Sussman S (2013). Adolescent neurocognitive development, self-regulation, and school-based drug use prevention. Prevention Science, 14(3), 218–228. 10.1007/s11121-012-0345-7 [PubMed: 23408284]

R Core Team. (2016). R: A Language and Environment for Statiscal Computing. Vienna, Austria Retrieved from https://www.r-project.org

Redmond C, Spoth R, Shin C, Schainker LM, Greenberg MT, & Feinberg M (2009). Long-term protective factor outcomes of evidence-based interventions implemented by community teams through a community-university partnership. Journal of Primary Prevention, 30(5), 513–530. 10.1007/s10935-009-0189-5 [PubMed: 19669885]

Robins JM, Hernán MA, & Brumback B (2000). Marginal structural models and causal inference in epidemiology. Epidemiology, 11(5), 550–560. [PubMed: 10955408]

Rosenbaum PR, & Rubin DB (1983). The central role of the propensity score in observational studies for causal effects. Biometrica, 70(1), 41–55.

Sandler IN, Schoenfelder EN, Wolchik SA, & Mackinnon DP (2010). Long-term impact of prevention programs to promote effective parenting: Lasting effects but uncertain processes. Annual Review of Psychology, 62, 299–320.

Spoth R, Clair S, Greenberg M, Redmond C, & Shin C (2007). Toward dissemination of evidence-based family interventions: maintenance of community-based partnership recruitment results and associated factors. Journal of Family Psychology, 21(2), 137–146. [PubMed: 17605536]

Spoth R, Guyll M, & Day SX (2002). Universal family-focused interventions in alcohol-use disorder prevention: cost-effectiveness and cost-benefit analyses of two interventions. Journal of Studies on Alcohol, 63(2), 219–228. [PubMed: 12033699]

Spoth R, & Redmond C (1995). Parent motivation to enroll in parenting skills programs: A model of family context and health belief predictors. Journal of Family Psychology, 9(3), 294–310. 10.1037/0893-3200.9.3.294

Spoth R, Redmond C, Mason WA, Schainker L, & Borduin L (2015). Research on the Strengthening Families Program for Parents and Youth Ages 10–14: Long-Term Effects, Mechanisms, Translation to Public Health, Prosper Partnership Scale Up In Scheier LM (Ed.), Handbook of Adolescent Drug use Prevention: Research, Intervention Strategies, and Practice. (2nd ed., pp. 267–292). Washington, D.C.: American Psychological Association.

Spoth R, Redmond C, Shin C, Greenberg M, Feinberg M, & Schainker L (2013). PROSPER community-university partnership delivery system effects on substance misuse through 6 1/2years past baseline from a cluster randomized controlled intervention trial. Preventive Medicine, 56(3–4), 190–196. 10.1016/j.ypmed.2012.12.013 [PubMed: 23276777]

Spoth R, Trudeau L, Guyll M, Shin C, & Redmond C (2009). Universal intervention effects on substance use among young adults mediated by delayed adolescent substance initiation. Journal of Consulting and Clinical Psychology, 77(4), 620–632. [PubMed: 19634956]

Trentacosta CJ, & Shaw DS (2009). Emotional self-regulation, peer rejection, and antisocial behavior: Developmental associations from early childhood to early adolescence. Journal of Applied Developmental Psychology. 10.1016/j.appdev.2008.12.016

van Buuren S & Groothuis-Oudshoorn K (2011). mice: Multiple imputation by chained equations in R. Journal of Statistical Software, 45(3). 10.18637/jss.v045.i03

Van Ryzin MJ, & Fosco GM (2016). Family-Based Approaches to Prevention In Van Ryzin MJ, Kumpfer KL, Fosco GM, & Greenberg MT (Eds.), Family-Based Prevention Programs for Children and Adolescents (1st ed., pp. 1–20). Psychology Press.

Van Ryzin MJ, Roseth CJ, Fosco GM, Lee Y, & Chen I-C (2016). A component-centered meta-analysis of family-based prevention programs for adolescent substance use. Clinical Psychology Review, 45, 72–80. [PubMed: 27064553]

Varvil-Weld L, Crowley DM, Turrisi R, Greenberg MT, & Mallett KA (2014). Hurting, helping, or neutral? The effects of parental permissiveness toward adolescent drinking on college student alcohol use and problems. Prevention Science, 15(5), 716–724. [PubMed: 23934443]

Table 1.

Program Component Content Dosage Descriptive Information

Program Component Content	Total Possible Min.	Mean (SD)	Range
Family Skills Domain			
Parental Monitoring and Behavior Management: *Training for skills around effective monitoring/tracking/management of child behavior*	228	161.42 (79)	0–228
Positive Family Relationships: *Promotes warm, friendly, engaged P-C relationship; training for skills in sharing, listening, emotional closeness*	396	287.3 (126.4)	0–396
Problem Solving: *Trains parents and youth to resolve ongoing problems/conflicts via communication and mutual agreements*	215	146.8 (80.4)	0–215
Individual Skills Domain			
Future Orientation: *Youth envisioning goals for themselves, parents thinking about goals and how they can help youth achieve them, parental support/encouragement of goals*	168	124.6 (57.4)	0–168
Peer Resistance Skills: *Develops skills/values to help youth resist peer pressure to engage in risky behaviors, and to help parents support youth in dealing with these situations*	159	100.9 (67.7)	0–159
Self-Regulation and Stress Management: *Training to help parents and youth cope with anger/stress*	97	66.5 (36.7)	0–97

Note. All statistics are in minutes. Program coding system developed by Van Ryzin & Fosco (2014).

Table 2.

Logistic Regression Analysis Employing Inverse Probability Weights

Family Domain						
Component Content	**1st Drunkenness**		**1st Cigarette Use**		**1st Marijuana Use**	
	B (SE)	**OR**	**B (SE)**	**OR**	**B (SE)**	**OR**
Model 1						
Parental Monitoring and Behavior Management	−0.17*(.07)	0.85	−0.13 (.07)	0.87	−0.22***(.06)	0.80
Model 2						
Positive Family Relationships	−0.09*(.04)	0.92	−0.05 (.05)	0.96	−0.11*(.05)	0.90
Model 3						
Problem Solving	−0.05 (.07)	0.96	−0.07 (.07)	0.93	−0.14*(.07)	0.87
Individual Domain						
Component Content	**1st Drunkenness**		**1st Cigarette Use**		**1st Marijuana Use**	
	B (SE)	**OR**	**B (SE)**	**OR**	**B (SE)**	**OR**
Model 1						
Future Orientation	−0.12 (.11)	0.89	−0.04 (.10)	0.96	−0.16 (.08)	0.86
Model 2						
Peer Resistance Skills	−0.08 (.08)	0.93	−0.09 (.08)	0.91	−0.17*(.07)	0.85
Model 3						
Self-Regulation and Stress Management	−0.24 (.15)	0.79	−0.34*(.15)	0.71	−0.42**(.13)	0.66

Note.

*$p < .05$

**$p < .01$

***$p < .001$.

Each regression model was run individually. Unbalanced covariates were included in Parental Monitoring and Behavior Management, Positive Family Relationships, Problem Solving, Future Orientation and Peer Resistance Skills models for double robustness.