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Original article

## Diffusion of Intervention Effects: The Impact of a Family-Based Substance Use Prevention Program on Friends of Participants

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 A B S T R A C T

**Purpose:** We tested whether effects of the Strengthening Families Program for Youth 10–14 (SFP10-14) diffused from intervention participants to their friends. We also tested which program effects on participants accounted for diffusion.

**Methods:** Data are from 5,449 students (51% female; mean initial age = 12.3 years) in the Promoting School-community-university Partnerships to Enhance Resilience community intervention trial (2001–2006) who did not participate in SFP10-14 (i.e., nonparticipants). At each of five waves, students identified up to seven friends and self-reported past month drunkenness and cigarette use, substance use attitudes, parenting practices, and unsupervised time spent with friends. We computed two measures of indirect exposure to SFP10-14: total number of SFP-attending friends at each wave and cumulative proportion of SFP-attending friends averaged across the current and all previous post-intervention waves.

**Results:** Three years post-intervention, the odds of getting drunk (odds ratio = 1.4) and using cigarettes (odds ratio = 2.7) were higher among nonparticipants with zero SFP-attending friends compared with nonparticipants with three or more SFP-attending friends. Multilevel analyses also provided evidence of diffusion: nonparticipants with a higher cumulative proportion of SFP-attending friends at a given wave were less likely than their peers to use drugs at that wave. Effects from SFP10-14 primarily diffused through friendship networks by reducing the amount of unstructured socializing (unsupervised time that nonparticipants spent with friends), changing friends' substance use attitudes, and then changing nonparticipants' own substance use attitudes.

**Conclusions:** Program developers should consider and test how interventions may facilitate diffusion to extend program reach and promote program sustainability.

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**IMPLICATIONS AND CONTRIBUTION**

The results of this study suggest that effects from a family-based prevention program can impact nonparticipating adolescents by diffusing through school-based friendship networks. Intervention developers should target processes that might facilitate diffusion, such as unstructured socializing, as interventions are scaled up for broad implementation in community contexts.

Most tests of behavioral interventions evaluate only whether participants are impacted by the intervention. Yet, nonparticipants may also benefit from indirect exposure to the intervention as attitudes, knowledge, and behaviors diffuse

through friendship networks [1,2]. When diffusion occurs during evaluation studies—such as when individuals assigned to a comparison group are affected by an intervention via friends—it is viewed as “contamination.” In real-world implementations of these interventions, however, diffusion is a desirable process. For example, given the typically low participation rates in family-based behavioral interventions [3], diffusion can extend the intervention's reach to the nonparticipants who comprise

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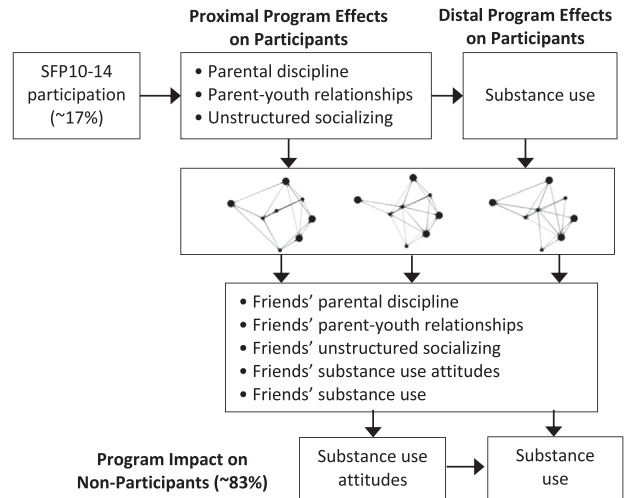
most of the population. This study explores whether and how diffusion occurs when an effective family-based prevention program is delivered to a small fraction of the targeted population.

We define diffusion as influence that occurs when non-participants are indirectly exposed to an intervention through friendships with intervention participants. In this study, our first goal was to test whether nonparticipants' *indirect exposure* to an intervention is associated with their substance use. By contrast, previous studies often inferred diffusion from school-wide effects of an intervention delivered to a subset of students [4] or from successful deployment of trained peer leaders as disseminators of intervention content [5–7]. A few studies have found better outcomes among nonparticipants who were fewer network “steps” from peer leaders [8] or situated within a peer leader's clique [9]. These studies, however, did not test whether diffusion depended on *amount* of indirect exposure to the intervention, and to our knowledge, no studies have directly assessed naturalistic diffusion processes. Our second goal was to test which proximal program effects could account for (i.e., mediate) diffusion of intervention effects from participants to their friends. Specifically, we test whether program effects on intervention participants' parenting practices, unstructured socializing with friends, substance use attitudes, or substance use account for indirect program effects on nonparticipants.

We use data from the PROMoting School-community-university Partnerships to Enhance Resilience (PROSPER) trial [10]. As part of PROSPER, intervention communities implemented the Strengthening Families Program for Youth 10–14 (SFP10-14), an effective substance use prevention program with sessions for adolescents and parents [4,11–13]. All sixth graders and their parents were invited to participate in SFP10-14, but 83% did not attend any sessions [14]. We argue that these non-participants can benefit from SFP10-14 when they are indirectly exposed to it through friendships with participants. Because peer influence is an ongoing process that can have enduring effects, the beneficial effects of having SFP-attending friends likely accumulate over time. Thus, we expected that nonparticipants' substance use would be associated with cumulative exposure to SFP-attending friends over time (i.e., cumulative indirect exposure).

SFP10-14's effectiveness has been demonstrated through a randomized control trial, with effects maintained 10 years past baseline [13]. Thus, data from a high-fidelity implementation of SFP10-14 provide a perfect test case for evaluating whether indirect exposure can reduce substance use among nonparticipants. Such diffusion occurs when an intervention first influences participants' attitudes and behaviors, which then influence the attitudes and behaviors of participants' friends. *Proximal program effects* of SFP10-14 on participants include enhanced parenting practices, reduced unstructured socializing with friends, and altered attitudes toward substance use, with *distal program effects* on participants' substance use [12,15]. These proximal and distal program effects may diffuse and impact nonparticipants' substance use attitudes and behaviors (Figure 1).

One potential pathway for diffusion is through proximal effects on *parenting practices* in participating families. We previously demonstrated that *friends' parents* influence adolescents' substance use [16,17]. SFP10-14 promotes supportive parent–youth relationships and consistent parental discipline. Participating parents may model these positive parenting practices for other youth through interactions with their own adolescent and



**Figure 1.** Hypothesized process through which intervention effects diffuse from the students who participated in SFP10-14 to intervention nonparticipants. First, SFP10-14 has proximal and distal effects on program participants (top row). Then, nonparticipants are exposed to intervention participants (larger nodes) through their friendship networks (second row); some nonparticipants have many SFP-attending friends, whereas others have few SFP-attending friends. The varying degrees of cumulative indirect exposure to SFP10-14 via friendship networks then impact the average characteristics of non-participants' friends (third row). In turn, these friends' characteristics impact nonparticipants' own anti-substance use attitudes and substance use (bottom row).

may engage directly in more positive interactions with non-participants. Both modeling and direct interaction may increase nonparticipants' social bonding and reduce their deviant behavior [18].

A second potential pathway for diffusion is through proximal effects on participating adolescents' unstructured socializing with friends, which leads to less substance use [19–21]. Past studies found that individual- and aggregate-level parental monitoring are associated with unstructured socializing [22]. Therefore, if SFP10-14 enhances parents' monitoring of adolescents' activities, participating adolescents should engage in less unsupervised, unstructured socializing with friends. In turn, nonparticipants with many SFP-attending friends should spend less unsupervised time with friends, thus having fewer opportunities to use substances.

A third potential pathway for diffusion is through proximal effects on participating adolescents' *substance use attitudes* (e.g., resistance skills, normative beliefs). Adolescents who believe that drug use is common or that their friends approve of substance use are more likely to use drugs [23–26]. Strengthening participants' anti-substance use attitudes could change the normative context within their peer group: if participants become less approving of substance use, their nonparticipating friends may adopt similar attitudes and be less likely to use drugs.

The most critical pathway for diffusion may be through SFP10-14's distal effects on participants' *substance use*, followed by peer influence on nonparticipant friends' substance use. Whether friends use drugs is one of the strongest predictors of adolescent substance use [27]. This association partly reflects substance-using adolescents selecting substance-using peers as friends, but it also reflects influence from friends [2,28–31]. Further evidence for this pathway for diffusion comes from

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