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Participation and Diffusion Effects of a Peer-Intervention for HIV Prevention among Adults in Rural Malawi

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Abstract

This paper examines whether a peer group intervention that reduced self-reported risky behaviors for rural adults in Malawi also had impacts on non-participants in the same communities. We randomly assigned two districts to the intervention and control conditions, and conducted surveys at baseline and 18 months post-intervention using unmatched independent random samples of intervention and control communities in 2003-2006. The six-session peer group intervention was offered to same-gender groups by trained volunteers. In this analysis, we divided the post-intervention sample into three exposure groups: 243 participants and 170 non-participants from the intervention district (total n=415) and 413 control individuals.

Controlling for demographics and participation, there were significant favorable diffusion effects on five partially overlapping behavioral outcomes: partner communication, ever used condoms, unprotected sex, recent HIV test, and a community HIV prevention index. Non-participants in the intervention district had more favorable outcomes on these behaviors than survey respondents in the control district. One behavioral outcome, community HIV prevention, showed both participation and diffusion effects. Participating in the intervention had a significant effect on six psychosocial outcomes: HIV knowledge (two measures), hope, condom attitudes, and self-efficacy for community HIV prevention and for safer sex; there were no diffusion effects.

This pattern of results suggests that the behavioral changes promoted in the intervention spread to others in the same community, most likely through direct contact between participants and non-participants. These findings support the idea that diffusion of HIV-related behavior changes can occur for peer group interventions in communities, adding to the body of research supporting diffusion of innovations theory as a robust approach to accelerating change. If diffusion occurs, peer group intervention may be more cost-effective than previously realized. Wider

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implementation of peer group interventions can help meet the global goal of reducing new HIV infections.

Keywords

HIV; peer group; diffusion of innovations; Malawi; primary prevention; risk reduction behavior

1. Introduction

Although new HIV infections have been declining steadily since 2001, there are still 2.1 million new HIV infections globally, and nearly 70% of new infections occur in sub-Saharan Africa. Reducing new infections is essential to control the epidemic (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2014). Throughout sub-Saharan Africa, heterosexual transmission accounts for the substantial majority of new infections (UNAIDS, 2014), and although prevalence is higher among recognized high risk groups such as commercial sex workers, the epidemic rapidly penetrated the general community. Injecting drug use is rare. Because homosexuality is highly stigmatized and illegal in many African countries, transmission from men who have sex with men or are bisexual is not well documented but is estimated to be low. In a generalized epidemic, preventing new infections is especially difficult because nearly all sexually active youth and adults are at risk. These difficulties are exacerbated by widespread poverty and severe shortages of health workers and supplies in many sub-Saharan African countries. The study described here occurred in Malawi, a very low-resource country in sub-Saharan Africa, with a high adult HIV prevalence of 12.4% when this study began and 10.3% today (Malawi Progress Report, 2014). Like the rest of sub-Saharan Africa, Malawi's epidemic is spread mainly by heterosexual transmission (88%) and high-risk groups such as commercial sex workers contribute less than 1% of new infections in Malawi, reinforcing the importance of reaching the general community to prevent new infections (Malawi Progress Report, 2014).

Meta-analyses and systematic reviews documented that behavioral change interventions reduce risky behaviors, HIV and sexually transmitted infections (STIs) (Albarracín et al., 2005; Albarracín, Albarracín, & Durantini, 2008; Medley, Kennedy, O'Reilly, & Sweat, 2009; Muula & Mfutso-Bengo, 2004; Scott-Sheldon, Huedo-Medina, Warren, Johnson, & Carey, 2011). These same reviews identified that efficacy was increased by a peer-based approach, interpreted as being more effective because peers share a common sociocultural identity, often come from the same social network, and face the same challenges in adopting safer behaviors. Behavior change messages from peers are appropriate for the specific context, and peer social support enhances credibility and trust. Explicit discussion of condoms and inclusion of skill-building activities also enhance efficacy. Peer-based interventions are appropriate for reaching both high-risk groups and the general population. However, bringing these interventions to scale has been viewed as difficult because of the need to reach each individual. If behavior change interventions have community-wide impacts beyond the immediate participants, this would increase the feasibility and cost-effectiveness of widespread implementation. In this paper, we examine whether a peer group intervention that reduced reported risky behaviors for rural adults in Malawi (*Identifying*

Reference 1) also shows results consistent with a process of diffusion to non-participants in the same communities. One strategy for wider diffusion of a behavioral intervention is to use a community's social networks to foster informal spread of the behavioral change message. The theoretical foundation for this approach comes from Rogers' theory of the diffusion of innovations (1962, 1995; 2004). Diffusion is the process by which an innovation is communicated through certain channels over time among the participants in a social system. Over 50 years of research in diverse fields have found an essentially similar exponential curve that describes the adoption rate of new interventions (Dearing, 2008; Rogers, 1962; Rogers, 2004). This same research has identified that only a few (2.5%) persons in a community are innovators who first adopt an innovation. They tend to be relatively independent risk-takers who may have high social status but are not opinion leaders. The early adopters (about 14%), in contrast, are likely to have both high local status and social influence, and are opinion leaders. The early majority (34%) are connected to and influenced by the early adopters. The late majority (34%) generally have lower social status, more skepticism about innovations and connections to the early majority that eventually influence them to adopt the innovation. The last to adopt, the "laggards" (16%), are highly skeptical about change and/or relatively isolated in their social network (Rogers, 1962). Thus, local opinion leaders play a critical role in diffusion because their endorsement and early adoption of the innovation encourage others to adopt it.

Beginning early in the AIDS epidemic, diffusion of innovation theory was used to guide behavior change programs for gay men. The STOP AIDS campaign in San Francisco, which engaged opinion leaders to hold small group discussions in their homes, was highly successful in reframing the AIDS issue in the gay community and was associated with a dramatic decrease in new HIV infections (Singhal & Rogers, 2003). Kelly and colleagues adapted this approach in a classic study in three Southern cities later replicated in an 8-city randomized trial. Trained opinion leaders delivered the intervention in gay bars and communities. There were substantial and sustained declines in reported HIV risk behaviors in the intervention communities (Kelly et al., 1991, 1992, 1997; St. Lawrence et al., 1994). Since then, this approach, usually referred to as peer leader intervention but more narrowly labelled as a popular opinion leader intervention by Kelly (2004), has been widely adopted for HIV prevention for many different target groups in many countries (Ngugi, Wilson, Sebstad, Plummer, & Moses, 1996; Sikkema et al., 2000; Welsh, Puello, Meade, Kome, & Nutley, 2001).

However, two opinion leader interventions for gay men in Great Britain were not effective (Elford, Bolding, & Sherr, 2001; Elford, Sherr, Bolding, Serle, & Maguire, 2002; Flowers, Hart, Williamson, Frankis, & Der, 2002). Also, a recent 5-country study for high-risk groups showed no greater behavior change in the intervention than the control communities (The NIMH Collaborative HIV/STD Prevention Trial Group, 2010).

It is unclear why some of these interventions succeeded while others did not. All these opinion leader interventions used informal contacts between trained opinion leaders and the target population and did not have structured small-group sessions. Kelly (2004) identified several issues of fidelity that he asserts led to lack of success in the two Great Britain interventions. However, Hartford et al. (2004) attribute their lack of success to cultural

barriers against explicit safer sex discussions in public settings and the difficulties of recruiting and retaining true opinion leaders in large cities; their intention was to follow the same model as Kelly but contextual factors made several aspects of fidelity difficult to achieve. The authors of the 5-country trial argue that their design included so many services to the control group, including counseling, testing and treatment of STIs, that the control group experienced the same level of change as those in the intervention groups (NIMH Collaborative HIV/STI Prevention Trial Group, 2010).

Another type of HIV prevention using peer leaders is the peer group intervention, where the intervention is offered to small groups in semi-structured sessions facilitated by trained peer leaders. Peer group leaders are not chosen because they are opinion leaders, although they often are influential in their communities. In addition to our own work, peer group interventions have been shown to be efficacious for different target groups, settings, and countries (Duan et al., 2013; Jemmott et al., 2010; Kirby, Obasi, & Laris, 2006).

However, whether peer group interventions also lead to diffusion of innovations beyond those who attend the groups has not been explored. An extensive literature search identified only one prior study that examined diffusion in a peer group intervention. Three companies of Thai military conscripts were assigned to an intervention group, a diffusion group (men at the same military base whose company did not receive the intervention), and controls at a distant location. Compared to the control group, the intervention group but not the diffusion group had reduced STIs (Celentanon et al., 2000). No other studies using a peer group intervention have examined whether there is any diffusion beyond the participants.

To begin to address this gap, we reanalyze outcome data for a peer group intervention for HIV prevention conducted in rural Malawi to evaluate separately the direct effects of program participation and those due to diffusion of a peer group intervention. Using multiple regression controlling for demographic factors, we previously reported that adults in the intervention communities had significantly more favorable outcomes than adults in control district communities at 18 months post-intervention, including four behavioral outcomes: partner communication, reported condom use, HIV testing, and community prevention activities (*Identifying Reference 1*). However, because the previous evaluation combines both participants and non-participants in the intervention district, that analysis masks the distinction between effects due to participation and those due to diffusion.

2. Methods

2.1. Design

To evaluate the intervention's efficacy at the community level, we randomly assigned two adjacent districts to the intervention and control conditions using a coin toss. We did not use individual-level random assignment because the peer groups were designed to encourage discussion with non-participating friends and family. At baseline we conducted a random sample of individuals in selected communities in both districts. We then offered the intervention in the communities in the intervention district. Our final evaluation was again an independent random sample of the communities. In other words, we compared the overall community sample at the 2 time points, not matched individuals at baseline and final

evaluation. As a result of this design, the intervention community sample included both persons who had participated in the intervention and non-participants. In this follow-up analysis, we separate the direct effect of the intervention on participants from the effect related to diffusion by comparing outcomes for three groups: participants, non-participants in the same community, and persons in the control community.

2.2. Site and Sample

This study occurred in two agricultural districts in the Central Region of Malawi. Our team began HIV prevention research in Malawi in 1999, at the urging of *Identifying Reference 2*, who became deeply concerned about HIV when she returned to Malawi after completing doctoral study in the U.S. with *Identifying Reference 3*. We developed a promising peer group intervention in the urban areas (*Identifying Reference 4*). To test the intervention we wanted to go to rural areas, where HIV was spreading rapidly and there were almost no prevention programs. We selected the Central region because HIV prevalence was approximately the national average. The two adjacent districts we chose had no other HIV prevention programs and our Malawi team had established relationships in both districts because their nursing students had clinic experiences in these districts.

After random assignment, we selected five rural clinics in each district and implemented the study in the communities that comprised these clinics' catchment areas. We chose intervention communities sufficiently far from control communities (at least two hours travel) to make cross-contamination highly unlikely. The communities were mapped and we selected a random sample of households. One randomly selected adult was interviewed in each household.

After the baseline survey was completed, individuals in the intervention sites volunteered to participate in the intervention. In each community, leaders held an open meeting where the study was introduced and people were invited to sign up for single-gender peer groups. They were free to sign up with friends and neighbors according to their preferences. Eighteen months after the intervention was completed, we conducted a second (unmatched) random sample survey in both districts.

For the current analysis, we divided the post-intervention sample into the three exposure groups of interest. Of the 415 individuals in the sample from the intervention district, 243 (58.6%) were participants and 170 were non-participants who said they did not attend the peer group intervention. There were 413 control individuals in the sample from the control district.

Table 1 shows the demographic characteristics of these three groups. Gender varied significantly among the three groups, with the primary difference being that in the intervention sample more non-participants than participants were male. We divided age into three groups, under 30, 30-49, and 50 and older. The three groups did not differ significantly in their age composition. Education was significantly different; the control district had fewer persons with at least some secondary school than either the participants or the non-participants in the intervention district. These demographic characteristics are associated with outcomes, so they are controlled for in our primary analyses.

2.3. Intervention

The peer group intervention consisted of six sessions offered to same-gender small groups of about 12 members by two co-facilitators. The intervention's theoretical basis integrates the primary health care model, social-cognitive learning theory and contextual tailoring (*Identifying Reference 5*). Facilitators were trained volunteer local health workers and community members, congruent with the WHO primary health care model of community-health worker collaboration. Bandura's social-cognitive learning model (Bandura, 1990) guided the content and skill-building activities. Extensive formative evaluation tailored intervention content to the context of rural Malawi (*Identifying Reference 6*). One goal of the program was to begin a process of diffusion through the community. Each session included an assignment to share some aspect of that session with partners, family, or friends before the next session, such as to discuss HIV stigmatization with a neighbor or talk with a partner about using condoms. The next session began with a review of the assignment, and these discussions made it evident that most participants did complete the assignments. A process evaluation documented that the peer group facilitators delivered the sessions with fidelity to the model (*Identifying Reference 7*).

Demand for the groups was high; we offered the intervention to over 2000 adults and stopped before demand was satisfied to start the same program adapted for adolescents. Program exposure was high among participants: 62% attended all six sessions, 90% attended five or more sessions, and only 4.5% attended fewer than three. Also, 22 people in the intervention district had helped deliver the program by leading groups.

2.4. Measures

2.4.1. Independent Variables: Participation and Diffusion—We first divided the total sample into three exposure groups: participants, non-participants, and control. We used these groups to define two comparisons that together comprise our primary independent variables. Comparing the participant group with the non-participant group in the intervention district measures the effect of participating in the intervention. Comparing the non-participants in the intervention district with the control district group measures the diffusion (or spill-over) effect of the intervention, most likely due to interaction with program participants.

2.4.2. Outcome Variables—Table 2 summarizes the operational measures and measurement properties for all study outcomes that exhibited significant variation across the three exposure groups in our preliminary bivariate analysis. The dependent variables include six psychosocial outcomes – the HIV knowledge index, the ABC's HIV prevention index (Abstain, Be Faithful, use Condoms), the hope index, condom attitudes scale, and self-efficacy for community prevention and for safer sex. There are six reported behavioral outcomes: partner communication index, three indicators of risky sexual behaviors in the past 2 months (risky sex behaviors index, unprotected sex, and ever used condoms), had an HIV test in the past 12 months, and the community HIV prevention index in the last two months. There is some overlap among the three sexual behavior indicators, but each addresses a somewhat different issue. The risky sex index includes unprotected sex plus other less common indicators generally associated with higher risk of sexual transmission,

e.g., sex for money. One of these outcomes – whether the respondent reported having unprotected sex in the last two months – was not in the original evaluation. It overlaps with abstinence and overlaps somewhat (but applies a higher standard) with ever using condoms among the sexually active. Overall, it is a more comprehensive behavioral outcome that incorporates both abstinence and condom use as means of protection. Ever using condoms is included because one possible prevention behavior is the use of condoms with non-marital partners only.

2.5. Procedure

We first conducted the baseline assessment. Then we trained the health worker and community member volunteers to be peer leaders, and they offered the intervention to adults in the community who signed up to participate. We conducted the final post-intervention assessment at 18 months. The procedure is described in greater detail in our prior publication (*Identifying Reference 1*).

2.6. Analysis

To interpret the differences in outcomes among exposure groups at 18 months, it is helpful to consider outcome variables at baseline for the intervention and control community samples. Of course, we cannot identify participants and non-participants in the baseline assessment, which antedated recruitment to the intervention. We used t-tests of differences between independent means or proportions (not shown) to assess the comparability of the intervention and control districts in baseline outcomes. The baseline and final samples were independent random (unmatched) samples, so we cannot evaluate individual change in outcomes. However, we used independent sample t-tests to establish change in outcomes within the intervention district between baseline and 18-months.

To evaluate the variation of outcomes across the exposure groups, we used analysis of variance (for continuous outcomes) and chi square (for dichotomous outcomes). In these preliminary analyses, we also examined the patterns of means and proportions for indications of a possible intervention effect, a diffusion effect, or both.

We then conducted regression analyses to test for participation controlling for diffusion as well as demographic factors (gender, age and education) and diffusion controlling for participation and demographic factors. These two comparisons are represented by two dummy variables: participation is coded 1 for participants and 0 for non-participants and those in the control district; diffusion is coded 1 for individuals in the control district and 0 for all those in the intervention district. We used ordinary least-squares regression for continuous outcomes and logistic regression and odds ratios for proportions. Within a regression equation, the regression coefficient for participation focusses on the difference between participants and non-participants (the intercept) in the intervention district. The diffusion coefficient directly compares non-participants in the intervention district (the intercept) with those in the control district. With this coding, we would expect the regression coefficients for participation and diffusion effects to be opposite in sign, with the control group showing less favorable outcomes, and the participant group showing more favorable outcomes. The extent to which outcomes are less favorable in the control district measures

the diffusion or spill-over effect of the intervention through interaction of non-participants with program participants. The participation-diffusion regression analyses controlled for gender, age, and education because these demographic factors are related to intervention outcomes.

3. Results

3.1 Bivariate Analyses for Selecting Dependent Variables

Comparing the intervention and control communities at baseline (results not shown), we found only two differences in initial outcome variables. Adults in the intervention district had higher self-efficacy for community prevention and they reported higher condom use, although condom use was very low in both districts. These differences disappeared when demographic characteristics were controlled.

For all outcomes that showed post-intervention differences between the intervention and control districts, comparing baseline and final levels showed that outcomes in the intervention district were significantly more favorable at 18 months than at baseline (tests not shown), and the change in average outcomes was smaller in the control district. For example, in the control district, 7.4% reported ever using condoms at baseline and 12.7% reported doing so at 18 months; comparable percentages in the intervention district were 12.3% and 24.5%. Mean HIV knowledge scores increased from 77.6 to 80.5 in the control district and from 75.3 to 85.5 in the intervention district.

Table 3 summarizes the bivariate relationships with exposure for all study outcomes that exhibit significant variation across exposure groups. We visually inspected the pattern of means or proportions across the three groups for continuous and dichotomous outcomes, respectively. A participation effect would be shown by more favorable outcomes for the participant group than the non-participants and control groups. In a diffusion effect, the non-participant group would have more favorable outcomes than the control group. Two psychosocial outcomes – the ABCs HIV prevention index and hope index – exhibit a pattern consistent only with a participation effect; the patterns for the other four psychosocial outcomes are consistent with both participation and diffusion effects. Among the behavioral outcomes, the partner communication index has a pattern consistent only with diffusion; the remaining five have patterns consistent with both participation and diffusion.

3.2. Regression Analyses to Test for Participation and Diffusion Effects

Table 4 summarizes the regression analyses of the outcomes by the exposure group comparisons, permitting the separation of participation and diffusion effects in the same equation. Controlling for demographic factors and diffusion, participating in the intervention has a significant effect on all six psychosocial outcomes – the HIV knowledge index, the HIV ABC's prevention index, the hope index, the condom attitudes scale, and self-efficacy for community HIV prevention and for safer sex. That is, participants have significantly more favorable scores on these outcomes than non-participants from the same district. However, participation directly enhances only one behavioral outcome, the community HIV prevention index.

Controlling for demographic factors and participation, there is no diffusion effect (in the predicted direction) for any of the psychosocial factors. On the other hand, there are significant favorable diffusion effects on five reported behavioral outcomes: the partner communication index, ever used condoms, unprotected sex, HIV test in the last 12 months, and the community HIV prevention index. This means that non-participants in the intervention district have more favorable outcomes on these behaviors than survey respondents in the control district. The intervention has neither a participation nor a diffusion effect on the risky sex index, although the preliminary analysis of variance shows significant variation across the three exposure groups, and the pattern of means is consistent with both effects. We note that in our earlier analysis (*Identifying Reference 1*), the intervention effect on risky sex also disappeared when demographic controls were introduced into the analysis.

4. Discussion and Implications

This is the first study to find evidence suggesting that there were diffusion effects from a peer group intervention for HIV prevention. In the intervention communities, even non-participants report more partner communication about safer sex, less unprotected sex, higher rates of condom use, more HIV tests in the last 12 months, and more community prevention activities than persons in the control communities at 18 months post-intervention. In the same analyses, we also find that the intervention has favorable effects on six psychosocial outcomes for program participants, but there is no evidence suggesting diffusion of these effects to non-participants in the same communities. In other words, the non-participants have knowledge and attitudes similar to the control community sample.

These results raise the question of whether the favorable reported behavioral outcomes of non-participants in the intervention community represent diffusion or if there are plausible alternative explanations. One alternative explanation is secular changes or trends in the larger society that are independent of the intervention. Beginning around 2000, HIV prevalence has slowly declined in Malawi, presumably as a result of individual changes in HIV-related behaviors. However, this society-wide trend would not explain the pattern observed in this study unless there was also reason to believe that these changes affected both participants and non-participants in the intervention district but affected persons in the control district significantly less. We know of no evidence that the overall trend was stronger in one district than the other, although this cannot be completely ruled out.

Another alternative explanation relates to baseline differences among the three comparison groups in this study. The most common design used to evaluate behavioral interventions uses pre and posttests of the same individuals, so any measured differences among the groups can be controlled for and outcome change scores calculated. These studies do not include non-participants in the same community and cannot examine possible diffusion of the intervention. The unmatched community samples design we used is what permitted us to explore possible diffusion effects, but with this design we cannot examine baseline characteristics for the same individuals. However, we do control for known factors related to the outcomes of interest (age, education and gender). We also know that there were only two differences between the districts at baseline in the psychosocial and behavioral outcomes,

and those differences disappeared when these three demographic factors were controlled. Thus, it is unlikely that differences between districts at baseline would account for the pattern of results we found. Moreover, differences between districts would not affect the comparisons between participants and non-participants in the same district.

Unmeasured differences between those in the intervention district who volunteered to be in the intervention and those who did not are also an alternative explanation for the results found. In this study, deciding whether to participate in the peer groups probably related both to convenience factors (e.g., not able to come when peer groups were offered) and to personal factors related to reluctance to attend an HIV prevention intervention. Rogers (1962) and others noted systematic differences between early and late adopters of an innovation, with early adopters having more prestige, education and social influence, who then persuade others to adopt the intervention. Because 58% of those in the intervention community participated in the intervention, participants in this study would include both early adopters, with high social influence, and the early majority and some late majority adopters, who are more like the typical community members. Thus, the group of participants probably includes most of the popular opinion leaders in the community, which should have facilitated diffusion because their example influenced non-participants.

In addition to general differences in willingness to adopt an innovation, there may also be psychological barriers related to this particular intervention focused on HIV prevention, a topic long associated with stigma, fear and sexuality issues. Those who volunteer to be in an intervention are probably more willing to explore HIV prevention issues and adopt recommended changes. This may have contributed to the observed participation effects. That is, participants would be more likely to report desirable outcomes than those who did not attend the peer group. However, pre-existing differences that led some people in the intervention district to volunteer and others not to do so would not explain why non-participants also had more favorable reported behavioral outcomes changes than persons in the control district.

In summary, there are several possible alternative explanations for our findings that cannot be ruled out. However, diffusion of the intervention appears to be an explanation that is more congruent with the full pattern of results.

Even if we assume that the results observed here indicate diffusion, there is not yet sufficient evidence to determine whether such diffusion is likely to occur in other peer group interventions. The only other study that examined diffusion for a peer group intervention found positive effects in the intervention group but no evidence of diffusion to Thai military conscripts in different units at the same base (Celentanon et al., 2000). Insufficient information was provided to judge how often the intervention and diffusion groups had sufficient contacts to foster diffusion. The contrasting findings of Celentanon and colleagues and our study suggest that diffusion of the impacts of a peer group intervention is possible but by no means certain.

If diffusion did occur, we must explore why only behavioral outcomes appear to have diffused to non-participants. One possible explanation may lie in the more social nature of

the behavioral outcomes in this study. For example, participants had to actively involve their partners to increase their partner communication and safer sex behaviors. Only one outcome, engaging in community HIV prevention, showed both participation and diffusion effects. Although exposure to the intervention was successful in influencing the personal HIV-related knowledge and attitudes of program participants, these psychosocial changes apparently were not discussed with family and friends enough to influence non-participants' knowledge and attitudes. The fact that HIV-related knowledge and attitudes did not show any possible diffusion effects suggests that these require the more intense discussion and explanation that is possible in a multi-session peer group intervention but not likely to occur in everyday conversations.

If diffusion of HIV prevention behaviors to non-participants occurred, as suggested by our results, this is important because it means that peer group interventions may be more cost-effective than previously realized. Therefore, we note the conditions in this peer group intervention that may have fostered diffusion in the hope that others can use this information to foster diffusion of future peer group interventions. The communities where this peer group intervention occurred are small, well-integrated and relatively isolated, conditions that may foster diffusion of the intervention's messages. As Kincaid (2004) pointed out, normative change can spread and dominate in a small network, even if that network is nested in a larger network that does not accept the new idea. In contrast, a large city location was identified as a barrier to successful diffusion for two opinion leader interventions in Great Britain (Elford et al., 2001, 2002; Hart, Williamson, & Flowers, 2004). The urban location made it more difficult to identify and retain opinion leaders and to achieve high saturation.

Our intervention also met several conditions that Kelly (2004) identified as fostering diffusion in opinion leader studies, including: opinion leaders that also represent the target group; content focused on endorsement, role-modeling and skill-building; leader training and support; and sufficient penetration of the target community. Although we did not explicitly recruit opinion leaders, the persons who volunteered to be peer group leaders shared many characteristics of opinion leaders, such as prior volunteer activities and community involvement (*Identifying Reference 8*).

Equally important, this peer group intervention was able to overcome cultural norms against public discussion of sexuality, a factor that Elford et al. (2001, 2002) and Hart et al. (2004) felt contributed to the failure of their opinion leader interventions in Great Britain. Prevailing social norms in rural Malawi also made open discussion of sexuality unacceptable, and initially the intervention met with negative reactions in some communities. However, prior discussion with community leaders regarding the need to discuss sexuality, the less public arena of small group meetings and support from local health workers all helped to overcome this barrier. Moreover, the "assignments" to share information with others doubtless contributed to both greater cultural acceptability and possible diffusion effects.

4.1. Study Limitations

There are several limitations regarding our results. This study uses only self-report of outcome data, which introduces biases, especially toward more socially desirable responses (e.g., not reporting sexual behaviors that violate local norms). It is possible that participants would have a stronger bias to report the behavior encouraged in the intervention due to social pressure from others in their small peer group, but non-participants who were influenced by those who did participate might also have been affected by social desirability biases in reporting behaviors. We did not use biomarkers of sexual behavior changes such as incidence of STIs or HIV. Adding biomedical outcomes to the assessment of behavioral interventions for HIV risk-reduction is a relatively recent phenomenon that was rare when this study began. Studies with biomarkers and reported behavioral change measures have generally found less change in biomarkers than reported behaviors, suggesting that there is underreporting of continuing risky behaviors (NIMH Collaborative HIV/STI Prevention Trial Group, 2010). However, reported behaviors, despite underreporting, remain a widespread and useful indicator of actual behaviors.

The most important limitation of this study is lack of evidence regarding mechanisms of diffusion. Because the primary objective of the study was to examine outcomes of the intervention, we did not collect data regarding possible mechanisms of diffusion. We know from peer leaders' reports that participants did do their assignments to talk to others. But we do not have information from non-participants about whether they talked to people in the intervention, what was said or their own responses to the discussion. Thus, direct communication between participants and non-participants seems the most likely mechanism of diffusion, but we cannot offer evidence supporting this. Future research on diffusion of impacts from behavioral interventions should incorporate information regarding mechanisms of diffusion to address this important issue.

4.2. Implications for HIV prevention

The vision of "Getting to zero new infections" is a key component of the UNAIDS (2010) global strategy for 2011-2015, with a goal of reducing new infections by 50%. Behavioral change interventions that have documented efficacy are an essential part of the strategy to meet this goal, but the *UNAIDS Report on the Global AIDS Epidemic 2013* expressed concern that attention to behavioral change efforts has diminished in many countries as more resources are devoted to treatment. The results of this study suggest that the peer group interventions may have a substantial impact on behaviors for non-participants in the same community, enhancing their cost-effectiveness. If our findings are due to diffusion and not some alternative explanation, it would be difficult to exaggerate the practical importance of diffusion of prevention behaviors to the goal of reducing new infections to stem the HIV epidemic. Peer group interventions for behavioral change should be an important component of overall efforts to reduce new HIV infections, especially in countries with high HIV prevalence.

This study also adds to the large body of research supporting diffusion of innovations theory as a robust approach for promoting and accelerating change for a wide range of social and public health issues. Although diffusion of innovations theory has been extensively used in

designing peer leader/opinion leader interventions for HIV prevention, this theory has not been previously applied to peer group interventions for HIV prevention that rely on structured sessions with groups or individuals. These tentative findings should lead to a new direction of research on the diffusion of innovations. Explicit incorporation of insights from research on the diffusion of innovations into peer group interventions may increase their impact and enhance wider implementation.

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Research Highlights

1. The intervention had diffusion effects on five reported behavioral outcomes.
2. Behavioral outcomes diffused to non-participants but psychosocial outcomes did not.
3. Behaviors requiring cooperation from others may diffuse more readily.
4. Peer group interventions that diffuse to others help prevent new HIV infections.
5. Diffusion may increase cost-effectiveness of peer group interventions.

Table 1

Demographic Composition of Exposure Groups

Demographic Characteristic	Control District		Intervention District		<i>P</i> (Chi Sq)
	Control (N = 413)	Non-participant (N = 170)	Participant (N = 243)	Total (N = 826)	
Gender					
Male (%)	49.9	61.8	42.8	50.2	< .01
Age					
Less than 30 (%)	41.3	48.8	42.4	43.2	N.S. *
50 or more (%)	16.5	15.9	21.0	17.7	N.S. *
Education					
Some Secondary (%)	34.9	50.0	48.6	42.0	< .01

* N.S: Not significant

Table 2**Outcome Variables and Operational Measures**

Variables and Items	# Items	Range	α^a
Psychosocial Outcomes			
<i>HIV Knowledge Index:</i>			
% correct, 6 items (AIDS caused by virus/ Menstruation washes away [false]/ Cured by sex with virgin [false]/ Not likely by: Giving blood/ Mosquito bites/ Using public toilet)	6	0-100	-
<i>HIV ABC's Prevention Index:</i>			
# mentioned when asked how a person can prevent HIV (Abstain/Be faithful or reduce partners/ Condoms)	1	0-3	-
<i>Hope Index:</i>			
Mean of 2 items [4=very likely to 1=not likely] (How likely: Stop HIV spread in Malawi/ People will change sexual behavior)	2	1-4	-
<i>Condom Attitudes Scale:</i>			
% positive to condoms of 10 items (Sexual enjoyment for self & partner, 3 items; Indicates promiscuity, 5 items; Effective prevention, 2 items)	10	0-100	.81
<i>Self-efficacy for Community Prevention:</i>			
Mean of 2 items [1=Not Confident, 2=Somewhat Confident, 3=Very Confident] (Can talk about HIV prevention/ safer sex with friends & relatives/ Own children)	2	1-3	-
<i>Self-efficacy for Safer Sex:</i>			
Mean of 6 items [1=not confident; 2=somewhat confident; 3=very confident] (Can abstain if decide not to have sex/ Talk about safer sex with partner/ Get partner to agree to use condoms/ Refuse sex without a condom/ Get condoms/ Use condoms correctly)	6	1-3	.82
Behavioral Outcomes			
<i>Partner Communication Index:</i>			
Sum of 2 items [1=Yes/0=No] (Talk with partner in last 2 months about: Safer sex / Condoms)	2	0-2	-
<i>Risky Sex Behaviors Index:</i>			
# of 5 risky sex behaviors in last 2 months (Unprotected Sex/ Multiple Partners/ Sex at Bars/ Sex for Money/ STI symptoms)	5	0-5	-
<i>Ever Had Unprotected Sex Last 2 Months:</i>			
[1=Yes/0=No, Abstained or always used condom]	1	0-1	-
<i>Ever Used Condom Last 2 Months: Sexually active only [1=Yes/0=No]</i>			
	1	0-1	-
<i>HIV Test in last 12 months: [1=Yes/0=No]</i>			
	1	0-1	-
<i>Community HIV Prevention Index:</i>			
# of 6 activities reported for last 2 months (Led discussion/ Talked prevention/Safer sex with: partner/ Other adults/ Own children/ Other young people/ Contributed money or time)	6	0-6	-

^a Internal consistency coefficient, Cronbach's *alpha* (α)

Table 3**Bivariate Analyses of Outcomes by Exposure Group**

	Exposure Group			P (F or χ^2)
	Control District	Intervention District		
	Control (n = 207)	Non-participant (n = 65)	Participant (n = 139)	
Psychosocial Outcome				
HIV Knowledge Index				
Mean (SD)	80.46 (21.26)	82.65 (20.22)	87.40 (17.98)	< .01 ^b
HIV ABC's Prevention Index				
Mean (SD)	1.61 (0.68)	1.58 (0.66)	1.83 0.60	< .05 ^b
Hope Index				
Mean (SD)	2.46 (1.11)	2.31 (1.03)	2.73 (1.08)	< .01 ^b
Condom Attitudes Scale				
Mean (SD)	50.48 (26.46)	54.38 (27.30)	59.98 (29.69)	< .01 ^b
Self-efficacy for Community Prevention				
Mean (SD)	2.76 (0.49)	2.83 (0.46)	2.93 (0.25)	< .01 ^b
Self-efficacy for Safer Sex				
Mean (SD)	2.23 (0.63)	2.36 (0.60)	2.61 (0.53)	< .01 ^b
Behavioral Outcome				
Partner Communication Index				
Mean (SD)	0.76 (0.69)	1.04 (0.74)	1.03 (0.74)	< .01 ^b
Risky Sex Behaviors Index				
Mean (SD)	0.78 (0.52)	0.73 (0.65)	0.65 (0.56)	< .05 ^b
Unprotected Sex in Last 2 Months				
	0.71	0.63	0.60	< .01 ^c
Ever used Condom in the Last 2 Months ^a				
	0.12	0.23	0.26	< .01 ^c
HIV Test in Last 12 Months				
	0.10	0.17	0.20	< .01 ^c
Community HIV Prevention Index				
Mean (SD)	2.38 (1.79)	2.80 (1.48)	3.53 (1.71)	< .01 ^b

SD: Standard Deviation

^a Among sexually active only^b p (F)^c p (χ^2)

Table 4

OLS and Logistic Regression Analyses of Outcomes by Exposure Group Comparisons, Controlling for Gender, Age and Education

		Participation (Participant = 1)	Diffusion (Control = 1)
Psychosocial Outcome			
HIV Knowledge Index ^a	B (SE) ^{††}	5.65 ^{**} (1.99)	-0.76 (1.81)
HIV ABC's Prevention Index ^a	B (SE)	0.28 ^{**} (0.07)	0.07 (0.08)
Hope Index ^a	B (SE)	0.47 ^{**} (0.11)	0.22 [*] (0.10)
Condom Attitudes Scale ^a	B (SE)	7.72 ^{**} (2.66)	-1.16 (2.43)
Self-efficacy for Community Prevention ^a	B (SE)	0.13 ^{**} (0.04)	-0.04 (0.04)
Self-efficacy for Safer Sex ^a	B (SE)	0.32 ^{**} (0.06)	-0.04 (0.05)
Behavioral Outcome			
Partner Communication Index ^a	B (SE)	0.07 (0.07)	-0.20 ^{**} (0.06)
Risky Sex Behaviors Index	B (SE)	-0.03 (0.06)	0.08 (0.06)
Unprotected Sex Last 2 Months ^b	B (SE) Exp (B)	0.02 (0.21) 1.02	0.48 [*] (0.20) 1.61
Ever used Condom Last 2 Months ^{b c}	B (SE) Exp (B) [†]	0.26 (0.30) 1.29	-0.77 ^{**} (0.30) 0.46
HIV Test in last 12 Months ^b	B (SE) Exp (B)	0.24 (0.27) 1.27	-0.51 [†] (0.27) 0.60
Community HIV Prevention Index ^a	B (SE)	0.86 ^{**} (0.16)	-0.25 [†] (0.15)

^a Ordinary least squares regression

^b Logistic regression

^c Among sexually active

[†] p < .10.

^{*} p < .05.

^{**} p < .01. All two-tailed

^{††} SE: Standard Error

[†] Exp (B): Odds Ratio