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ORIGINAL PAPER

Intervention Reach and Sexual Risk Reduction of a Multi-level, Community-Based HIV Prevention Intervention for Crack Users in San Salvador, El Salvador

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Abstract
This article examines the effects of a multi-level, community-based HIV prevention intervention for crack users residing in low-income neighborhoods in San Salvador, El Salvador conducted between August 2011 and June 2016. The intervention consisted of three components introduced sequentially: (1) rapid HIV testing in community settings; (2) a social network HIV testing intervention; and (3) small group interventions with crack users who were members of the same social network. The intervention was evaluated with an interrupted time series design in which we used respondent-driven sampling to conduct 7 cross-sectional surveys with crack users along a 3–4 month period for each assessment (total n = 1597). Results revealed a significant increase in exposure to the intervention over time with 50% of the participants reporting exposure to one or more of the three components. Getting an HIV test at the community site was associated with reductions in total times each individual had sex without a condom ($p < 0.05$) compared to those who had been exposed to no intervention components. Being referred by another crack user through the Social Network HIV intervention was also associated with reductions in total numbers of condomless sex ($p < 0.05$) The cumulative effect of being exposed to more than one intervention component was associated with reductions in total number of times individuals had condomless sex ($p < 0.05$). In spite of the high level of intervention reach and that self-reported exposure to intervention components was associated with lower sexual risk, reductions in sexual risk over time were not observed in the full sample, indicating that the penetration of HIV prevention components was not sufficient to produce population level change.

Keywords Crack · People who use non-injection drugs · El Salvador · HIV

Resumen
La investigación consistió en evaluar el efecto de una intervención comunitaria con el objetivo de reducir el riesgo de VIH en usuarios de crack residentes de comunidades de bajo ingreso en San Salvador, El Salvador. La intervención consiste de 3 componentes, los cuales se implementaron de forma secuencial: (1) pruebas rápidas de VIH en comunidades; (2) promoción de la prueba de VIH por medio de la red social; (3) talleres impartidos a grupos pequeños de usuarios de crack que se conocen entre sí. Se utilizó un diseño de series de tiempo interrumpido para evaluar el efecto de la intervención. El estudio consistió en administrar 7 ciclos de encuestas seccionales a usuarios de crack reclutados por medio de la metodología conocida como muestreo por medio del participante o "respondent driven sampling". Cada ciclo de encuesta se administró cada 3–4 meses a partir de la implementación de un componente de la intervención y se administraron 1579 encuestas. Los resultados indicaron que la muestra fue expuesta a los componentes de la intervención a través del tiempo y aproximadamente 50% de los encuestados reportaron haber participado en uno de los componentes de la intervención. Los participantes que reportaron haber recibido una prueba de VIH en los sitios donde se implementó la intervención, comparados con los que no fueron expuestos a la intervención, reportaron una reducción en el número de relaciones sexuales sin condón ($p < 0.05$). Haber hecho una prueba de VIH por referencia de otro usuario de crack resulto en una reducción en el número de relaciones sexuales sin condón ($p < 0.05$). Se detectó una relación entre número de componentes de la intervención al cual fueron expuestos los

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participantes y sexo sin uso de condón ($p < 0.05$). A pesar de que la intervención penetro las comunidades bajo estudio, y que se detectó una asociación entre la participación en los varios componentes de la intervención y reducción en conductas sexuales de riesgo, no se detectó una reducción en las conductas sexuales de riesgo a través del tiempo en la muestra entera. Para reducir conductas de riesgo a nivel población es necesario que las intervenciones de salud pública penetren la población de interés. intervenciones.

Introduction

Researchers have increasingly called for the use of multi-level, community-based interventions that address the multiple social-ecological levels that contribute to ill-health among populations [1–3]. Multi-level, community based interventions acknowledge community resources that are available to confront health problems, and advocate for collaboration with community stakeholders in order to develop interventions [4]. Multi-level, community based interventions are expected to offer a number of advantages to HIV prevention interventions that focus on individual level behavior change or those that are developed by researchers from very different cultural settings [1]. These include cultural fit between the intervention and communities' perceived needs, increases in community capacity that can be translated to tackle other social problems, and increased sustainability [2, 4, 5].

HIV/AIDS in Latin America has received less research attention than other regions, in spite of the fact that it is the third region most affected by HIV after sub-Saharan Africa (SSA) and South East Asia (SEA), with an estimated 2 million people living with HIV/AIDS (PLH) and an estimated 208,600 PLH in Central America [6–8]. Central America is the subregion most affected by HIV in Latin America and the Caribbean, having 4 of the 6 countries with the highest rates of HIV infection (Belize, Honduras, Guatemala and El Salvador) [9].

Unlike the epidemic in SSA and SEA, HIV in Latin America is concentrated among vulnerable populations such as men who have sex with men (MSM), commercial sex workers (CSW) and transgender women [8]. However, people who use non-injection drugs, particularly crack cocaine and other stimulants are also a population with high rates of HIV infection that largely has been overlooked in prevention efforts. Compared to the rest of the world, crack use is highest in the Americas [10, 11]. In Latin America, crack use is associated with a number of HIV risk behaviors including low rates of HIV testing [12, 13] and high rates of sex exchanges [14]. HIV rates among crack users is high in Brazil with 5.27% of male crack users and 16.8% of female crack users testing positive for HIV [14]. Our own research in El Salvador has shown that people who use non-injection drugs (PWUD), in particular crack, are a population with high levels of HIV risk behavior and infection. In a study of 420 crack users, the estimated prevalence ranged from 4.9 to 7% (95% CI 2.3–9.8%), larger than the prevalence among female sex workers (3.4%) who have been the focus of intensive prevention efforts. In addition, crack users reported a number of risky sexual behaviors including sex with multiple partners (72%), condomless sex with casual partners (40%), sex under the influence of drugs and other substances (51%), and sex for money exchanges (33%). In spite of these high risk behaviors, over half of study participants reported never having had an HIV test [15].

In spite of the high HIV prevalence among crack users in Latin America and elsewhere in the world, very few HIV prevention interventions have been tested for crack users and even fewer have been shown to be effective [16]. Moreover, to our knowledge, no interventions have been developed or evaluated for the Central American context, a region plagued by community violence. To address these issues, we developed Project Encuentro, a multi-level, community-based intervention to increase HIV testing and reduce the sexual risk behaviors of crack users in San Salvador, El Salvador. The intervention included three components that were introduced sequentially to promote testing and reduce sexual and substance use risk among crack users in three communities of San Salvador [17].

In this manuscript, we evaluated the individual and combined effects of Encuentro's components on sexual risk behaviors and HIV testing, as well as the penetration of intervention components into the population of crack users within the communities over time. We used an interrupted time series design with multiple cross-sectional surveys before and after each intervention component was introduced. We expected that self-reported exposure to each of the three components, namely, receiving rapid HIV testing in community sites, receiving HIV testing from peer referrals, and attending a small group HIV prevention workshop would increase over time, and that individuals who reported exposure to one or more intervention components would be more likely to report fewer HIV risk behaviors.

Methods

Project Encuentro consisted of three components designed to increase HIV testing and reduce sexual risk behaviors among crack users: rapid HIV testing in community sites; social

network HIV testing; and small peer-led group interventions for crack users. For evaluation, the components were introduced sequentially and, once introduced, they were followed until the end of the project. Duration of Project Encuentro with the introduction of the three components wsa 42 months. All participants who received any intervention components or participated in a survey provided their written informed consent.

Research Setting

All intervention and data collection activities took place in three low-income communities of San Salvador, including a community multi-purpose house in an informal slum settlement, and a soup kitchen and an AIDS Service Organization located in two different skid row areas of the city, adjacent to several informal settlements.

The study was conducted in collaboration with the Fundación Antidrogas de El Salvador (FUNDASALVA), a nonprofit organization committed to the treatment and prevention of, and research on, substance abuse in El Salvador, which recruited and trained the field team. The team, which included six research associates and a coordinator, collected data, conducted the community HIV testing and social network testing intervention in the three communities, and helped facilitate small peer group HIV interventions with crack users along with a "peer" facilitator, i.e. a community member who formerly used crack.

Intervention Components

Community-Based HIV Testing

Rapid HIV testing was provided to anyone over the age of 18 who requested an HIV test whether or not they reported smoking crack. The availability of rapid tests in community sites was advertised through posters placed throughout the communities and through word of mouth. Eight hundred twelve rapid HIV tests were administered to people who self-referred during the project period.

Social Networks HIV Testing

We introduced the social network HIV testing intervention after conducting the community-based testing for 18 months. Participants who initiated the referral chains, or "seeds," were identified and recruited in collaboration with our community partners. Seeds, who were 18 years or older, had smoked crack in the previous month, and had not received an HIV test at the community testing sites in the previous three months, provided informed consent and completed a short questionnaire assessing demographics, substance use and sexual risk behaviors, and received HIV counseling and testing according to the World Health Organization (WHO) guidelines. After counseling, study staff invited HIV testers who engaged in sexual risk in the past month according to the risk surveys (i.e. having sex with more than one partner, sex with someone with HIV, experiencing sexual violence, exchanging sex for drugs or money, injecting drugs, or, for men, having sex with another man) to recruit their peers for an HIV test. While some of these behaviors do not carry direct risk for becoming infected with HIV (for example, MSM are only at risk if they have condomless sex with a man of unknown or positive serostatus) we believed these criteria would enable recruitment of those who may be at high risk since MSM have one of the highest rates of HIV infection in Central America, with rates 33 times higher than the general population [18].

To recruit peers to take an HIV test, participants were asked to list the initials of persons who they thought were at risk for HIV and to describe these persons in terms of their sexual behaviors and substance use. This list of initials was not kept as part of any research or programmatic record and was used only to help participants to identify potential peers to recruit. Lists were destroyed after participants recruited 3 peers or a month after their HIV tests in the case that they did not recruit anyone. From this list, interviewers selected the network members who were described as using crack and engaging in sexual risk (as defined above) and gave them up to three coupons to refer these members to take an HIV test. Participants were instructed that they did not need to use the real initials of participants. In addition, to maintain confidentiality, participants approached their peers to recruit them to the study and no information regarding what the participant had revealed was shared with potential recruits. Interviewers did not disclose eligibility criteria to avoid false reporting of eligibility. Counselors scheduled appointments for testers to bring in their peers, asking them to inform their potential recruits of the confidentiality of the HIV test.

Testers who were also crack users and reported past month sexual risk also obtained three coupons to refer members of the social networks who were crack users and engaged in sexual risk. All testers who came with a referral coupon received $5 regardless of whether they were eligible based on crack use or sexual risk to refer their network members. Testers who recruited other testers received a $2 referral incentive for each tester, regardless of whether they were eligible to recruit members of their social networks. Finally, any person 18 years or older was still allowed to self-refer for an HIV test at the community testing sites. They completed the same short questionnaire and, if they reported crack use and sexual risk within the last 30 days, they were interviewed about their social network members and were eligible to receive the $2 incentive for each referral. Incentive amounts were not high enough to be coercive or influence drug use patterns as they were barely enough

to cover the costs of one rock of crack in San Salvador. All participants who tested positive either in the community testing self-referral, component 1, or during the Social Network HIV testing phase, component 2, were referred to the Ministry of Health or a private lab contracted by the project for confirmatory testing and free HIV medical treatment. A total of 1660 HIV tests were administered through the Social Network HIV Prevention Intervention.

Peer Network Small Group Intervention

After 9 months of implementing the Social network HIV prevention intervention, we introduced the peer network intervention. For this purpose, we selected a peer leader from each of the 3 community sites. Peer leaders were identified by community residents, were former crack users, and had extensive contact and a great degree of trust among crack users in the community. FUNDASALVA trained Peer Leaders in 10, 3-h sessions held over 2 weeks to cover in detail components of the intervention, psychosocial theory, methods for ensuring participatory (as opposed to didactic) interventions, facts about HIV/AIDS, and methods for recruiting participants.

Peer leaders recruited active crack users who were invited to bring members of their drug using networks (i.e. people who know each other and use crack) for each intervention cycle. Two peer network intervention cycles with 5–6 participants were held per month, for a total of 30 cycles per community. Five hundred and three (90%) out of 561 potential participants approached agreed to participate. Reasons for refusal included lack of time or interest. Each cycle consisted of three, 2-h sessions held on consecutive days in the late morning. Peer leaders dedicated 10 h per week in recruiting and/or facilitating the intervention and were paid monthly stipends of $75 to compensate their time. Participants in the Peer Network groups received $5 and lunch for participation.

The Peer Network Intervention was based on the Transtheoretical Model (or Stages of Change) [19] and designed to move participants from pre-contemplation to action and maintenance. Sessions were interactive with ample opportunity to practice skills through role playing. Topics covered included information about HIV risk and protective behaviors, sexually transmitted diseases, condom use skills, condom negotiation, locations to obtain free condoms, identifying and avoiding situations in which risk behaviors occur, sexual rights and communicating with peers about harm reduction norms and practices.

FUNDASALVA staff was present and observed all peer network group intervention sessions to offer support to facilitators and ensure fidelity to the intervention. Staff presence was requested by peer facilitators to ensure safety and to support facilitators when needed. Fidelity checklists were completed for 15% of all sessions. Seventy-one percent of the sessions achieved 100% fidelity with mean fidelity at 94%.

Cross-Sectional Surveys

We used an interrupted time-series design with multiple, cross-sectional surveys to evaluate the individual and cumulative effects of intervention components. While randomized controlled trials (RCTs) are often considered the gold-standard in determining the efficacy of interventions, they are not always appropriate for evaluating community-level interventions. Because Encuentro was directed at the entire community of crack users, the high risk of contamination obviated the ability to randomize participants to treatment and control conditions. Further, a cluster randomized control trial was rejected as infeasible because of the lack of information about equivalency of clusters. While pre and post-test longitudinal designs would increase statistical power to detect intervention effects, they were also deemed inappropriate for a number of reasons. First, tracking participants over 5 years was logistically impractical in the Salvadoran context due to the transience of the population, particularly in one of the low-income communities [20, 21], their lack of consistent phone service or housing, and the dangers associated with street outreach in a country that currently has the highest homicide rate in the world. More importantly, a pre-, post-test design would require research staff to actively recruit participants and encourage them to attend all components, rather than the more natural self-selection or peer-referral to intervention components that more closely mimics implementation in real life settings.

To identify changes in trend or level in the time series design, cross-sectional surveys were timed to correspond to the roll out of different intervention components. Two surveys were conducted during the period of rapid testing but before initiating the Social Network HIV testing intervention, two surveys were conducted after initiation of the Social Network HIV testing intervention but before the Peer Network HIV prevention groups, and three surveys were conducted after the Peer Network HIV prevention groups. There was a small overlap between finishing the Assessment 4 surveys and beginning the workshops due to interruptions in recruitment due to increases in violence during that period. Each cross-sectional survey consisted of, on average, 300 crack users 18 years old or older (100 per community site) for a total of 2107 surveys. Accounting for participants who completed more than one survey, we had 1597 unduplicated participants.

Eligibility Criteria and Sampling

Eligibility criteria for the survey included being 18 years or older, having smoked crack in the last month, currently living in, buying or using crack in one of the study communities, and being able to provide informed consent. The decision to keep the criterion of recent crack use was made in order to measure the effects of the intervention on the target population. Unfortunately, the eligibility criterion of past 30-day drug use eliminated surveying those who may have smoked crack during the study period but were no longer smoking, possibly missing crack abstinence and other behavioral changes associated with reduced sexual risk. Having previously participated in a survey did not make a participant ineligible to participate in a second survey as long as it was in a different intervention phase.

Respondent driven sampling (RDS) was used to recruit participants for the surveys [22, 23]. For each survey, we recruited 3–4 "seeds" in each of the three community sites. Seeds were identified and recruited in collaboration with our community partners. If eligible and interested, participants were asked to give their written consent. Surveys were conducted face to face and answers recorded on paper surveys. Each seed was given three coupons (with survey location, project contact information, and a code used to record who recruited whom). Seeds were asked to recruit three of their peers who were crack smokers, but were not informed of the precise eligibility criteria. Study staff scheduled appointment times for seeds to bring in their recruits who were then screened for eligibility and given informed consent. Cross-sectional surveys included an average of 7 waves of recruitment after seeds. Conventionally, RDS is considered to reach equilibrium and be reflective of the population of interest after 5 waves of recruitment [23–25]. Participants were interviewed in the community testing sites and received $5 for participating in the survey and $2 for each participant they successfully recruit to the project.

Measures

Network Characteristics for RDS

We asked participants the number of crack users they saw on a weekly basis, and how many of them were women. Demographic and personal characteristics measured include sex, age, marital status, gang membership, income, employment and level of education. Also included was the community site in which they took the survey. Previous survey participation was measured by two items. The first asked whether they had participated in a survey regarding HIV and crack use previously, and the second asked how long ago (less than a month, between 1 and 6 months, between 6 months and a year, over a year but less than 2 years, between 2 and 3 years, between 3 and 4 years, over 4 years). Repeat participants were also identified by research staff.

Exposure to and Dose of Encuentro

We measured exposure to the various components of Encuentro including whether participants self-referred to receive an HIV test at the community sites, had received a coupon to receive an HIV test (Social Network HIV Testing Intervention), or attended the three day intervention with other crack users they know (Peer Intervention). Dose was calculated as the total number of components participants were exposed to and the particular combinations of components. Although participants were allowed to take HIV tests every 3 months and we tracked repeat HIV testing, these data were collected in a separate database with different identification numbers. Thus, we were not able to link number of tests taken with participant survey data, and therefore could not use this as an additional measure of dose. In addition to exposure to Encuentro, we measured exposure to non-Encuentro HIV prevention interventions including receiving an HIV test during national testing days, receiving an HIV test at Ministry of Health clinics or community-based organizations (CBOs), receiving free condoms, and receiving information about how to prevent HIV from CBOs working in HIV prevention. CBOs working in HIV prevention or working with people living with HIV were listed on the survey for participants to identify exposure to alternative interventions.

HIV-related risk behaviors included the number of times participants had condomless anal or vaginal sex, number of times condomless sex was exchanged for crack, and total number of times participants had condomless sex [26, 27]. PrEP was not available to people who were at risk for becoming infected with HIV in El Salvador during the time of the study.

Analysis

Statistical software R 3.3.2 was used for all analyses. Our data analyses focused on increases in exposure to Encuentro components over time and associations with self-reported intervention exposure to reductions in sexual risk. Analyses of the effects of intervention exposure to changes in sexual risk included three major analyses: (1) increases in exposure to Encuentro components over time (Figs. 1, 2, 3); (2) decreases in HIV sexual risk behaviors over time (Table 3); and (3) the association of sexual risk with self-reported exposure to Encuentro components considered separately or in tandem (Table 4).

Recruitment networks were formed by excluding seeds which resulted in a total number of 300 recruitment networks: 80 were in networks with only one wave

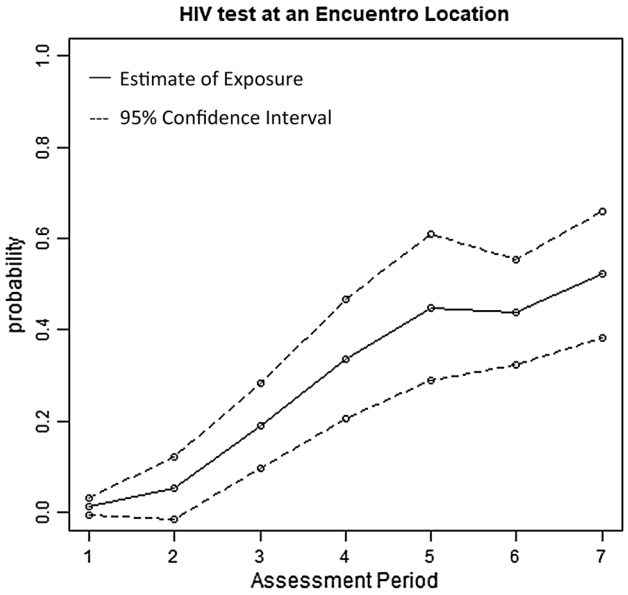

Fig. 1 HIV test at an Encuentro location over time

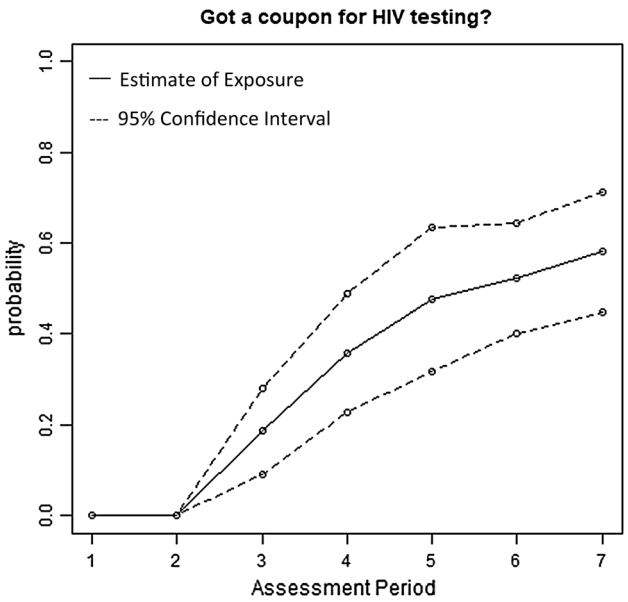

Fig. 2 Proportion of participants surveyed who received a coupon to receive an HIV test

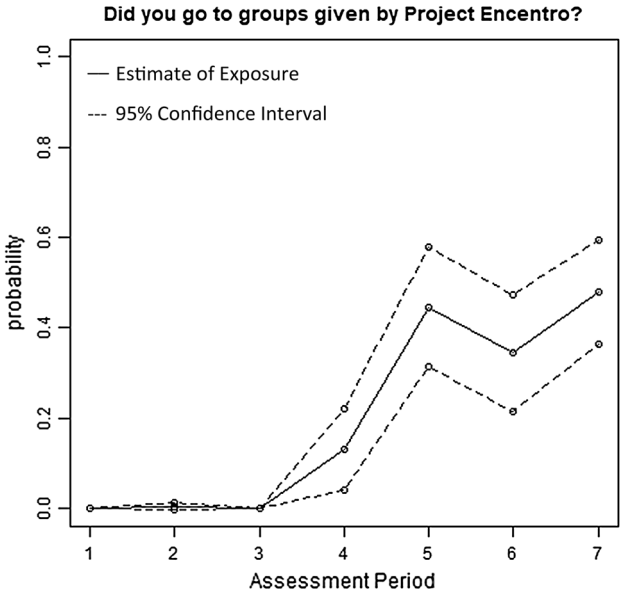

Fig. 3 Proportion of participants surveyed who attended the Encuentro peer network intervention

of recruitment; 31 networks had 2 waves of recruitment; 23 networks had 3 waves; 17 networks with 4 waves; and the largest network had 44 waves. Each recruitment period resulted in around 40 recruitment networks: 39 for period 1, 42 for period 2, 43—3, 46—4, 42—5, 47—6, and 41 in period 7. Due to observational nature of our study we had to account for (1) various sources of confounding, (2) repeated surveys from the same respondent, (3) dependencies imposed by RDS. In addition, analyses had to accommodate non-linear association with count response variables. Widely available RDS software does not allow accommodation of these important specific aspects of our study. Thus, we followed procedures by Selvaraj et al. [28] to analyze RDS data with weighted generalized estimating equations (WGEE). Specifically, we fitted weighted Poisson regression for count outcomes and the presence of more than 300 recruitment networks in our study ensured consistent estimation of standard errors. We applied inverse probability weighting, where the selection probabilities are estimated by an asymptotic outcome-independent formula introduced and justified by Salganik and Heckathorn [29]. The Selvaraj et al. [28] approach mimics an "ultimate cluster" approach where consistent estimates of standard errors for population parameters are obtained relying on primary sampling units only, ignoring more detailed within cluster dependencies. Thus, as required to analyze RDS data, WGEE models accounted for the dependence of multiple observations per person and the degree of homophily between recruiter and recruited within recruitment networks. As a limitation of weighting, we should mention that weights were unstable due to the highly unreliable numbers of crack using networks reported by participants (range 0–5600). To reduce the effect of overly high and low reported network members, we winsorized 0–2, and numbers of crack users above 1000 to 1000. Outcomes are all count variables. In all our analyses reported in Table 3 we adjusted for significant confounding variables.

Overtime behavior of binary variables ("Had an HIV test at an Encuentro site", "Came with a Coupon", and "Attended an Encuentro Workshop") reported in Figs. 1, 2 and 3 were

modeled using WGEE with identity link function since we faced convergence issues with the logit link. Nevertheless, the large number of independent recruitment networks ensured us that the central limit theorem is applicable and the reported proportions and Wald confidence intervals were consistently estimated.

Results

Table 1 reports demographic characteristics on the multiple RDS cross-sectional surveys. Table 2 reports means, medians or frequencies of risk behaviors of the sample during the first assessment, before much exposure to intervention components.

Figure 1 presents the predicted trends in proportion of survey takers who reported having received an HIV test over the 7 assessment periods. As predicted, the number of HIV tests taken at Encuentro sites increased significantly over time, with approximately 50% reporting taking a test at an Encuentro community site at last assessment.

Table 1 Participant and visit characteristics (1597 study participants with 2107 visits)

Characteristic	% or M(SD): surveys
Income	
None	21.55
Up-to-$233	51.54
$233–$466	18.37
$467-or-more	8.50
Missing	0.05
Age	35.95 (11.33)
Number of days smoked crack in last month	19.57 (11.21)
Gender	
Male	86.05
Female	13.62
Transgender	0.24
Missing	0.09
Education	
Grade 0–3	15.28
Grade 4–9	54.96
Incomplete high school	7.45
High school diploma	16.18
Some college	6.12
Job-status	
Full-time-job	6.60
< Full-time-job	59.04
Retired	0.33
Unemployed	30.56
Student	3.27
Missing	0.19

Table 2 Means and 95% confidence intervals of times condomless sex in last 30 days at first 2 assessments (N = 304)

Times had condomless sex in last 30 days	Means and 95% confidence intervals
With non-main partners	2.80 (1.88, 4.15)
In exchange for crack	0.35 (0.23, 0.52)
Total times sex	7.04 (5.61, 8.84)

Figure 2 presents the number of people who arrived by peer-referral in the social network HIV-testing. The number of those who reported being exposed to the social network HIV testing intervention (having received a referral coupon) increased significantly over time, following the first two assessment periods in which recruitment coupons were not offered. In assessment 7, over 50% of a community sample of crack users reported they had received a coupon to take an HIV test. Finally, there was a significant increase in number of participants who reported having attended the peer network HIV intervention (3 day workshop with other crack users) after it was introduced (about 50%), presented in Fig. 3. While some (15%) reported attending a three day workshop at assessment 4, this may have been due to a slight overlap in finishing the last surveys and beginning workshops. We found few participants reporting exposure to non-Encuentro HIV prevention activities. (Data not shown.)

We then analyzed changes in risk behavior over time by assessment period (p cat) in the figure. While there was a significant effect of assessment period on total times participants had condomless sex, looking at IRR and CI for each assessment period showed no pattern of decrease or increase in risk behaviors over time. Thus, we added an analyzed trend in sexual risk over time and found no significant effect (Table 3).

Given the absence of population effects on sexual risk behaviors, we conducted analyses to observe effects on those exposed to one or more intervention components. Table 4 presents the effects of exposure to intervention components on sexual risk behavior without controlling for exposure to other components, while the final column shows the cumulative effects of exposure to more than one Encuentro component. In total, we conducted 12 regressions for four intervention components (receiving a community rapid HIV test; receiving a coupon for Social Network HIV testing; going to a peer group HIV prevention intervention; and the cumulative effects of exposure to one or more intervention components) on three sexual risk outcomes (number of times had condomless sex with a non-main partner in past 30 days; number of times exchanged sex for crack without a condom, last 30 days; and total number of times had condomless sex in last 30 days). All analyses controlled for repeated

Table 3 Incident rate ratios over the first six assessment periods and their 95% confidence intervals (N = 1395 with 1796 visits)

Assessment	Times had condomless sex with non-main partner	Times had condomless sex in exchange for crack	Total times had condomless sex
1 (IRR + CI)	2.18(0.97, 4.88)	0.33(0.16, 0.68)	8.78(6.09, 12.66)
2 (IRR + CI)	1.41(0.76, 2.6)	0.19(0.09, 0.42)	5.13(3.01, 8.75)
3 (IRR + CI)	1.65(0.97, 2.79)	0.15(0.08, 0.27)	4.04(2.81, 5.82)
4 (IRR + CI)	2.1(1.28, 3.46)	0.52(0.25, 1.07)	6.56(4.37, 9.86)
5 (IRR + CI)	4.52(1.7, 12.03)	0.35(0.17, 0.74)	9.72(4.83, 19.57)
6 (IRR + CI)	2.92(1.79, 4.77)	0.37(0.16, 0.89)	6.97(5.06, 9.6)
P(cat)	0.2585	0.1059	0.0456
P(trend)	0.0748	0.331	0.4803

After excluding missing data the sample size decreased to N = 1395 with 1796 visits (based on the first six assessments since 7th assessment recruitment network structure was not collected)

Table 4 Effects of individual components of Encuentro and cumulative Encuentro components on numbers of condomless sexual acts in last 30 days (GEE adjusted incidence rate ratios with 95% confidence intervals)

Times had condomless sex in last 30 days	Got an HIV test at an Encuentro site	Social network HIV testing	Peer-network group intervention	Cumulative Encuentro components
In exchange for crack?	0.59 (0.26, 1.31)	0.50 (0.30, 1.22)	1.20 (0.42, 3.47)	0.84 (0.57, 1.22)
Total times sex with non-main partner	0.44 (0.23, 1.26)	0.51 (0.22, 1.19)	0.82 (0.27, 2.53)	0.79 (0.56, 1.13)
Total times sex	0.60 (0.35, 1.05)*	0.54 (0.31, 0.93)*	0.65 (0.35, 1.24)	0.79 (0.63, 1.00)*

Twelve regression models (three for the effect of HIV test, three for the effects of peer led interventions, three for coupon effects, and three for cumulative effects) were fitted for this table; all analyses controlled for repeated measures, assessment period, site, gender, age, marital status and income. * = < 0.05, after excluding missing data the sample size decreased to N = 1395 with 1796 visits (based on the first six assessments since 7th assessment recruitment network structure was not collected)

measures, assessment period, intervention site, gender, age, marital status and income.

Having an HIV test at an Encuentro site was significantly associated with lower odds of having condomless sex in the last 30 days. Being referred to an HIV test by another crack user in the Social Network HIV testing intervention was significantly associated with reductions in the number of times participants had sex without a condom. Being exposed to more Encuentro components was significantly associated with reductions in the total number of times participants had condomless sex, including with main partners.

Discussion

Our results indicate that Encuentro showed some promise in reaching a community population of crack users and in changing the risk behaviors of those who had directly received any components. These results add to a growing literature on the effectiveness of multi-level interventions [30–35], including our own previous analysis of the effects of the introduction of the social network component, which significantly increased the monthly numbers of HIV tests among crack users [36].

In this paper, we presented results from 7 cross-sectional surveys timed to correspond to the introduction of each of the intervention components. Results suggest that a significant proportion of the crack using members of the community were exposed to each of the intervention components (between 40 and 60%). While we did not see significant reductions in sexual risk behaviors in the cross-sectional community samples over time, individuals who reported exposure to HIV testing in an Encuentro site, Social Network HIV testing and to a greater number of intervention components reported significantly fewer number of condomless sex acts in the past 30 days.

The present study is difficult to compare with other interventions to reduce sexual risk behavior among crack users due to differences in study design. Most published HIV prevention interventions for crack users are randomized controlled trials and compare changes in risk behavior between experimental and control groups. A substantial number of these RCTs have evaluated brief outreach based interventions, or brief group interventions using behavioral change models [37]. These have shown some efficacy in reducing HIV-risk and crack use outcomes in experimental versus controlled conditions [38–46]. However, few of these studies showed effects that were sustained post-intervention. In

addition, none of these studies were conducted in Low or Middle Income countries or in Latin America, despite the extensive evidence of high HIV rates among crack users in some of these countries (e.g., Brazil). Finally, none of the interventions aimed to increase HIV testing among crack users.

Potentially, one of the most impactful effects of our intervention was in increasing the numbers of crack users who took an HIV test. In surveys, the number of crack users who reported taking an HIV test at the community location and those who reported being referred by another crack user increased significantly over time. In an earlier paper analyzing only the effects of introducing the Social Network HIV testing intervention, we found that the total number of monthly testers increased significantly and decayed more slowly, and the total number of crack-using testers increased almost fourfold. HIV prevalence among crack users and non-users was approximately 5% [36]. Given the emphasis on treatment as prevention in the current era of HIV prevention, increasing testing rates among crack users is of utmost importance.

As in other studies, our results showed moderate effect sizes in reducing sexual HIV behaviors among those who were exposed to intervention components. Interestingly, the effect of attending a small group intervention following the Transtheoretical Model was not significant, suggesting that small group interventions may not be efficacious for this population. The effects of attending the small group intervention may have been underestimated, however, as we did not measure changes in knowledge and attitudes about HIV transmission over time. Our previous study showed that HIV knowledge and protective behaviors were generally low. In addition, many of our participants may have been at a lower stage of change than many high-risk participants in other countries who have been exposed to multiple HIV media campaigns and interventions over time. As mentioned, drug users as a risk category have been relatively ignored in HIV prevention in LMIC and Latin America, so many participants may have been at the precontemplation stage of change.

The purpose of multi-level, community-based interventions is to create community-level change in health outcomes. Along this line, our interrupted time-series design using RDS allowed us to measure the penetration of the intervention components into the targeted population which RCT and pre-, post-test longitudinal designs cannot do.

Researchers are increasingly interested in questions of the implementation and scale-up of multi-level interventions [47]. A difficulty in determining the reach of an intervention into vulnerable and hidden populations is that the size of the population is often unknown, particularly in LMICs. If the assumptions of RDS are met, RDS should be able to assess the proportion of the population that is exposed to interventions. Although the penetration of Encuentro appeared to be good, it failed to create significant sample-level behavior change. This may have been due, in part, to the high mobility of residents of poor, urban neighborhoods in San Salvador during the time of the study due to increases in community violence. However, another possible explanation is that intervention reach was not sufficient to cause population level changes. The question of how many people must be reached in order to create population level changes in behaviors is an important one that has been relatively ignored in the literature. Interrupted time-series designs with community samples recruited using RDS are one way of answering this important question. Future analyses will use survey data, including detailed social network data, to set parameters to model the penetration needed to create behavior change.

Limitations and Conclusions

Several limitations should be noted in this study. We used an interrupted time-series design using cross-sectional surveys which, while it offers several advantages noted above, also has disadvantages, including exposure to non-intervention events and the inability to make causal conclusions. A cluster randomized control trial would have allowed us to determine more effectively if observed effects were due to other HIV prevention efforts. As mentioned, however, we measured exposure to non-Encuentro HIV prevention interventions and found limited exposure to these. Another limitation includes the biases inherent in self-report including faulty memory and self-presentation biases.

An important source of bias in the present study is the use of RDS to recruit participants for the multiple cross-sectional surveys. Recent research has called into question some of the assumptions central to RDS estimators, as they are often violated in RDS implementation. These violations may also have been present in this study. These include that recruits are randomly selected from recruiters' networks, that enrollment probability is proportional to the size of recruiters' networks, and that recruitment occurs within recruiters' networks [48]. In particular, empirical research that used extensive sociometric data indicated that almost half of recruitment coupons were redistributed to other eligible individuals by network members whom recruiters initially gave coupons [48]. In addition, qualitative research indicates that recruiters often select network members who they feel are reliable and will show up to survey appointments [49]. These findings regarding recruitment processes should be used to improve the performance and sensitivity to violations of RDS assumptions in estimators. Additionally, there are some ethical issues related to RDS, including the fact that participants provide sensitive information including

drug use and sexual behavior about people who have not yet consented to participate in research, and potential negative effects of peers who are approached to participate in the study who may be offended or feel that their illicit behaviors were revealed without their permission. Despite limitations, RDS is one of the few options to recruit hard to reach populations and potentially to make population estimates of disease prevalence or intervention reach in a population whose size and parameters is unknown. Thus, results must be interpreted with caution until new and less biased estimators reflecting real-life RDS implementation are developed.

In spite of these limitations, this paper makes several important contributions to the literature. First, it provides some indication that components of a community-wide intervention can reach a significant proportion of the population and that exposure to intervention components can reduce reported risk behaviors. Results also confirm that it is possible to conduct and assess community-level interventions in low-income countries with high levels of community violence. This suggests that this intervention can be replicated in other high conflict and low-resource areas. Finally, the paper also suggests a new area of inquiry, the penetration needed for an intervention to have population level effects on behavioral outcomes. This is an important implementation outcome that is increasingly relevant as Global Health Initiatives such as PEPFAR, the Global Fund to combat HIV, Tuberculosis and Malaria, and the WHO attempt to scale up multi-level, national strategies to prevent and treat HIV.

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Compliance with Ethical Standards

Conflict of interest All 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 committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was reviewed and approved by Institutional Review Boards at the Medical College of Wisconsin and the Universidad Centroamericana José Simeón Canas.

Informed Consent Written informed consent was obtained from anyone who participated in any intervention component or completed a survey.

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