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MAJOR ARTICLE

A Brief Peer-Led Intervention to Increase COVID-19 Vaccine Uptake Among People Who Inject Drugs in San Diego County: Results From a Pilot Randomized Controlled Trial

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Background. We evaluated the impact of a brief peer-led intervention on COVID-19 vaccination among people who inject drugs (PWID) presenting at syringe services program (SSP) locations in San Diego County, California.

Methods. Between March and July 2022, PWID aged ≥18 years without recent voluntary COVID-19 testing who were not up to date on COVID-19 vaccinations received a single-session motivational interviewing intervention (LinkUP) or an attention-matched didactic control condition from trained peer counselors at SSP sites randomized by week. Following either 30-minute session, counselors offered referrals to local vaccination services. Multivariable log binomial regression via generalized estimating equations assessed LinkUP effects on (1) acceptance of COVID-19 vaccination referrals immediately postintervention and (2) COVID-19 vaccine uptake at 6-month follow-up.

Results. COVID-19 vaccination outcomes were obtained on 135 (90.6%) of 149 participants. In multivariable analysis, participants receiving LinkUP had greater acceptance of COVID-19 vaccination referrals than controls (adjusted relative risk, 3.50; 95% CI, 1.01–12.2) and were marginally more likely to report receiving a new COVID-19 vaccine dose (adjusted relative risk, 1.57; 95% CI, .99–2.48). After 6 months, 20% reported receiving a new vaccine dose; however, if COVID-19 vaccine had been available at SSPs, this proportion could have been as high as 34.3% (45.3% LinkUP vs 24.3% control; $P = .01$).

Conclusions. A brief peer-led SSP-based intervention significantly improved COVID-19 vaccination among PWID. Further improvements could likely be obtained by supporting SSPs to offer COVID-19 vaccination on-site instead of relying on referrals.

Clinical Trials Registration. ClinicalTrials.gov NCT05181657.

Keywords. COVID-19; harm reduction; motivational interviewing; substance use; vulnerable populations.

People who use drugs are more vulnerable to acquiring SARS-CoV-2 than the general population, and their high prevalence of comorbidities predisposes them to serious COVID-19 disease and related complications [1]. People who inject drugs (PWID) experience particularly heightened COVID-19 risk due to pervasive structural factors, including homelessness, lack of health insurance and transportation, and stigma and medical mistrust, which may compromise their ability to adhere to COVID-19 prevention measures or seek health care when needed [2, 3].

COVID-19 vaccination rates among PWID are suboptimal. By June 2021, only 10% of PWID attending a syringe services program (SSP) in Oregon had received at least 1 COVID-19 vaccine dose [4]. In contrast, 68% of PWID in a long-standing cohort in Baltimore, Maryland, had received at least 1 COVID-19 dose by the same date, but this was still lower than the general population [5].

From a study of PWID in San Diego County, California, we previously reported that only 37.8% of participants had completed their primary vaccination series by April 2022 and none had received boosters by that time [6]. COVID-19 vaccination rates were significantly lower among those who lacked

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health insurance and believed that COVID-19 vaccines contained tracking devices, whereas ever receiving influenza vaccines, being HIV seropositive or SARS-CoV-2 RNA positive, knowing more people vaccinated against COVID-19, and recently being incarcerated independently predicted higher COVID-19 vaccination rates. In the same study, more than one-third of PWID tested SARS-COV-2 seropositive, of whom half reported at least 1 missed opportunity for COVID-19 testing [7]. In-depth interviews with a subset of these participants confirmed that major barriers to COVID-19 vaccination included low perceived risk from COVID-19; distrust of pharmaceutical companies and government agencies distributing vaccines; conflicting information from news, social media, and peers; and limited health care access [8].

As part of the RADx-UP initiative to increase uptake of COVID-19 testing and vaccination among marginalized US populations, we designed LinkUP, a brief social cognitive theory–based intervention with motivational interviewing (MI) delivered by trained counselors at SSP sites. In a randomized controlled trial [9], PWID randomized to LinkUP were significantly more likely to agree to rapid COVID-19 testing immediately following their counseling session, which was the primary outcome [10]. Herein, we evaluated the extent to which the LinkUP intervention was associated with the secondary outcomes of greater acceptance of COVID-19 vaccination referrals and subsequent COVID-19 vaccine uptake relative to the didactic attention-matched control condition.

METHODS

Study Design and Setting

The LinkUP trial was delivered from March to June 2022 through OnPoint, a mobile SSP in San Diego County, as previously described [9], with follow-up interviews conducted through March 2023. To recruit participants, we leveraged the infrastructure of La Frontera, a cohort study examining infectious disease and overdose risk among PWID in the San Diego–Tijuana border region [11]. La Frontera survey data were used to identify potentially eligible participants who had indicated interest in being recontacted for future studies. These participants were contacted through phone calls, texts, social media, and street outreach to assess their LinkUP eligibility through a short screener. We also reopened street outreach–based recruitment for La Frontera to ensure that the target sample size for LinkUP ($n = 150$) could be met. Eligibility for LinkUP required being ≥18 years old, injecting drugs in the last month, and residing in San Diego County. Since the primary outcome of the trial was to increase COVID-19 testing and a secondary outcome was vaccination uptake, individuals were excluded if they reported past voluntary COVID-19 testing or being up to date on COVID-19 vaccinations per the 2022 guidelines of the US Centers for Disease Control and Prevention (CDC) ; however, those reporting mandatory COVID-19 testing within shelters and correctional facilities >2 months ago were considered eligible for inclusion [9]. For eligible individuals, research staff explained the study in English or Spanish using a consent form, answered any questions, and obtained written informed consent. All study procedures were approved by the Office of IRB Administration at the University of California San Diego in accordance with the ethical standards of the institution and national research community and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Baseline Assessments

Trained interviewers collected data outdoors using interviewer-administered, computer-assisted assessments in English or Spanish. Baseline surveys assessed sociodemographics, substance use behaviors, and medical history; COVID-19 knowledge, beliefs, exposures, and protective behaviors; and additional RADx-UP tier 1 common data elements [12]. COVID-19 misinformation was assessed through 6 dichotomized items (ie, true/unsure vs false). COVID-19 disinformation was assessed through a scale consisting of 6 dichotomized conspiracy-related items, such as endorsing the statement that "COVID-19 vaccines contain tracking devices" (Cronbach $\alpha = 0.72$) [13]. Participants also provided blood specimens for serologic testing for HIV and HCV [11]. Participants received $20 for baseline visits and laminated study identification cards and were usually accompanied to OnPoint by La Frontera staff after they had completed their baseline interview and provided consent for LinkUP. In cases where La Frontera staff did not accompany participants, OnPoint peer counselors confirmed their identities by viewing their laminated identification cards before administering the LinkUP intervention or didactic attention control, for which participants received an additional $10 compensation.

Randomization and Intake

We randomized weeks of study implementation as intervention or control, which minimized contamination since staff could then focus on only a single intervention in a given week and were less likely to introduce elements from one intervention arm to the other. After confirming participants' identities, counselors briefly reassessed their COVID-19 testing and vaccination history and harm reduction needs before delivering the condition randomly allocated to that week.

LinkUP Intervention Condition

The single-session LinkUP intervention was designed to be delivered in English or Spanish within 30 minutes by peer counselors who had been formally trained in research ethics and MI (up to 8 hours of self-directed training, depending on experience), as well as COVID-19 biology, testing, and vaccination. Additional training involved observations, opportunities for

practice, and feedback from the MI-experienced project director, who supervised intervention delivery and monitored fidelity using a structured form [9]. Intervention content was based on available literature, social cognitive theory [14], formative research with PWID and key stakeholders [7, 8, 11], and input from the Community Scientific and Advisory Board. The session began with brief educational videos on COVID-19 epidemiology, testing, and vaccination (~5 minutes), which were developed by the World Health Organization, CDC, and RADx-UP and were available in English and Spanish [15–17]. The remainder was interactive, with tailored COVID-19 education based on participants' unique questions and concerns, MI strategies to identify their primary concerns and tip their decisional balance (eg, rating personal motivation, debating and clarifying myths vs facts, elaborating on personal meaning), and problem-solving and planning strategies for following through on future vaccination [9, 18].

Didactic Intervention Condition

The didactic condition was designed to last 30 minutes as an attention control. Also conducted in English or Spanish, the session began with the same brief educational videos (~5 minutes), followed by another educational video on cardiopulmonary resuscitation developed by the National Safety Council (~25 minutes) [19]. Counselors were instructed to avoid engaging in prolonged discussion or MI during the didactic session but could answer questions using standardized scripts.

Immediate Postintervention Assessments

Immediately after each session, counselors offered participants on-site COVID-19 rapid antigen testing. Since OnPoint was not equipped with medical personnel to provide on-site vaccination, counselors offered referrals to local community clinics and pharmacies with COVID-19 vaccination services. Specifically, counselors asked participants, "Do you want a referral to get a COVID-19 vaccine right now?" Those who declined were asked possible reasons in a nonjudgmental manner. Those who were interested were given a list of nearby community clinics and pharmacies providing free COVID-19 vaccines approved or authorized by the Food and Drug Administration. This list consisted of venues that had agreed to accept LinkUP study photo identification cards for those who lacked government-issued photo identification, which presents a substantial barrier to health care access for many marginalized individuals [20]. Counselors completed outtake forms to document the components of the interventions that were administered, their duration (in minutes), and whether participants received a rapid COVID-19 test and accepted vaccination referrals.

Follow-up Assessments

Study staff used street outreach, phone calls, texts, and social media (eg, Facebook Messenger, La Frontera's Facebook page) to recontact participants approximately 6 months later to conduct follow-up interviews reassessing their COVID-19 vaccination status, including dates, doses, and manufacturers. Study flyers were also posted near parks, encampments, and vacant lots. Participants were compensated $20 for follow-up interviews.

Data Analysis

Of the 150 participants enrolled in the trial, at follow-up 1 participant presented a vaccination card that showed being up to date on COVID-19 vaccination at the time of enrollment; this person was thus ineligible for the trial and excluded from analysis. All others were included in an intent-to-treat analysis (Figure 1). Following CONSORT guidelines, we compared participant characteristics between the study conditions at enrollment (Supplementary Table 1) [10] and between those who were interviewed at follow-up and those who were lost to follow-up. We used frequency, percentage, and chi-square or Fisher exact test for binary variables and median, IQR, and Mann-Whitney *U* test for continuous variables. We also compared those who did and did not accept COVID-19 vaccination referrals and those who did and did not report receiving new COVID-19 vaccine doses postintervention (Table 1). COVID-19 vaccine hesitancy was defined as not wanting to receive a COVID-19 vaccine or being unsure. To determine if the LinkUP intervention was significantly associated with greater acceptance of COVID-19 vaccination referrals and subsequent COVID-19 vaccine uptake, we restricted the analytic sample to those with follow-up data on COVID-19 vaccination outcomes (n = 135/149, 90.6%). We developed separate multivariable log-binomial regression models via generalized estimating equations, with intervention group as the primary variable of interest and potential confounders as covariates. We accounted for potential clustering by specifying an exchangeable correlation structure for participants recruited during the same week. Possible covariates were selected from previous research with the same sample [6, 10, 21] and modified disjunctive cause criteria [21]. Variables yielding P values $\leq$.10 in univariate regressions were considered in multivariable models and retained when $P \leq .10$. Interactions were evaluated to determine if any covariates moderated the effects of the intervention on the outcome. Multicollinearity was assessed by examining the largest condition index and variance inflation factors. All analyses were conducted in SAS (version 9.4; SAS Institute).

RESULTS

Study Sample Characteristics

Comparison of the 149 participants by condition at enrollment revealed that the 2 study arms were balanced with respect to proportions who were partially vaccinated against COVID-19 and other behavioral characteristics [10]. However, LinkUP intervention participants were significantly more likely to be

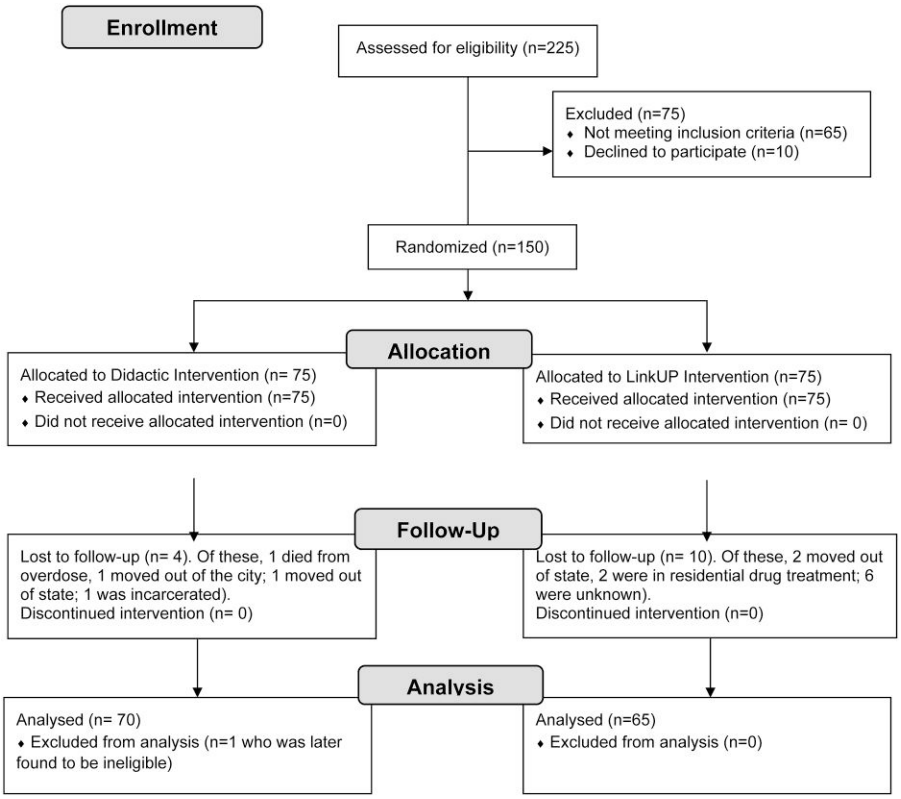

Figure 1. CONSORT flow diagram.

younger and to have recently experienced homelessness or food insecurity (Supplementary Table 1).

Overall, 135 (90.6%) completed follow-up interviews at a median 6.7 months (IQR, 5.0–9.3) postintervention. Proportions retained at follow-up were similar between the groups (86.7% LinkUP vs 94.6% control; $P = .16$; Figure 1). When compared with participants who were retained (n = 135), those lost to follow-up (n = 14) were significantly more likely to report using fentanyl ($P = .03$) or receiving methadone or buprenorphine treatment in the 6 months prior to baseline ($P = .02$). Reasons for attrition included overdose death (n = 1), entering residential drug treatment (n = 2), having moved out of the region (n = 4), being incarcerated (n = 1), and unknown (n = 6).

Of the 135 participants, the median age was 40 years (IQR, 34–52); 31.9% identified as Hispanic/Latinx/Mexican; and 63% identified as male. At baseline, 23.7% were partially vaccinated against COVID-19; 8.9% reported sleeping in a shelter or welfare residence; and 12.7% had been incarcerated in the prior 6 months (Supplementary Table 1).

Effect of the LinkUP Intervention on Acceptance of COVID-19 Vaccination Referrals

All 135 participants in the analytic sample underwent randomization and received either the LinkUP intervention (n = 65) or didactic control (n = 70) on the same day as their baseline interviews. Following the sessions, 20 (30.8%) LinkUP and 5 (7.1%) control participants accepted COVID-19 vaccination referrals ($P < .001$). In univariate analysis, this corresponded to a relative risk (RR) of 3.74 in favor of the LinkUP intervention (95% CI, 1.11–12.6; $P = .03$; Table 1). Other variables associated with greater acceptance of COVID-19 vaccine referrals were as follows: older age, being Hispanic/Latinx/Mexican, sleeping in a shelter/welfare residence, food insecurity, more years of injection drug use, injecting more times per day, having at least 1 chronic illness, knowing someone who died of COVID-19, having had a mandatory COVD-19 test prior to the study, and ever having had an influenza vaccine. COVID-19 vaccine hesitancy was negatively associated with accepting a referral.

In multivariate analyses controlling for baseline age, COVID-19 vaccine hesitancy, and having had mandatory COVID-19 testing prior to enrollment, LinkUP intervention participants remained more likely than control participants to accept COVID-19 vaccination referrals (adjusted RR, 3.50; 95% CI, 1.01–12.2; Table 2).

Effect of Active LinkUP Intervention on COVID-19 Vaccine Uptake

At follow-up, 27 (20.0%) participants reported having received a new COVID-19 vaccine dose: 15 (55.6%) from LinkUP and 12

Table 1. Factors Associated With COVID-19 Vaccine Referral Acceptance Among PWID in San Diego County Who Participated in the LinkUP Intervention Trial

Variable	RR (95% CI)	
	Univariate	Adjusted
Active vs didactic intervention	3.74 (1.11–12.6)[a]	3.50 (1.01–12.2)
Length of intervention session in minutes	0.97 (.94–1.01)	…
Sex at birth: male	1.03 (.30–3.57)	…
Age per 5-y increase	1.18 (1.07–1.29)[a]	1.08 (1.00–1.17)
Hispanic/Latinx/Mexican	1.87 (1.30–2.70)[a]	…
Years of education	0.99 (.88–1.11)	…
Married or common law	1.47 (.74–2.91)	…
Monthly income US <$500	0.88 (.57–1.36)	…
Experienced homelessness[b]	0.97 (.48–1.93)	…
Slept in shelter or welfare residence[b]	3.13 (1.94–5.06)[a]	…
Attended a syringe exchange program[b]	1.26 (.56–2.81)	…
Overdosed[b]	1.42 (.56–3.57)	…
Lacks health insurance	1.09 (.37–3.22)	…
Incarcerated[b]	0.80 (.30–2.17)	…
Engaged in sex work[b]	2.25 (.75–6.74)	…
Since COVID-19 pandemic began		
Income worse	0.80 (.43–1.47)	…
Low/very low food security	2.12 (1.08–4.16)[a]	…
No. of years of injection drug use per year	1.02 (1.00–1.04)	…
No. of times injected drugs per day[b]	0.85 (.76–.95)[a]	…
Receptive needle sharing[b]	1.52 (.86–2.71)	…
Tested seropositive		
HIV[c]	0.48 (.21–1.07)[a]	…
HCV[d]	1.31 (.94–1.83)	…
Has asthma or other lung problem	2.37 (.81–6.93)	…
Has hypertension	1.56 (.73–3.32)	…
Has at least 1 chronic illness	1.79 (1.30–2.46)[a]	…
Practiced social distancing	0.69 (.27–1.75)	…
Wore face mask	0.77 (.43–1.38)	…
Increased handwashing/sanitizer	0.90 (.54–1.49)	…
Engaged in at least 1 protective behavior	2.63 (.62–11.2)	…
Enrolled in a methadone/buprenorphine program[b,e]	1.53 (.47–5.03)	…
COVID-19 disinformation measures		
Thinks the pharmaceutical industry created COVID-19[f]	0.73 (.24–2.19)	…
Thinks COVID-19 was created by the Chinese government as a biological weapon[g]	1.00 (.58–1.72)	…
Thinks vaccines cause autism[g]	1.06 (.52–2.14)	…
Thinks COVID-19 vaccines being offered to "people like me" are not as safe[g]	1.63 (.85–3.13)	…
Thinks COVID-19 vaccines include a tracking device[g]	1.07 (.44–2.62)	…
Thinks COVID-19 vaccines could change DNA[g]	0.80 (.25–2.55)	…
No. of conspiracy items that they believe (out of 6)[g]	1.00 (.79–1.26)	…
COVID-19 misinformation measures[g]		
Does NOT think the virus that causes COVID-19 can be easily spread	0.59 (.33–1.06)[a]	…
Does NOT think many thousands of people have died from COVID-19	1.02 (.44–2.34)	…
Thinks most people already have immunity to COVID-19	1.28 (.64–2.53)	…
Thinks you can tell someone has COVID-19 by looking at them	1.06 (.50–2.25)	…
Thinks having COVID-19 is about as dangerous as having the flu	1.07 (.64–1.80)	…
Does NOT think COVID vaccines are safe for pregnant women	1.71 (.87–3.36)	…
Other COVID-19–related measures		
Most important source of COVID-19 information		
Friends[h]	0.95 (.43–2.14)	…
Doctors/health professionals[i]	1.55 (.59–4.09)	…
Liberal TV/radio[j]	1.52 (.59–3.91)	…
Social media[k]	0.42 (.18–1.02)[a]	…
Knows someone who died of COVID-19[f]	2.27 (1.03–5.00)[a]	…
On a scale of 1 to 10, how worried are you of getting COVID-19?	1.01 (.89–1.14)	…
No. of people they know who have had a COVID-19 vaccine[e]	0.99 (.98–1.01)	…
Thinks they had COVID-19	0.90 (.37–2.16)	…
Had a mandatory COVID-19 test prior to study	2.49 (1.15–5.36)[a]	1.56 (.99–2.45)
Ever had an influenza vaccine[l]	2.37 (1.28–4.40)[a]	…
Hesitant to get vaccinated for COVID-19[i]	0.15 (.06–.39)[a]	0.19 (.08–.45)
Partially vaccinated for COVID-19	1.42 (.61–3.33)	…
Immediately postintervention		
Interested in getting COVID-19 vaccinated "today" or in future[g]	8.43 (1.91–37.3)[a]	…
Agreed to and was tested for COVID-19	1.94 (.79–4.74)	…

Abbreviations: PWID, people who inject drugs; RR, relative risk.

[a]*P* values ≤.10 for the Wald chi-square tests from univariate regression models.

[b]Past 6 months.

Missing values:[c] n = 11.[d] n = 12.[e] n = 3.[f] n = 2.[g] n = 1.[h] n = 7.[i] n = 5.[j] n = 6.[k] n = 8.[l] n = 4.

(44.4%) from control ($P = .39$). Of the 103 previously unvaccinated participants, 15 (14.6%) received their first COVID-19 vaccine dose postintervention (66.7% intervention vs 33.3% control; $P = .10$). Of the 32 participants partially vaccinated at baseline, 12 (37.5%) received at least 1 new COVID-19 vaccine dose postintervention (41.7% intervention vs 58.3% control; $P = .20$). Of the 77 (59.2%) study participants who were previously vaccine hesitant, 9 (11.7%) received a new vaccine dose (12.5% intervention vs 11.1% control; $P > .99$). Although a significantly higher proportion of participants who agreed to rapid COVID-19 testing immediately postintervention accepted a COVID-19 vaccine referral and subsequently received vaccine (Table 1), having received a rapid COVID-19 test was not a significant predictor of either outcome in multivariate analyses. At follow-up, 5.2% of the participants were up to date on COVID-19 vaccinations per the CDC guidelines (6.2% intervention vs 4.3% control); 29.6% were partially vaccinated (36.9% vs 22.8%); and 65.2% remained unvaccinated (56.9% vs 72.9%). However, based on the proportion of participants

Table 2. Factors Associated With COVID-19 Vaccine Uptake Among PWID in San Diego County Who Participated in the LinkUP Intervention Trial

Variable	RR (95% CI)	
	Univariate	Adjusted
Active vs didactic intervention	1.43 (.83–2.48)	1.57 (.99–2.48)
Length of intervention session in minutes	1.02 (1.00–1.04)[a]	…
Sex at birth: male	0.85 (.40–1.83)	…
Age per 5-y increase	1.23 (1.11–1.36)[a]	1.22 (1.11–1.35)
Hispanic/Latinx/Mexican	0.49 (.18–1.34)	…
Years of education	0.99 (.89–1.10)	…
Married or common law	1.03 (.20–5.30)	…
Monthly income US <$500	0.55 (.28–1.07)[a]	…
Experienced homelessness[b]	0.62 (.27–1.41)	…
Slept in shelter or welfare residence[b]	2.35 (1.03–5.36)[a]	2.09 (1.10–3.96)
Attended a syringe exchange program[b]	0.50 (.23–1.10)[a]	…
Overdosed[b]	1.46 (.77–2.78)	…
Lacks health insurance	0.52 (.08–3.58)	…
Incarcerated[b]	1.98 (.98–3.99)[a]	…
Since COVID-19 began		
Income worse	0.78 (.31–1.95)	…
Low/very low food security	1.84 (.98–3.48)[a]	…
No. of years of injection drug use	1.03 (1.01–1.06)[a]	…
No. of times injected drugs per day[b]	0.85 (.60–1.21)	…
Receptive needle sharing[b]	1.37 (.71–2.63)	…
Tested seropositive		
HIV[c]	2.24 (.80–6.30)	…
HCV[d]	1.29 (.67–2.47)	…
Has diabetes	2.81 (1.17–6.72)[a]	…
Has asthma or other lung problem	0.50 (.09–2.84)	…
Has hypertension	1.18 (.56–2.49)	…
Has at least 1 chronic illness	1.46 (.79–2.72)	…
Practiced social distancing	0.90 (.35–2.27)	…
Isolated or quarantined itself	0.90 (.32–2.53)	…
Wore face mask	2.19 (.50–9.62)	…
Increased handwashing/sanitizer	0.52 (.18–1.54)	…
Enrolled in a methadone/buprenorphine program[b,e]	0.73 (.17–3.13)	…
COVID-19 disinformation measures		
Thinks the pharmaceutical industry created COVID-19[f]	0.75 (.43–1.30)	…
Thinks COVID-19 was created by the Chinese government as a biological weapon[g]	0.77 (.35–1.67)	…
Thinks vaccines cause autism[g]	1.01 (.62–1.65)	…
Thinks COVID-19 vaccines being offered to "people like me" are not as safe[g]	1.02 (.43–2.42)	…
Thinks COVID-19 vaccines include a tracking device[g]	0.63 (.26–1.56)	…
Thinks COVID-19 vaccines could change DNA[g]	0.83 (.39–1.76)	…
No. of conspiracy items that they believe (out of 6)[g]	0.93 (.75–1.14)	…
COVID-19 misinformation measures[g]		
Does NOT think the virus that causes COVID-19 can be easily spread	1.41 (.79–2.53)	…
Does NOT think that many thousands of people have died from COVID-19	1.33 (.71–2.49)	…
Thinks that most people already have immunity to COVID-19	2.22 (.79–6.23)	…
Thinks that you can tell someone has COVID-19 by looking at them	1.97 (.94–4.14)[a]	…
Thinks that having COVID-19 is about as dangerous as having the flu	1.15 (.58–2.27)	…
Does NOT think that COVID vaccines are safe for pregnant women	0.78 (.33–1.84)	…
Other COVID-19–related measures		
Most important source of COVID-19 information		
Friends[h]	1.12 (.63–2.00)	…
Doctors/health professionals[i]	2.18 (.93–5.11)[a]	…
Liberal TV/radio[j]	1.09 (.36–3.30)	…
Social media[k]	0.28 (.08–1.03)[a]	…
Knows someone who died of COVID-19[f]	1.40 (.85–2.30)	…
On a scale of 1 to 10, how worried are you of getting COVID-19?	1.04 (.93–1.17)	…
Thinks they had COVID-19	1.07 (.47–2.45)	…
Had a mandatory COVID-19 test prior to study	1.59 (.75–3.40)	…
Ever had an influenza vaccine[l]	0.73 (.34–1.58)	…
Hesitant to get vaccinated for COVID-19[i]	0.39 (.21–.73)[a]	…
Partially vaccinated for COVID-19	2.59 (.90–7.41)[a]	2.10 (.87–5.06)
Immediately postintervention		
Interested in getting COVID-19 vaccine "today" or in future[g]	3.41 (2.39–4.86)[a]	…
Agreed to and was tested for COVID-19	4.21 (1.11–16.0)[a]	…

Abbreviations: PWID, people who inject drugs; RR, relative risk.

[a] *P* values ≤.10 for the Wald chi-square tests from univariate regression models.

[b] Past 6 months.

Missing values:[c] n = 11.[d] n = 12.[e] n = 3.[f] n = 2.[g] n = 1.[h] n = 7.[i] n = 5.[j] n = 6.[k] n = 8.[l] n = 4.

who expressed interest in getting vaccinated that day or in the future, the proportion who could have received a new dose if vaccination was available on-site could have been as high as 34.3% (45.3% intervention vs 24.3% control; $P = .01$).

Of the 88 participants who remained unvaccinated, 77.3% indicated that they did not want to get a COVID-19 vaccine, with the most commonly stated reasons being "I don't trust that the vaccine will be safe" (48.5%), "I'm not concerned about getting really sick from COVID-19" (23.5%), and "I don't think vaccines work very well" (19.1%).

Despite some baseline differences between study conditions, only age and years of drug use were significantly associated with COVID-19 vaccine uptake and were considered potential covariates with other variables that were significantly associated with greater uptake of COVID-19 vaccination, which included longer duration of the intervention session, older age, sleeping in a shelter/welfare residence, more years of injection drug use, having diabetes, and not being vaccine hesitant (Table 1). The LinkUP intervention was not significantly associated with

uptake of new COVID-19 vaccine doses at follow-up in univariate analyses (RR, 1.43; 95% CI, .83–2.48; $P = .20$), but after adjusting for age, baseline COVID-19 vaccination status, and having slept in a shelter or welfare residence in the last 6 months, it became marginally associated with greater COVID-19 vaccine uptake (adjusted RR, 1.57; 95% CI, .99–2.48; Table 2).

DISCUSSION

Findings from this study suggest that LinkUP, a brief peer-led intervention, improved COVID-19 vaccination outcomes among PWID accessing mobile SSP services in San Diego County. Substance-using populations including PWID are vulnerable to COVID-19–related morbidity and mortality yet have low rates of COVID-19 vaccination [1]. There were several strengths of our intervention approach that supported its success in increasing COVID-19 vaccination referral acceptance and subsequent vaccine uptake. First, our community-academic partnership involved regular community consultation; these consultations, our formative research, and literature review helped identify multilevel barriers to COVID-19 vaccination experienced among PWID [7, 8, 11, 13, 22, 23]. Second, we trained peer counselors to be interventionists delivering LinkUP, as peers are more highly trusted and may possess lived experience with multilevel barriers to vaccination and health care access [23–25]. Third, we integrated delivery of LinkUP into the ongoing operations of the OnPoint SSP because SSPs are trusted, highly accessible institutions that can successfully deliver preventative services to PWID, including vaccination and infectious disease testing and treatment [26–29]. Furthermore, by working with a mobile SSP operation, we reached particularly vulnerable subpopulations of PWID (eg, those experiencing homelessness) [30].

An additional strength of our intervention approach lies in its theoretical grounding. Drawing from social cognitive theory [14], LinkUP included tailored education, MI, and problem solving and planning [18]. Although the educational and MI-based intervention components likely helped address knowledge and attitudinal barriers to the acceptance of vaccination referrals, problem-solving and planning strategies may have more specifically supported participants' subsequent efforts to access off-site COVID-19 vaccines. Although our pilot trial was not designed to test mechanisms through which LinkUP operated, its preliminary efficacy in increasing actual vaccine uptake through external organizations suggests that this component may have been particularly helpful.

Our findings clearly indicate that efforts are needed to support direct provision of COVID-19 vaccines through SSPs whenever possible, instead of relying on referrals to external services that may be less known, trusted, or accessible [2, 31]. SSPs have successfully provided vaccination for other infectious diseases, such as viral hepatitis B and influenza [32–35]. In a recent study in Tijuana, COVID-19 vaccination rates significantly increased among PWID when a pop-up vaccine clinic was located adjacent to study operations and staffed by personnel with experience with substance-using populations [36]. Recent surveys of SSPs in the United States found that the majority were not providing COVID-19 or other vaccination services on-site [37, 38], with major barriers including limited staff capacity (eg, licensed personnel), physical infrastructure (eg, appropriate storage space and equipment), and administrative and data systems needed to track multidose vaccines [39]. In addition to sustained investments in staff capacity and infrastructure, SSP-based vaccination initiatives benefit from adequate financial, political, and local community support [9, 40, 41]. Capacity-strengthening and quality improvement strategies within SSPs could enhance the delivery of on-site vaccination services [42, 43]. For organizations that are unable or unwilling to provide on-site vaccination, other models could include patient navigation, supported referrals from trained peers, and financial incentives [44].

This pilot randomized controlled trial had several limitations. Our sample of PWID, recruited largely via street outreach, may not be representative of the entire PWID population in San Diego County or other jurisdictions. We also excluded individuals reporting any past voluntary COVID-19 testing who may have been more open and willing to be vaccinated against COVID-19, possibly attenuating our findings regarding intervention effects. We relied on self-report of vaccine uptake behaviors, which may have elicited socially desirable responses. The limited size and scope of this trial preclude further exploration of potential mediators and moderators of intervention effects identified by theory, literature, or our team's previous research (eg, homelessness, which moderated LinkUP effects on the uptake of COVID-19 testing) [10]. It is possible that during the 6-month follow-up, participants could have received other interventions that influenced their decisions to become vaccinated. Since intentions do not necessarily translate into actual behaviors, we cannot definitively conclude that all participants who accepted a vaccine referral would have agreed to be vaccinated immediately after the intervention if on-site COVID-19 vaccination had been offered. Finally, our study was conducted during the period when first-generation COVID-19 vaccines were available; vaccination uptake may differ for newer COVID-19 vaccines that may require fewer doses for protection.

CONCLUSIONS

This study supports the potential efficacy of intervention models such as LinkUP, which integrate community and academic expertise and leverage confidence in peers and SSPs, in increasing COVID-19 vaccine acceptability and uptake among PWID, a vulnerable population with limited institutional trust and health care

access. Although additional research is needed to investigate the specific hypothesized mechanisms through which LinkUP operated and the implementation factors that could support its scale-up to other SSPs, our findings suggest that LinkUP could be considered for adaptation for other vaccination promotion efforts with PWID or community-based service settings (eg, outpatient opioid treatment programs). Finally, our findings support the need to engage community research partner organizations and peers in interventions designed to reach people who use drugs, who are disproportionately affected by SARS-CoV-2 and other infectious diseases yet experience multilevel barriers to accessing essential prevention services.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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Data availability. Data are available upon request from the authors. Common data elements are available from the RADx-UP consortium.

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