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Pay-it-forward and social network distribution to increase doxycycline post-exposure prophylaxis uptake among men who have sex with men and transgender women in China: study protocol for a three-arm randomised controlled trial

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ABSTRACT

Introduction Doxycycline postexposure prophylaxis (doxy-PEP) can prevent sexually transmitted infections (STIs) among men who have sex with men (MSM) and transgender women (TGW). STI rates are high among MSM and TGW in China, and implementation strategies are needed to optimise doxy-PEP services. Pay-it-forward and social network distribution approaches may increase uptake of STI services and could increase the uptake of doxy-PEP. We present the protocol for a randomised controlled trial evaluating the effectiveness of pay-it-forward strategies with and without adjunctive social network distribution among MSM and TGW in China.

Methods and analysis A total of 399 MSM and TGW will be recruited at seven sites in China and randomly allocated in a 1:1:1 ratio to (1) self-pay, (2) pay-it-forward alone or (3) pay-it-forward with adjunctive social network distribution of doxy-PEP. Participants assigned to the self-pay arm can purchase a doxy-PEP packet out-of-pocket. Participants in the pay-it-forward arm will be offered a free doxy-PEP packet and the opportunity to donate to support doxy-PEP for future participants. Participants in the pay-it-forward arm with social network distribution will receive the pay-it-forward intervention as well as additional free doxy-PEP packets to distribute to peers. Those randomised to the self-pay and the pay-it-forward with social network distribution arms (ie, index participants) will receive and distribute referral cards to recruit additional peers (ie, alter participants). Alter participants recruited through the control arm will be referred to the clinic to purchase doxy-PEP. Alter participants recruited through the pay-it-forward with adjunctive social network distribution arm will receive doxy-PEP directly from referring index participants. Both index and alter participants in each arm will be asked to complete a follow-up survey 3 and 6 months after enrolment. The primary outcome will be the proportion of participants who report using doxy-PEP within 72-hours of condomless anal or oral sex on one or more occasions during follow-up.

Ethics and dissemination Ethical approval was obtained from the ethics review committee of the Dermatology Hospital of Southern Medical University (Approval number: 2023109). The findings will be disseminated in peer-reviewed publications.

Trial registration number The study has been registered with the Chinese Clinical Trial Registry (trial ID ChiCTR2300074903). Date of registration: 18 August 2023.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study addresses an important gap in the literature by evaluating new implementation strategies to increase doxy postexposure prophylaxis use in a middle-income country.
⇒ Co-creation activities were used to engage the local community in developing and refining the intervention as well as study design.
⇒ Community-based organisations in seven cities across China were selected to participate in this interventional trial to increase geographical representation.
⇒ Participating organisations were not randomly sampled; consequently, those recruited for enrolment may not be representative of all men who have sex with men and transgender women in China.
⇒ Many study outcomes, including the primary outcome, will be self-reported, which may introduce social desirability and recall biases.

INTRODUCTION

Bacterial sexually transmitted infections (STIs), including syphilis and chlamydia, are increasing globally, especially among men

who have sex with men (MSM) and transgender women (TGW).[1 2] In China, prevalence estimates among MSM range from 5.3% to 24.4% for chlamydia and 7.6% to 10.8% for syphilis.[3] A systematic review and meta-analysis in 2017 found the pooled incidence of syphilis among MSM in China to be 9.6/100 person years.[4] Existing STI control programmes for MSM and TGW are primarily focused on behavioural interventions, such as sex education, risk reduction counselling, free condom provision and frequent STI testing and treatment.[3 5 6] Given the persistently high burden of STI among MSM and TGW in China, additional prevention strategies are needed.[7]

Several recent randomised controlled trials (RCTs) in high-income settings found that a single dose (200 mg) of doxycycline within 72 hours of sex can significantly reduce incident syphilis and chlamydia among MSM and TGW.[8–10] Based on these findings, some public health authorities have begun recommending the use of doxycycline post-exposure prophylaxis (doxy-PEP) for MSM and TGW at higher risk of STI.[11 12] An interrupted time series analysis of data collected from three sentinel STI clinics in San Francisco found that release of city-wide doxy-PEP guidelines and early implementation reduced reported cases of chlamydia and early syphilis.[13]

Doxy-PEP may help curb the STI epidemic among MSM and TGW in China and other low- and middle-income countries (LMICs). However, doxy-PEP implementation has not been previously evaluated in these settings. A 2021 online cross-sectional survey of MSM living in three Chinese cities found fewer than one-third of men had heard of using doxycycline to prevent STI after higher-risk sex.[14] Barriers to doxy-PEP implementation in China include low awareness about doxy-PEP, concerns about drug efficacy, safety and cost and stigma associated with accessing sexual healthcare services.[7 14 15] Additional research is needed to develop implementation strategies to optimise doxy-PEP uptake and inform practices in China, where there are no clinical guidelines. Moreover, few previous clinical trials of sexual health interventions in China have evaluated strategies inclusive of both MSM and TGW. Because doxy-PEP has demonstrated effectiveness in both populations, including MSM and TGW, in this study, this ensures alignment with clinical guidelines and addresses a critical gap in local evidence.

Interventions that leverage generosity and peer networks can promote uptake and engagement in sexual healthcare services. Pay-it-forward is a strategy that first offers an individual a gift or service that has been donated by a peer and then invites the recipient to donate toward the same gift or service for another peer.[16 17] Pay-it-forward has been applied to sexual health services and found to increase STI testing among higher-risk groups, including MSM in China.[16–19] Social network distribution, where individuals distribute a supply or service directly to peers after receiving brief training or education, is another strategy to increase engagement in sexual healthcare among groups with limited healthcare access. Social network distribution of HIV self-test kits has been shown to increase test uptake among MSM, and the WHO recommends secondary distribution of HIV self-test kits.[20 21] Expedited partner therapy also uses social network distribution to provide STI treatment to sexual partners who are unlikely to seek timely evaluation and treatment, and this strategy is recommended by the U.S. Department of Health and Human Services and Centers for Disease Control and Prevention (CDC).[22]

Both pay-it-forward and social network distribution may be effective strategies for increasing uptake and use of doxy-PEP. In this study, we propose to explore the effectiveness of the pay-it-forward approach with and without adjunctive social network distribution among MSM and TGW through a three-arm RCT in China.

METHODS AND ANALYSIS

Trial design

This study will be a parallel-group, open-label, three-arm RCT among MSM and TGW in seven Chinese provinces. Eligible participants will be randomly assigned in a 1:1:1 ratio into three arms: (1) self-pay (control), (2) pay-it-forward alone and (3) pay-it-forward with adjunctive social network distribution. Individuals assigned to the self-pay arm will be given the opportunity to purchase a doxy-PEP packet. Individuals assigned to the pay-it-forward alone arm will be offered a free doxy-PEP packet, the cost of which had been paid for by a peer, and then will be given the opportunity to donate money towards doxy-PEP packets for future study participants. Individuals assigned to the pay-it-forward with adjunctive social network distribution arm will receive the same intervention as those in the pay-it-forward alone arm, plus three additional free doxy-PEP packets to distribute to peers.

Participants assigned to the self-pay and pay-it-forward with adjunctive social network distribution arms (ie, index participants) will also be provided with peer referral cards to distribute to other MSM in their social network who may be interested in doxy-PEP. Those who are recruited through peer referral cards (ie, alter participants) will be asked to contact study personnel to be assessed for eligibility. Alter participants recruited by index participants in the control arm will be encouraged to come to the study sites in person to learn about doxy-PEP and, if interested, purchase a doxy-PEP packet. Alter participants recruited by index participants in the pay-it-forward with adjunctive social network distribution arm will receive a doxy-PEP packet directly from the referring index participant. Both index and alter participants will be prospectively followed for 6 months after enrolment. Recruitment began in August 2024, and we anticipate follow-up for all participants will be completed by September 2025. The trial design is summarised in the study flow diagram (figure 1). This study protocol was written according to the Standard Protocol Items: Recommendations for Interventional Trials framework.

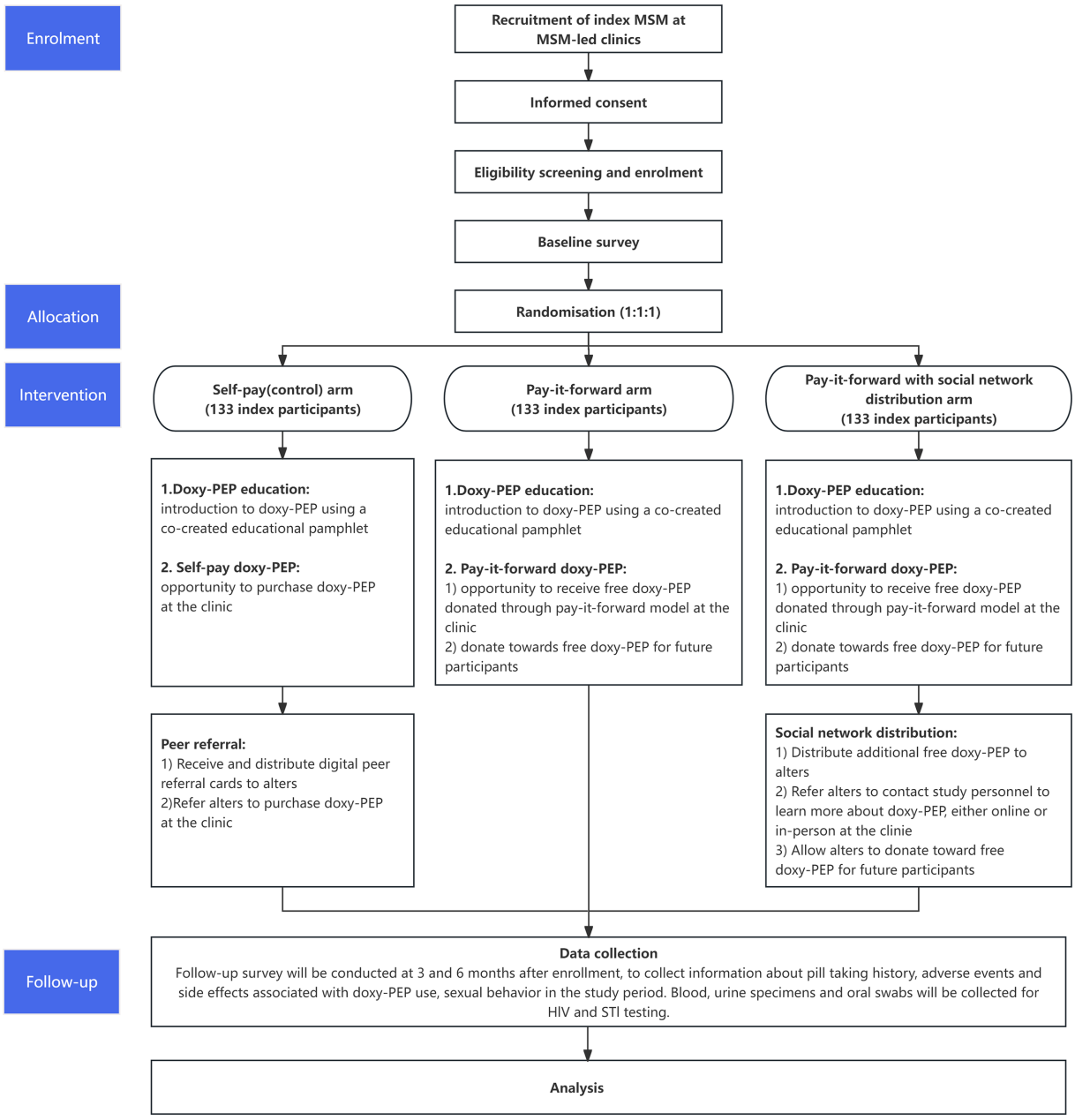

Figure 1 Study flow diagram. doxy-PEP, doxycycline post-exposure prophylaxis; MSM, men who have sex with men; STI, sexually transmitted infection.

Study setting

We will implement this study at MSM-led sexual health clinics run by community-based organisation (CBO) that serve lesbian, gay, transgender, bisexual and queer (LGTBQ) people in seven provinces located in different parts of China: East China (Shandong Province, You and Me Health Volunteer Service Center), South China (Guangdong Province, Pengyou AIDS Care Assistance Center), Northeast China (Liaoning Province, Yikang Health Education Service Center), Northwest China (Gansu Province, Sunshine Health Consulting Service Center), Central China (Hubei Province, Wuhan LGBT Centre), Southwest China (Chongqing, Zhideng Social Work Service Center) and North China (Hebei Province, Night Vessel Anti-AIDS Service Center). All clinics provide free HIV and syphilis testing and sexual health consultation services for MSM and TGW. CBO staff at each site have experience and expertise in delivering sexual health education, counselling, blood collection, results reporting and referral to STI treatment at local hospitals and CDC sites. All sites will follow the same study procedures, and all research assistants and community staff involved in this project will be trained using the same training materials and standard operational protocols.

Patient and public involvement

To ensure our design is pragmatic, tailored to the needs of local MSM and TGW and adapted to trial settings, we used a co-creation approach[23] to develop this research project. Co-creation groups were convened to serve as a

source of shared leadership. Group members included LGTBQ community members, CBO leaders, project researchers and local clinicians and public health professionals who deliver sexual healthcare services to MSM and TGW. Monthly co-creation meetings and feedback sessions were held to iteratively refine the research questions, study protocol, intervention development, implementation plan and future dissemination activities. The co-creation group collaborated with the study team to refine study outcomes and discuss how to assess these outcomes in a culturally competent manner using survey instruments that were not overly burdensome. This group also created materials to educate trial participants about doxy-PEP, pay-it-forward and social network distribution. These co-created educational materials were developed through an iterative process that responded to community preferences and recommendations.

After completion of the co-creation activities, the seven participating sexual health CBOs will be responsible for recruiting study participants and delivering the intervention, with ongoing oversight and support to be provided by the research team. After completion of the trial, the research team will summarise results from the trial to the co-creation group and CBO leadership to facilitate dissemination to the wider community.

Eligibility criteria

To be eligible for enrolment, participants must: (1) be aged ≥16 years; (2) identify as a cisgender man or transgender woman; (3) report previously having anal or oral sex with a man; (4) report having at least one of the following risk factors for STI acquisition in the past 12 months: ≥1 bacterial STI diagnosis, anal sex with ≥2 male partners or condomless anal or oral sex with ≥1 male partner and (5) provide informed consent and personal contact information, including a cell phone number or WeChat ID. Those who report allergy or intolerance to doxycycline, are using medications which may impact doxycycline metabolism (ie, barbiturates, phenytoin, carbamazepine or systemic retinoids), are taking warfarin or anticipate using doxycycline during the coming 12 months for non-STI prevention (eg, acne treatment) will be excluded.

Recruitment

CBO partners will conduct public-facing educational events before recruitment to promote this project to potential participants. Study advertisements will be disseminated online through the official WeChat accounts of CBO partners, providing a brief overview of this study and details about enrolment locations. The study will also be promoted through posters, fliers and face-to-face consultations at local clinics and outreach venues near the seven CBO sexual health clinics that serve as enrolment locations. Interested persons will be asked to come in person to a sexual health clinic enrolment location to undergo an eligibility screening hosted on *Wenjuanxing*, an encrypted online survey platform that has previously been used in clinical trials[24] in China to collect sexual health information (Changsha Ranxing Information Technology Co., China).

Enrollment, baseline survey and baseline study visit

Eligible participants will proceed to complete an online informed consent form and baseline survey also hosted on *Wenjuanxing*. The informed consent form is included in the online supplemental materials. The baseline survey will ask participants to report sociodemographic characteristics, sexual behaviours, HIV and STI testing history and knowledge about and previous use of doxy-PEP. After completing the baseline survey, participants will be asked to provide samples for baseline STI testing. These samples will include a pharyngeal swab, a rectal swab and a urine sample to test for chlamydia and gonorrhoea as well as blood specimens for HIV and syphilis testing. Participants will only be considered enrolled and ready for randomisation as index participants once they have completed both the online informed consent and baseline survey as well as provided samples for baseline STI testing.

Randomisation

Index participants will be randomly assigned 1:1:1 to the self-pay, pay-it-forward alone and pay-it-forward with adjunctive social network distribution arms through a permuted block randomisation. At each site, the schedule will consist of five blocks of size 3 and seven blocks of size 6, yielding a total of 57 random assignments per site. The randomisation schedules for each of the seven sites will be generated independently so that each site enrols the same number of index participants to each arm. An independent statistician will be responsible for producing the final randomisation plans. Each assignment will receive a consecutive randomisation ID that can be used to easily distinguish the participants according to site (eg, 1001–1057 for Site 1, 2001–2057 for Site 2). The randomisation plan will be generated in SAS V.9.4 (SAS Institute, Cary, North Carolina, USA) and will be stored by the study statisticians on a secure server maintained by the University of North Carolina at Chapel Hill (UNC) biostatistics department and on a secure server at the Dermatology Hospital of Southern Medical University.

Due to the nature of the intervention, this RCT will be unblinded. Participants will be able to determine their assignment based on whether they received intervention materials during the study period. Study personnel that interact with participants will also know allocation assignments to deliver the intervention materials. Only those who are responsible for conducting the final data analysis will remain blinded to the participant allocation until the data are locked after quality control, although they will be familiar with the final block sizes used in the randomisation scheme.

Trial arms and interventions

Self-pay arm (control)

Index participants randomised to the self-pay arm will receive the following at their baseline study visit: (1) a brief introduction to doxy-PEP use and safety using a printed educational pamphlet developed by the co-creation group; (2) the opportunity to purchase one doxy-PEP packet at the sexual health clinic; and (3) digital peer referral cards to distribute to MSM in their social network which encourage them to come to the sexual health clinic to learn about and potentially obtain doxy-PEP. Each doxy-PEP packet will contain 24 delayed-release doxycycline 100 mg tablets (12 doses) and an instructional leaflet developed by the co-creation group explaining doxy-PEP use, risk, benefits and contraindications. Participants randomised to the self-pay arm will have the opportunity to purchase a doxy-PEP packet at the market price (40 RMB/US$5.50). Purchasers will also receive complimentary lubricant and condoms as gifts.

Index participants randomised to the self-pay arm will initially receive three digital referral cards to distribute to peers whom they think may benefit from doxy-PEP. Each index can apply for a total of five referral cards during the study. Referral cards contain educational information about doxy-PEP, the location of the sexual health clinic, a unique numeric ID linking referred alter participants with the referring index participant and reminders of the benefits of purchasing doxy-PEP at the clinic (eg, free gifts, counselling services). Index participants will be encouraged to talk to alters about doxy-PEP in the way they would typically have conversations about sexual behaviours and other healthcare and to refer them to sexual health clinics. When alter participants present to the sexual health clinic in person, they can purchase the doxy-PEP packet at market price using the referral card and receive free condoms, lubricant, HIV and syphilis rapid testing and counselling and education about doxy-PEP use, risks, benefits and contraindications.

Pay-it-forward alone arm

Participants randomised to the pay-it-forward alone arm will receive the following at their baseline study visit: (1) a brief introduction to doxy-PEP use and safety using a printed educational pamphlet developed by the co-creation group; (2) a community co-created postcard introducing the pay-it-forward concept; and (3) the opportunity to receive a free doxy-PEP packet donated by previous participants, with the option to voluntarily donate money towards doxy-PEP packets for future trial participants. Participants willing to accept doxy-PEP will receive the same doxy-PEP packet as participants in the self-pay arm. Additionally, participants will also be provided with condoms and lubricant as gifts. Each participant (regardless of whether they accepted or rejected the free doxy-PEP packet) will be informed of the standard price of the doxy-PEP packet and will be given the option to leave donations for future trial participants, either through cash or the WeChat money transfer function. All donations will be voluntary, with no fixed amount required.

Of note, the pay-it-forward intervention will be exclusively delivered by trained CBO staff, and participants outside the intervention arm will not have access to the messaging materials or donation mechanisms. Because of this structure, and assuming adherence to protocol by CBO staff, participants in the self-pay arm will not be exposed to the pay-it-forward materials, will not receive donated doxy-PEP packets and will not have the opportunity to contribute donations for others. This design minimises risk of contamination between arms.

Pay-it-forward with adjunctive social network distribution arm

Initial participants randomised to the pay-it-forward with adjunctive social network distribution arm will receive the following at their baseline study visit: (1) a brief introduction to doxy-PEP use and safety using a printed educational pamphlet developed by the co-creation group; (2) a community co-created postcard introducing the pay-it-forward concept; (3) the opportunity to receive a free doxy-PEP packet donated by previous participants, with the option to voluntarily donate money towards doxy-PEP packets for future trial participants; and (4) additional free doxy-PEP packets to distribute to peers in their social network.

After completing the pay-it-forward study procedures as in the pay-it-forward arm, index participants in the pay-it-forward with adjunctive social network distribution arm will be invited to participate in social network distribution. Each index participant will initially receive three doxy-PEP packets to distribute to individuals in their social network whom they think will benefit from doxy-PEP. Each index participant can apply for a total of five packets during the study. The doxy-PEP packet will also include a printed peer referral card. This referral card will include the same information as the referral card used in the self-pay arm as well as an introduction to the pay-it-forward concept, a QR code for donations and instructions to contact study personnel to ask questions about doxy-PEP use, risk, benefits and contraindications.

Doxy-PEP refill procedures

In all three study arms, index and alter participants can obtain refills at the local sexual health clinic during the follow-up period. Participants in the pay-it-forward and pay-it-forward with adjunctive social network distribution arms will receive refills at no charge and when obtaining refills will again be given the opportunity to voluntarily donate money towards doxy-PEP packets for other trial participants. Participants in the control arm will pay for refills out-of-pocket.

Interventions and intervention delivery across the three trial arms are summarised in table 1.

Follow-up

All participants will be followed for 6 months with two study visits at months 3 and 6. We will inform participants

Table 1 Trial arms

Arms	Intervention	Intervention delivery
Self-pay arm (control)	1. Doxy-PEP education: co-created educational information on doxy-PEP use and safety. 2. Self-pay doxy-PEP: opportunity to purchase doxy-PEP pack at clinic. Each pack will include one bottle with 24 delayed-release doxycycline 100 mg tablets and an informational leaflet on how to use doxy-PEP and related contraindications. 3. Peer referral: digital referral cards to distribute to peers, encouraging them to seek consultation about doxy-PEP at clinic	► Index participants will be given the opportunity to purchase one doxy-PEP packet at market price (40 RMB/US$5.50) at the baseline study visit ► Index participants will receive three digital peer referral cards at enrolment to be distributed to potential alter participants in their social network who may benefit from doxy-PEP ► Index participants can apply for up to two additional peer referral cards. ► Alter participants will be encouraged to come to a participating study clinic to learn about doxy-PEP, receive co-created educational materials and potentially purchase a doxy-PEP packet. ► Both indexes and alters can purchase refills at the local clinic during the follow-up period.
Pay-it-forward alone arm	1. Doxy-PEP education: co-created educational information on doxy-PEP use and safety. 2. Free doxy-PEP donated through pay-it-forward: opportunity to receive a free doxy-PEP packet. Each pack will include one bottle with 24 delayed-release doxycycline 100 mg tablets and an informational leaflet on how to use doxy-PEP and contraindications. 3. Community engagement: opportunity to receive community co-created postcards and donate towards free doxy-PEP pack for future participants.	► Participants will be introduced to the pay-it-forward model. ► Participants will receive one free doxy-PEP pack at enrolment. ► Participants can choose to leave a donation to support doxy-PEP for future trial participants with study personnel. Donations can be provided in cash or through the WeChat money transfer function. ► Participants can self-pickup refills at the local clinic during the follow-up period free of charge.
Pay-it-forward with adjunctive social network distribution	1. Doxy-PEP education: co-created educational information on doxy-PEP use and safety. 2. Free doxy-PEP donated through pay-it-forward: opportunity to receive a free doxy-PEP packet. Each pack will include one bottle with 24 delayed-release doxycycline 100 mg tablets and an informational leaflet on how to use doxy-PEP and contraindications. 3. Community engagement: opportunity to receive community co-created postcards and donate towards free doxy-PEP packs for future participants. 4. Social network distribution: receive additional free doxy-PEP packets to distribute to peers in their social network.	► Index participants will be introduced to the pay-it-forward model. ► Index participants will receive one free doxy-PEP pack at the baseline study visit ► Index participants can choose to leave a donation to support doxy-PEP for future trial participants. Donations can be provided in cash or through the WeChat money transfer function. ► Index participants will receive three additional free doxy-PEP packets to distribute to potential alter participants in their social network who may benefit from doxy-PEP. Index participants will be asked to distribute a maximum of one doxy-PEP packet to each potential alter participant. ► Index participants can apply for up to two additional doxy-PEP packets to be distributed to peers. ► Peers who receive doxy-PEP packets from index participants will be asked to contact study personnel through WeChat to learn about doxy-PEP use, risks, benefits and contraindications. Peers will also be assessed for eligibility to be enrolled in the study as alter participants. ► Alter participants can choose to leave a donation to support doxy-PEP for future trial participants. Donations can be provided in cash or through the WeChat money transfer function. ► Both indexes and alters can self-pickup refills at the local clinic during the follow-up period free of charge.

doxy-PEP, doxycycline postexposure prophylaxis.

of their scheduled follow-up visits, which includes sending reminders using WeChat messaging and telephone calls. In case of missed visits, study personnel will promptly contact participants via phone or WeChat to reschedule appointments within the following 2 weeks. At all follow-up visits, index and alter participants will be asked to complete a follow-up survey hosted on *Wenjuanxing* to assess doxy-PEP uptake, sexual behaviours, HIV and STI testing history and adverse events during the follow-up period. Index participants randomised to the self-pay and pay-it-forward with adjunctive social network distribution arms will be asked to report their experiences with social network distribution of peer referral cards and doxy-PEP packets, respectively. Index and alter participants in the pay-it-forward with adjunctive social network distribution arm will be asked to answer questions related to the acceptability, appropriateness and fidelity of doxy-PEP disseminated through social network distribution. At the 6-month follow-up visit, all index participants will be asked to return in person to the site at which they were enrolled to provide samples for follow-up STI testing. These samples will include a pharyngeal swab, a rectal swab and a urine sample to test for chlamydia and gonorrhoea as well as blood specimens for HIV and syphilis testing.

For all index and alter participants in the study, each study clinic will have a clinician available who is knowledgeable about doxy-PEP and able to answer participant questions about the safety and use of doxycycline, either in person or via WeChat.

Incentives

Index and alter participants will be provided with 20 RMB/US$3 and 30 RMB/US$4 for completing baseline and follow-up surveys, respectively. Gonorrhoea, chlamydia, HIV and syphilis testing at baseline and follow-up will be provided free of charge to all index participants.

Laboratory procedures

Blood samples will be transported to the third-party laboratories (Jinyu Medical Laboratory Group Co.) located in each study province for syphilis and HIV testing. Syphilis toluidine red unheated serum reagin test (TRUST; Shanghai Rongsheng Biotech Co, Shanghai, China) will be used to test for nontreponemal antibodies. If TRUST results are positive, an additional Treponema pallidum particle agglutination (TPPA) test will be performed to confirm a diagnosis of syphilis infection. Urine samples, pharyngeal swabs and rectal swabs will be transported to the Southern Medical University Dermatology Hospital for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* testing by using the Cobas 4800 CT/NG detection kits (Roche Molecular Systems, New Jersey, USA). All HIV and other STI testing results will be returned to each clinic within 2 weeks after receiving samples. All participants who have provided samples will receive their results through WeChat within 1 week. Those who tested positive will be referred to a local facility and treated according to guidelines for the diagnosis and treatment of STIs.[25]

Participants who test positive for *N. gonorrhoeae* at any anatomical site (urine, pharyngeal or rectal) by PCR will be asked to return to the CBO to provide an additional sample, which will be sent for culture-based antibiotic susceptibility testing. Urine samples, pharyngeal swabs or rectal swabs with positive results will be used to attempt isolation of the organism via culture, and where successful, isolates will be assessed for antibiotic susceptibility. Specimens positive for *N. gonorrhoeae* will be inoculated onto chocolate agar plates to produce a stock inoculum of each strain. Minimal inhibitory concentrations (MICs) will be ascertained with the E-test method. *N. gonorrhoeae* tetracycline resistance will be defined as a MIC greater than 1 mg/L.[9] MICs between 2 mg/L and 8 mg/L indicate intermediate resistance, and MICs ≥8 mg/L indicate high-level resistance to tetracycline. PCR will be used to identify chromosomal resistance determinants in NG, including rpsJ (V57M) and plasmid-mediated tet(M). Additionally, the overexpression of the MtrCDE-encoded efflux pump will be investigated by identifying mutations in the mtrR gene promoter or the MtrR protein. Resistance-associated mutations for other antibiotics will also be examined, including 23S rRNA, mtr promoter (a57del) and porB1a (G120K, G120D/A121D) for azithromycin resistance; penA (A311V, V316T, I312M, ins346D, T483S, P551S, G542S, G545S) for ceftriaxone resistance; gyrA (S91F, D95A, D95G, D95N) and parC (D86N, S88P, E91K) for ciprofloxacin resistance; rpsL and associated loci for streptomycin resistance; and ponA (L421P), penA and porB1a for penicillin resistance. The presence of genes conferring tetracycline resistance in *C. trachomatis* will be identified by sequencing the tet(C) and ompA genes. Sequence typing will be performed using multi-locus sequence typing, whereby five highly variable genes (hctB, CT058, CT144, CT172 and pbpB) will be amplified and then bidirectionally sequenced.[26]

Procedures for STI diagnosis at baseline or follow-up

Participants diagnosed with an STI at baseline or follow-up will be contacted by study personnel, instructed to temporarily stop doxy-PEP and referred to a designated local healthcare facility for evaluation and treatment by a physician. After completing treatment, participants will be asked to contact study personnel to confirm STI treatment completion, at which time they will be provided with instructions on resuming doxy-PEP use. The presence of chlamydia, gonorrhoea or syphilis at baseline will not preclude enrolment, and the 6-month follow-up period will not begin until STI treatment has been completed and participants have been instructed it is appropriate to resume use of doxy-PEP. Participants may independently seek STI testing and treatment between the enrolment and follow-up visits from non-study healthcare providers. These experiences will be captured through self-report during the 6-month follow-up survey.

Outcome measures

The primary outcome will be the proportion of participants who report using doxy-PEP within 72-hours of condomless anal or oral sex on ≥1 occasion during the 6-month follow-up period after enrolment.

Secondary outcomes will include the following: (1) proportion of participants who obtain a doxy-PEP packet at baseline; (2) the frequency of doxy-PEP use during the follow-up period, including the proportion of participants who report using doxy-PEP within 72 hours of condomless anal or oral sex on ≥50% and 100% of such occasions, respectively; (3) time from enrolment to first doxy-PEP use; (4) incidence of syphilis during the follow-up period, defined as a negative TRUST at baseline and positive TRUST and TPPA at follow-up or a positive TRUST and TPPA at baseline with a four-fold or greater increase in TRUST titres at follow-up; (5) incidence of chlamydia during the follow-up period, defined as negative CT PCR from all three sites at baseline with a positive CT PCR from any/all three sites; (6) incidence of gonorrhoea during the follow-up period, defined as negative GC PCR from all three sites at baseline with a positive GC PCR at follow-up from any/all three sites; (7) combined incidence of syphilis, gonorrhoea and chlamydia; (8) the proportion of index participants who disseminate doxy-PEP packets or peer referral cards to ≥1 peer during follow-up (control and pay-it-forward with adjunctive social network distribution arms only); (9) tetracycline resistance in *N. gonorrhoeae* and *C. trachomatis* isolated at baseline as compared with organisms isolated in the follow-up period; (10) the proportion of participants who donated any amount (pay-it-forward and pay-it-forward with adjunctive social network distribution arms only); (11) the total donated amount (pay-it-forward and pay-it-forward with adjunctive social network distribution arms only); (12) self-reported STI diagnoses, symptoms and treatment-seeking behaviours that occurred outside of study visits, including care obtained from non-study clinics or pharmacies; (13) the acceptability, appropriateness and fidelity of doxy-PEP disseminated through social network distribution (pay-it-forward with adjunctive social network distribution arm only) and (14) self-reported adverse events after taking doxy-PEP, including allergic, dermatological, gastrointestinal and neurological symptoms.

Data collection

Baseline survey for index participants

Index participants will complete an online baseline survey at the local clinic at enrolment. The baseline survey will collect information along the following domains: (1) sociodemographic characteristics, including age, sex assigned at birth, gender, sexual orientation, residence status, marital status, highest level of educational attainment, monthly income and whether they disclosed their sexual orientation with health provider, family or friends; (2) sexual behaviours in the past 6 months, including sexual history with men, role during sex with men, condom use, type of sex partners, group sex and sexualised drug use; (3) site-based testing or self-testing history for HIV, syphilis, chlamydia and/or gonorrhoea, as well as STI treatment in the past 12 months; and (4) awareness, willingness to use and actual use of doxy-PEP in the past 6 months.

Baseline survey for alter participants

Alter participants will complete an online baseline survey by scanning the QR code on the peer referral card or the doxy-PEP packet to enter the online (*Wenjuanxing*) platform. The survey will collect information on (1) the relationship between the referring index participant and the referred alter participant, (2) sociodemographic characteristics, (3) sexual behaviours in the past 6 months, (4) history of STI diagnosis and treatment in the past 12 months, (5) awareness, willingness to use and actual use of doxy-PEP in the past 6 months and (6) acceptability, appropriateness and negative experiences about receiving peer referral cards or social network distribution of doxy-PEP. Negative experiences that will be specifically asked about will be (1) being forced or coerced into taking doxy-PEP and (2) having suffered physical and/or verbal abuse when receiving doxy-PEP from a peer.

Follow-up survey for index and alter participants

Index and alter participants will complete an online follow-up survey that will collect information on the following domains: (1) sexual behaviours during the follow-up period, including sexual history with men and/or women, role during anal sex, condom use during anal sex and number and type of sex partners; (2) HIV, syphilis, gonorrhoea and chlamydia testing and treatment history during the follow-up period; and (3) doxy-PEP use during the follow-up period, frequency of use, date of first use after enrolment, types of sex acts before doxy-PEP was used, dosage taken, timing of doxy-PEP use after sex and adverse events experienced after using doxy-PEP. Index participants in the self-pay and pay-it-forward with adjunctive social network distribution arms will also be asked to report whether they recommended that any peers obtain doxy-PEP, distributed peer referral cards and/or doxy-PEP packets to peers, reasons why they did or did not engage in social network distribution and types of relationships with referred peers. To help distinguish between study-based and external referrals, we will ask index and alter participants in all arms where they obtained any doxycycline they used, including whether it was sourced from outside the study (eg, pharmacies, unaffiliated clinics). Finally, both index and alter participants will be asked about the acceptability, appropriateness and fidelity of social network distribution through a series of multiple-choice questions. Negative experiences with social network distribution will also be reassessed at follow-up.

Pilot study results

A pilot study was conducted from 6 September 2023 to 9 January 2024 to compare the impact of the pay-it-forward alone or pay-it-forward with adjunctive social network distribution arms to the self-pay arm on doxy-PEP uptake (results unpublished). After a 30-day follow-up period, the proportion of index participants in the pay-it-forward, pay-it-forward with adjunctive social network distribution and self-pay arms who reported using doxy-PEP at least once within 72 hours of high-risk sexual encounter was 56.7% (17/30), 53.6% (15/28) and 33.3% (9/27), respectively. The proportion of alter participants who accepted and took the doxy-PEP was 10% (3/30) in the control arm and 37% (11/30) in the pay-it-forward with adjunctive social network distribution arm. These pilot results informed the recruitment process and sample size calculations. After the pilot, implementation steps and survey instruments were refined via an iterative process that incorporated feedback from pilot study participants, organisers and community partners. Educational materials, CBO staff training materials and study protocols were updated to improve participant recruitment and minimise loss to follow-up (LTFU).

Statistical methods

All inferential tests will be carried out using SASV.9.4 (SAS Institute, Cary, North Carolina, USA) assuming two-sided testing and a significance level of $\alpha = 0.05$. We will display baseline sociodemographic and behavioural characteristics by treatment group and also aggregate them across groups. Where possible, we will use data visualisation to showcase both individual data points and aggregate summary statistics.

In our analysis, the resulting p values for the two comparisons for the primary outcome (self-pay vs pay-it-forward arm and self-pay vs pay-it-forward with adjunctive social network distribution arm) will be adjusted using Hochberg's method to control the family-wise error rate. This adjustment involves initially ordering the p values from smallest to largest, denoted as p_1 and p_2, respectively, where $p_1 < p_2$. Subsequently, the largest p value (p_2) will be compared directly to the significance level of $\alpha = 0.05$. If $p_2<\alpha$, both hypotheses are rejected. If $p_2>\alpha$, then p_1 is compared with $\alpha/2$ (0.02 5). If $p_1<\alpha/2$, then the hypothesis corresponding to p_1 is rejected. This procedure controls type 1 error at α for the two comparisons.

Sample size

Sample size was calculated using an unpooled z-test for two proportions[27] based on estimates from the pilot study data of n=85 participants with complete follow-up. The doxy-PEP uptake rate was 33.3% (9/27) in self-pay, 56.7% (17/30) the in pay-it-forward arm and 53.6% (15/28) the in pay-it-forward with adjunctive social network distribution arm. Since we plan to compare self-pay to pay-it-forward and self-pay to pay-it-forward with adjunctive social network distribution arm, the smallest risk difference of 0.536–0.333=0.203 was used to compute the required sample size.

For sample size calculations, we assumed equal sample sizes in all three arms (ie, 1:1:1 allocation ratio), 80% power, significance level of α=0.025 (to Bonferroni correct for two comparisons), two-sided testing and 15% LTFU. Due to the increased duration in the follow-up period from the pilot study, the anticipated LTFU is anticipated to be higher than the LTFU across treatment arms in the pilot study, which was 6%. We estimate that a total of n=399 participants (133 per arm) will be needed to ensure 80% power to detect a probability difference of 0.203 between the self-pay and pay-it-forward with adjunctive social network distribution arms. Since seven sites will randomise participants, a total of n=57 participants will be randomised at each site with 19 participants randomised to each treatment arm (n=19 to control, n=19 to pay-it-forward and n=19 to pay-it-forward with adjunctive social network distribution arm).

Primary endpoint analysis plan

We will assess the primary outcome, which is the uptake of doxy-PEP within 72 hours of condomless anal or oral sex at least once during the follow-up period, by examining the difference in probabilities (ie, risk difference). Our objective is to identify any statistically meaningful differences in doxy-PEP uptake between both the self-pay and pay-it-forward arms and the self-pay and pay-it-forward with adjunctive social network distribution arms. The analytical sample will be limited to index participants who report engaging in condomless anal or oral sex at least once during the follow-up period.

Given that populations might vary across provinces, it may be necessary to account for site-specific differences in our analysis should such discrepancies become evident. A stratified test like the Mantel–Haenszel test can be used to compute the p value after adjusting for site. We will use PROC FREQ in SAS V.9.4 to generate descriptive cross-tabulations and compute a stratified p value using the Cochran-Mantel-Haenszel (CMH) test. The CMH test can be used to assess the association between treatment group and doxy-PEP uptake while adjusting for stratification by site.[28] The stratified risk difference can then be computed as a weighted average of the differences in proportions between treatment groups across strata. The observed proportions used in this calculation (ie, the proportion of participants with the outcome in each treatment group within each site) can be obtained directly from the cross-tabulation output produced by PROC FREQ.[28] In scenarios where particular sites exhibit notably low or high uptake rates, we will aggregate data from these sites before making adjustments for site-specific effects. Sites will be considered to have extreme rates if fewer than three participants either refrain from or choose to use doxy-PEP within the pooled arms for a pairwise treatment comparison. A point estimate for the mean number of alters who use doxy-PEP per index will also be computed

for the self-pay and pay-it-forward with adjunctive social network distribution arms.

Missing data plan

The primary analyses will adopt an intention-to-treat approach, meaning that participants will be analysed based on their initial randomisation assignment, irrespective of their adherence to the protocol. To address missing data from those who do not complete the 6-month follow-up survey, we will implement one of two strategies based on the extent of missing data. We expect LTFU to be less than 20%. For situations where less than 10% of the data on the primary outcome is missing, analyses will proceed with a complete case analysis. Conversely, if the data missing on the primary outcome are higher than 10%, multiple imputation methods will be employed for the primary analysis, with a sensitivity analysis that employs the complete-case approach.

DISCUSSION

Prevention strategies are urgently needed to curb the ongoing STI epidemic among MSM and TGW in China. Doxy-PEP is a novel method to prevent STIs[8–10]; however, knowledge and access to doxy-PEP among MSM and TGW in China are currently limited. Our study will develop and evaluate innovative strategies to increase the reach and uptake of doxy-PEP to prevent STIs by conducting a pragmatic trial in a community setting.

Pay-it-forward can increase healthcare services uptake by using community generosity and inspiring a sense of social obligation to contribute to peers' health.[16 17] Social network distribution can efficiently increase intervention uptake among populations with close social connectivity.[29] Previous research has demonstrated that both pay-it-forward and social network distribution are feasible and acceptable approaches to optimising sexual health services among MSM in China[16-19]. An important component of pay-it-forward is community connection and social responsibility, which may be more widely accepted in collectivist societies (such as China) compared with individualistic societies (such as the USA and Canada).[30] Unlike in countries like the USA, where informal distribution of prescription medications is strictly prohibited, access to antibiotics is relatively unregulated in China, making social network distribution of doxy-PEP legally and logistically possible. This three-arm RCT will be the first trial to evaluate the impact of pay-it-forward and social network distribution on doxy-PEP uptake and incidence of STIs. This trial will also be the first evaluation of an intervention to optimise doxy-PEP implementation in an LMIC.

Antimicrobial resistance (AMR) is a potential risk of population-level doxy-PEP use.[31 32] East Asia is a region with high rates of bacterial STI AMR, and novel highly-resistant *N. gonorrhoeae* strains and tetracycline-resistant chlamydia species have previously emerged in China.[33 34] Our RCT will collect data on *N. gonorrhoeae* and *C. trachomatis* AMR using both culture and PCR tests to detect common resistance genes. This will provide important information on both the efficacy of doxy-PEP in LMICs with high baseline rates of AMR as well as the potential for doxy-PEP use to contribute to emerging resistance.

There are several important limitations to this trial. First, the sexual health CBOs selected for participation in this trial were not randomly sampled. Locations with larger MSM communities were selected to facilitate recruitment, and CBO partners were selected based on previous experiences implementing research studies with complex protocols. Consequently, people recruited for enrolment in this trial may not be representative of all MSM and TGW in China, limiting generalisability of results. Second, behavioural outcomes, including doxy-PEP use, will be self-reported, which may introduce social desirability bias. All surveys will be self-administered to reduce the impact of social desirability bias. The self-reported nature of study outcomes may also introduce recall bias as participants randomised to the pay-it-forward arms may more readily recall doxy-PEP use due to social reinforcement from the intervention. Lastly, the follow-up time in this study will be only 6 months. Few incident STIs may be detected during such a short follow-up period, which will limit our ability to determine the impact of the intervention on STI incidence. Instead, the primary outcome in this study will be doxy-PEP use after condomless anal or oral sex, an important intermediate outcome for the prevention of STI.

ETHICS AND DISSEMINATION

The study has been reviewed and approved by the ethics review committee of the Dermatology Hospital of Southern Medical University (approval number: 2023109) and registered on the ChiCTR platform (https://www.chictr.org.cn/showproj.html?proj=203098, ChiCTR2300074903) on 18 August 2023. Informed consent will be obtained from all participants and signed electronically prior to enrolment in the study. The results will be submitted for publication to an international, peer-reviewed journal, regardless of whether the results are positive or negative in relation to the study hypothesis.

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REFERENCES

1 Unemo M, Bradshaw CS, Hocking JS, *et al*. Sexually transmitted infections: challenges ahead. *Lancet Infect Dis* 2017;17:e235–79.
2 Chow EPF, Grulich AE, Fairley CK. Epidemiology and prevention of sexually transmitted infections in men who have sex with men at risk of HIV. *Lancet HIV* 2019;6:e396–405.
3 Chen X-S, Peeling RW, Yin Y-P, *et al*. The epidemic of sexually transmitted infections in China: implications for control and future perspectives. *BMC Med* 2011;9:1–8.
4 Chen G, Cao Y, Yao Y, *et al*. Syphilis incidence among men who have sex with men in China: results from a meta-analysis. *Int J STD AIDS* 2017;28:170–8.
5 Ramchandani MS, Golden MR. Confronting Rising STIs in the Era of PrEP and Treatment as Prevention. *Curr HIV/AIDS Rep* 2019;16:244–56.
6 Soriano V, Romero JD. Rebound in Sexually Transmitted Infections Following the Success of Antiretrovirals for HIV/AIDS. *AIDS Rev* 2018;20:187–204.
7 Maynard MA, Chan PA. Implementation of Sexually Transmitted Infection Chemoprophylaxis in the United States. *Sex Transm Dis* 2023;50:185–7.
8 Luetkemeyer AF, Donnell D, Dombrowski JC, *et al*. Postexposure Doxycycline to Prevent Bacterial Sexually Transmitted Infections. *N Engl J Med* 2023;388:1296–306.
9 Molina J-M, Charreau I, Chidiac C, *et al*. Post-exposure prophylaxis with doxycycline to prevent sexually transmitted infections in men who have sex with men: an open-label randomised substudy of the ANRS IPERGAY trial. *Lancet Infect Dis* 2018;18:308–17.
10 Bolan RK, Beymer MR, Weiss RE, *et al*. Doxycycline prophylaxis to reduce incident syphilis among HIV-infected men who have sex with men who continue to engage in high-risk sex: a randomized, controlled pilot study. *Sex Transm Dis* 2015;42:98–103.
11 California Department of Public Health. Doxycycline post-exposure prophylaxis (doxy-PEP) for the prevention of bacterial sexually transmitted infections (STIs). 2023. Available: https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/CDPH-Doxy-PEP-Recommendations-for-Prevention-of-STIs.pdf
12 San Francisco Department of Public Health. San Francisco ends public health emergency on MPX on October 31, advances new tool to prevent other sexually transmitted infections. 2022. Available: https://www.sfcityclinic.org/sites/default/files/2022-10/MPX%20Emergency%20Declaration%20and%20Doxy-PEP%20Statement_EMB.1.pdf
13 Sankaran M, Glidden D, Kohn R, *et al*. Doxy-pep associated with declines in chlamydia and syphilis in MSM and trans women in San Francisco. Conference on Retroviruses and Opportunistic Infections (CROI), 3-6 March 2024, Denver, Colorado; 2024
14 Zhang X, Qi S-Z, Du F-Z, *et al*. Awareness and willingness to accept syphilis chemoprophylaxis among men who have sex with men from three cities in China: a cross-sectional study. *BMC Public Health* 2022;22:1926.
15 Hornuss D, Mathé P, Usadel S, *et al*. Already current practice? A snapshot survey on doxycycline use for prevention of sexually transmitted infections in parts of the German MSM community. *Infection* 2023;51:1831–4.
16 Yang F, Zhang TP, Tang W, *et al*. Pay-it-forward gonorrhoea and chlamydia testing among men who have sex with men in China: a randomised controlled trial. *Lancet Infect Dis* 2020;20:976–82.
17 Li KT, Tang W, Wu D, *et al*. Pay-it-forward strategy to enhance uptake of dual gonorrhea and chlamydia testing among men who have sex with men in China: a pragmatic, quasi-experimental study. *Lancet Infect Dis* 2019;19:76–82.
18 Tang W, Zhang Y, Li J, *et al*. Pay-it-forward to increase testing for hepatitis b and c: a community-led randomized controlled trial in china. *In Review* [Preprint] 2022.
19 Zhang Y, Li J, Xie Y, *et al*. Pay-it-forward incentives for hepatitis virus testing in men who have sex with men: a cluster randomized trial. *Nat Med* 2023;29:2241–7.
20 Lightfoot MA, Campbell CK, Moss N, *et al*. Using a Social Network Strategy to Distribute HIV Self-Test Kits to African American and Latino MSM. *J Acquir Immune Defic Syndr* 2018;79:38–45.
21 World Health Organization. WHO recommends social network-based HIV testing approaches for key populations as part of partner services package: policy brief. 2019.
22 Centers for Disease Control & Prevention (CDC. Guidance on the use of expedited partner therapy in the treatment of gonorrhea. U.S. Department of Health and Human Services; 2013.18987617.
23 Leask CF, Sandlund M, Skelton DA, *et al*. Framework, principles and recommendations for utilising participatory methodologies in the co-creation and evaluation of public health interventions. *Res Involv Engagem* 2019;5:2.
24 Fitzpatrick T, Tang W, Mollan K, *et al*. A crowdsourced intervention to promote hepatitis B and C testing among men who have sex with men in China: A nationwide online randomized controlled trial. *EClinicalMedicine* 2019;16:64–73.
25 National Center for STD Control, Chinese Center for Disease Control and Prevention; Venereology Group, Chinese Society of Dermatology; Subcommittee on Venereology, China Dermatologist Association. Guidelines for diagnosis and treatment of syphilis, gonorrhea, and genital Chlamydia trachomatis infection. *Chin J Dermatol* 2020;32:168–79.
26 Storm M, Gustafsson I, Herrmann B, *et al*. Real-time PCR for pharmacodynamic studies of Chlamydia trachomatis. *J Microbiol Methods* 2005;61:361–7.
27 Joseph L. Fleiss BL, Paik MC. Statistical methods for rates and proportions. 3rd edition. Hoboken: Wiley, 2003.
28 Stokes ME, Davis CS, Koch GG. Categorical data analysis using SAS: SAS institute, 2012. Available: https://vb3lk7eb4t-search-serialssolutions-com.libproxy.lib.unc.edu/?ctx_ver=Z39.88-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rfr_id=info%3Asid%2Fsummon.serialssolutions.com&rft_val_fmt=info%3Aofi%2Ffmt%3Akev%3Amtx%3Abook&rft.genre=book&rft.title=Categorical+Data+Analysis+Using+SAS%2C+Third+Edition&rft.au=Stokes%2C+Maura+E&rft.au=Davis%2C+Charles+S&rft.au=Koch%2C+Gary+G&rft.date=2012-07-31&rft.pub=SAS+Institute&rft.isbn=9781607646648&rft.externalDocID=9781612900902
29 Fuqua V, Chen Y-H, Packer T, *et al*. Using social networks to reach Black MSM for HIV testing and linkage to care. *AIDS Behav* 2012;16:256–65.
30 Li KT, Huang W, Tang W, *et al*. A Secondary Mixed Methods Analysis of a Pay-it-Forward Gonorrhea/Chlamydia Testing Program Among Men Who Have Sex With Men in China. *Sex Transm Dis* 2020;47:395–401.

31 Kong FYS, Kenyon C, Unemo M. Important considerations regarding the widespread use of doxycycline chemoprophylaxis against sexually transmitted infections. *J Antimicrob Chemother* 2023;78:1561–8.
32 Gestels Z, Manoharan-Basil SS, Kenyon C. Doxycycline post exposure prophylaxis could select for cross-resistance to other antimicrobials in various pathogens: An in silico analysis. *Int J STD AIDS* 2023;34:962–8.
33 Zhu X, Xi Y, Gong X, *et al*. Ceftriaxone-Resistant Gonorrhea - China, 2022. *MMWR Morb Mortal Wkly Rep* 2024;73:255–9.
34 Li M, Zhang X, Huang K, *et al*. Presence of Chlamydia trachomatis and Mycoplasma spp., but not Neisseria gonorrhoeae and Treponema pallidum, in women undergoing an infertility evaluation: high prevalence of tetracycline resistance gene tet(M). *AMB Express* 2017;7:206.